THE

HYDROPATHIC ENCYCLOPEDIA:

A SYSTEM OF

HYDROPATHY AND HYGIENE.

In Eight Parts:

I. OUTLINES OF ANATOMY, ILLUSTRATED.
II. PHYSIOLOGY OF THE HUMAN BODY.
III. HYGIENIC AGENCIES, AND THE PRESERVATION OF HEALTH.
IV. DIETETICS AND HYDROPATHIC COOKERY.
V. THEORY AND PRACTICE OF WATER-TREATMENT.
VI. SPECIAL PATHOLOGY AND HYDRO-THERAPEUTICS, INCLUDING THE NATURE, CAUSES, SYMPTOMS, AND TREATMENT OF ALL KNOWN DISEASES.
VII. APPLICATION TO SURGICAL DISEASES.
VIII. APPLICATION OF HYDROPATHY TO MIDWIFERY AND THE NURSERY.

DESIGNED AS

A GUIDE TO FAMILIES AND STUDENTS,

AND A TEXT-BOOK FOR PHYSICIANS.

BY R. T. TRALL, M.D.

With Numerous Engraved Illustrations.

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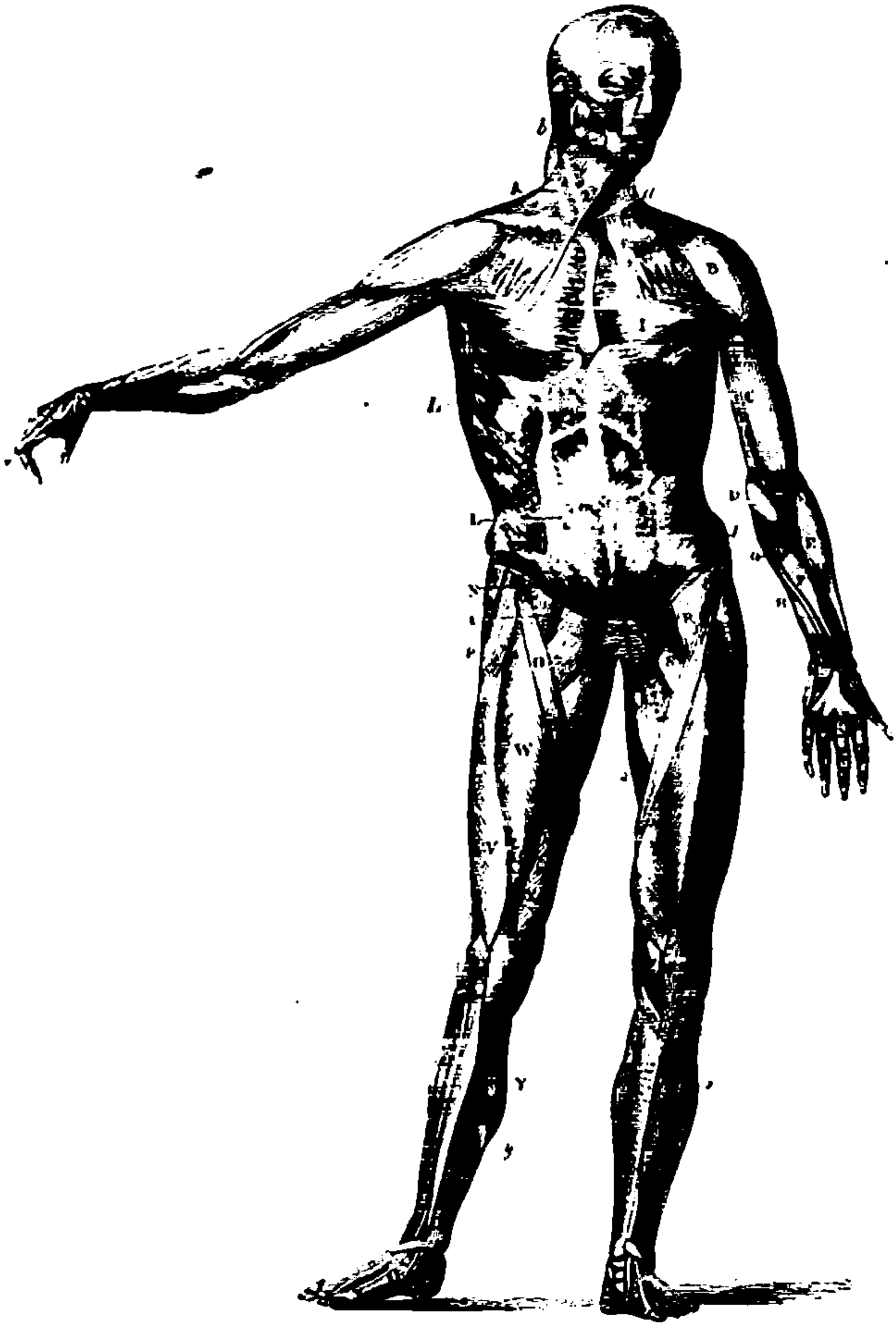
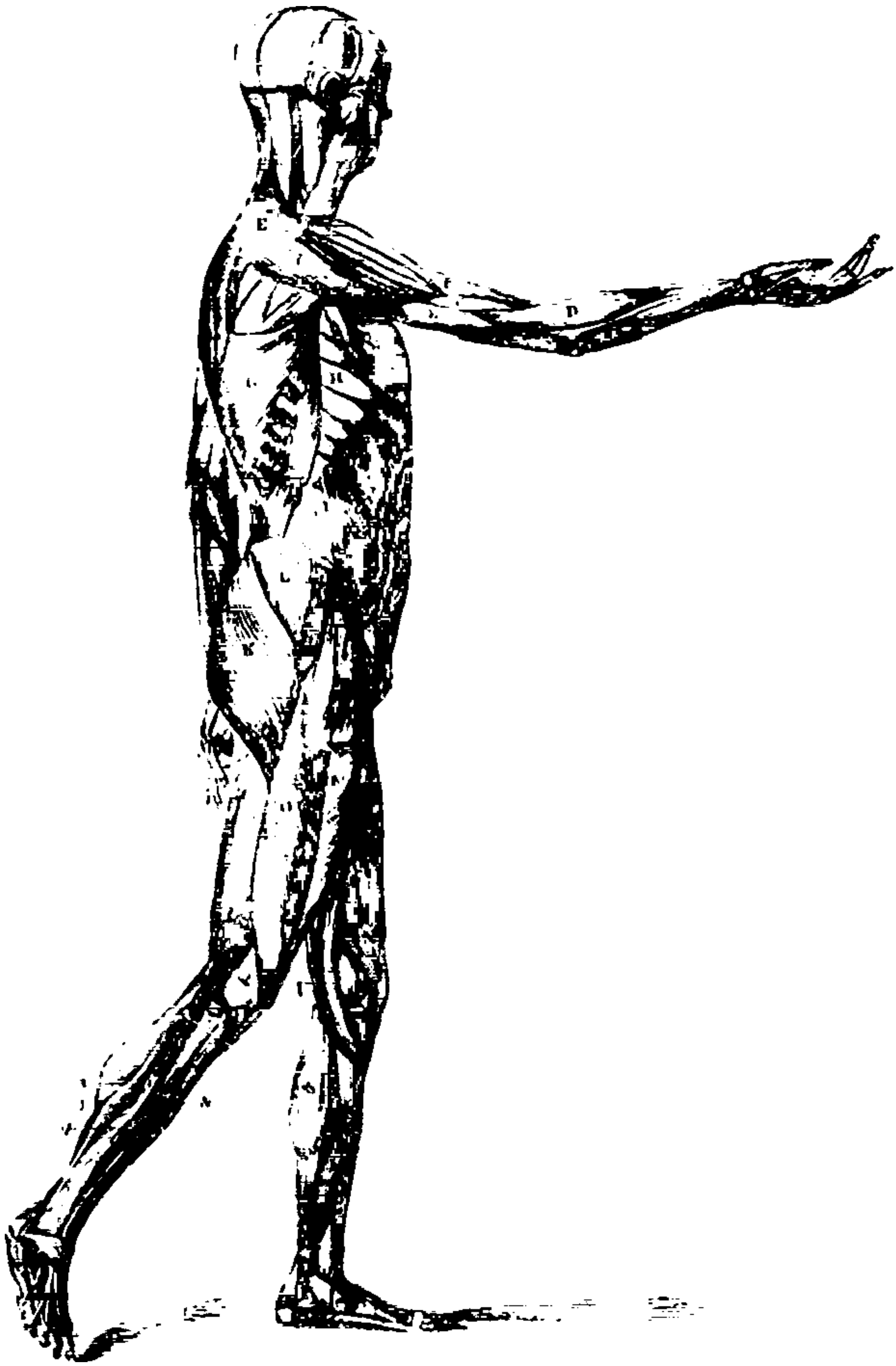


MUSCLES OF THE FRONT FIGURE.

MUSCLES OF THE FRONT FIGURE.

A PLATISMA MYOIDES—broad muscle of the neck.
a STERNO-HYOIDEUS—muscle between the breast and tongue bones.
b MASTOIDEUS—mastoid muscle.
B DELTOIDES—the muscle covering the shoulder-joint.
C BICEPS BRACHII—two-headed muscle of the arm.
D PRONATOR RADII TERES—pronating muscle of the arm.
E SUPINATOR RADII LONGUS—supinating muscle of the arm.
F FLEXOR CARPI RADIALIS—radial flexor of the wrist.
G PALMARIS LONGUS—long bending muscle of the hand.
H FLEXOR CARPI ULNARIS—ulnar flexor of the wrist.
I PECTORALIS MAJOR—large muscle of the chest.
K OBLIQUUS DESCENDENS—oblique descending muscle.
L L RECTUS—straight muscle.
L LINEA SEMILUNARIS—semilunar line.
M LINEA ALBA—white line.
N POUPART'S LIGAMENT—Poupart's ligament.
O O SARTORIUS—the "tailor's muscle."
P TENSOR VAGINÆ FEMORIS—stretcher of the fascia lata.
U PSOAS MAGNUS—large lumbar muscle.
V VASTUS EXTERNUS—great external muscle.
W RECTUS FEMORIS—straight femoral muscle.
X VASTUS INTERNUS—great internal muscle.
Y GASTROCNEMIUS—muscle of the calf of the leg.
y SOLEUS—a broad flat muscle of the leg.
Z TIBIALIS ANTICUS—anterior muscle of the leg.



MUSCLES OF THE SIDE FIGURE.

MUSCLES OF THE SIDE FIGURE.

A DELTOIDES—muscle covering the shoulder-joint.

B BICEPS BRACHII—two-headed muscle of the arm.

C BRACHIALIS INTERNUS—internal muscle of the arm.

D SUPINATOR RADII LONGUS—long supinator of the radius.

E TRICEPS—three-headed muscle.

F TRAPEZIUS—trapezium-shaped muscle.

G LATISSIMUS DORSI—lateral muscle of the back.

H SERRATUS MAJOR ANTICUS—large serrated anterior muscle.

I OBLIQUUS DESCENDENS EXTERNUS—external oblique descending muscle.

K GLUTÆUS MAXIMUS—largest thigh muscle.

L GLUTÆUS MEDIUS—middle-sized thigh muscle.

M RECTUS FEMORIS—straight muscle of the thigh.

N VASTUS INTERNUS—great internal muscle.

O VASTUS EXTERNUS—great external muscle.

P TENDONS OF THE SEMIMEMBRANOSUS AND SEMITENDINOSUS MUSCLES, forming the inner hamstring.

Q TENDON OF THE BICEPS FEMORIS, forming the outer hamstring.

R ILLACUS INTERNUS—internal iliac muscle.

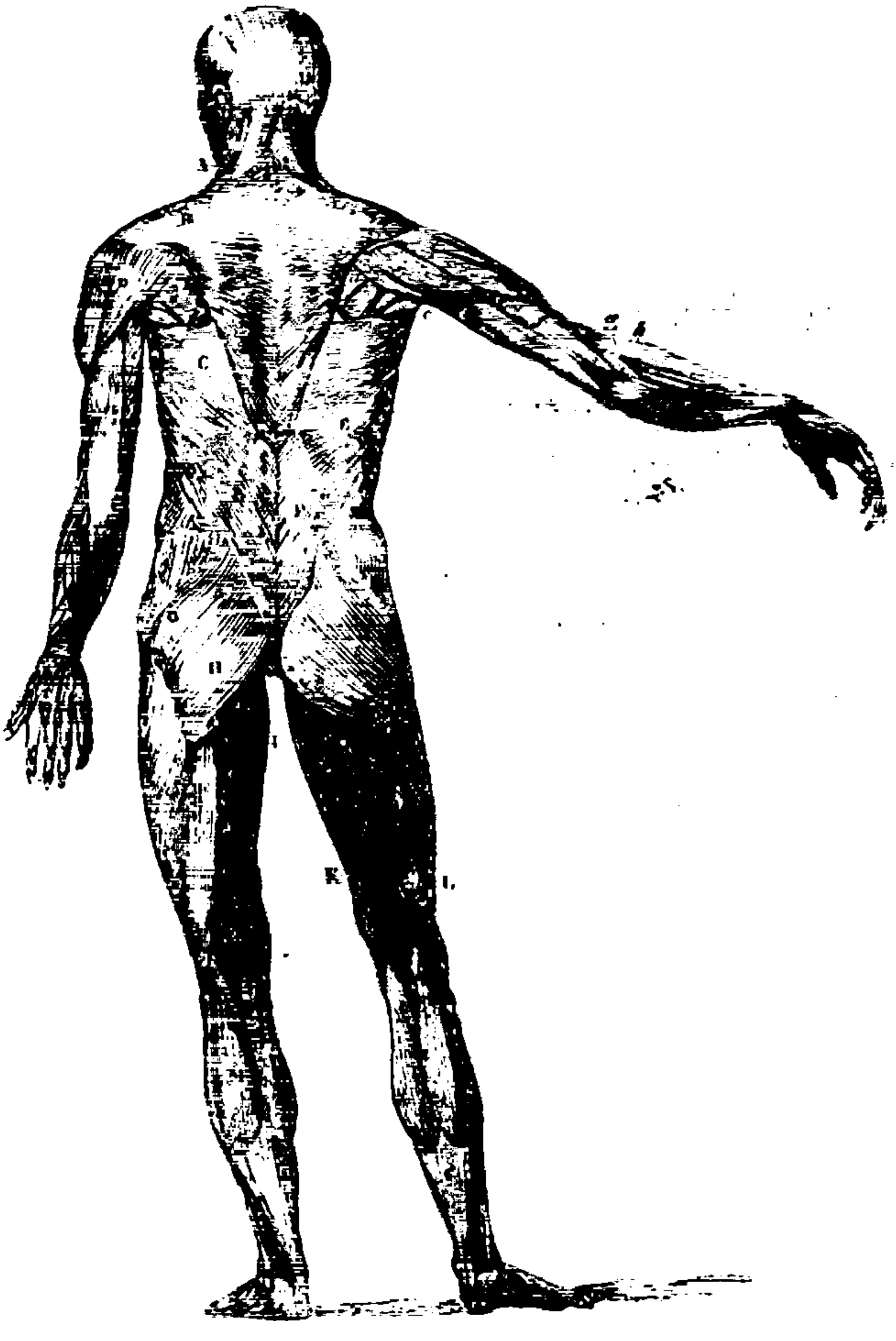
S GASTROCNEMIUS EXTERNUS—external muscle of the calf.

T SOLEUS—a broad flat muscle of the leg.

U PERONEUS TERTIUS—fibular muscle of the leg.

V EXTENSOR LONGUS DIGITORUM PEDIS—long extensor muscle of the toes.

W TIBIALIS ANTICUS—anterior muscle of the leg.



MUSCLES OF THE BACK FIGURE.

MUSCLES OF THE BACK FIGURE.

A MASTOIDEUS—mastoid muscle.

B TRAPEZIUS—trapezium-shaped muscle.

a INFRA SPINATUS—the muscle beneath the spine of the scupula.

b TERES MINOR—long round smaller muscle.

c TERES MAJOR—long round larger muscle.

C LATISSIMUS DORSI—lateral muscle of the back.

D DELTOIDES—muscle covering the shoulder-joint.

f TRICEPS BRACHIALIS—three-headed muscle of the arm.

g ANCONEUS—muscle of the elbow.

h EXTENSOR CARPI RADIALIS LONGUS—long radial extensor of the wrist.

E SACRO LUMBALIS—muscle of the sacrum and loins.

F LONGISSIMUS DORSI—long muscle of the back.

G GLUTÆUS MEDIUS—middle-sized muscle of the thigh.

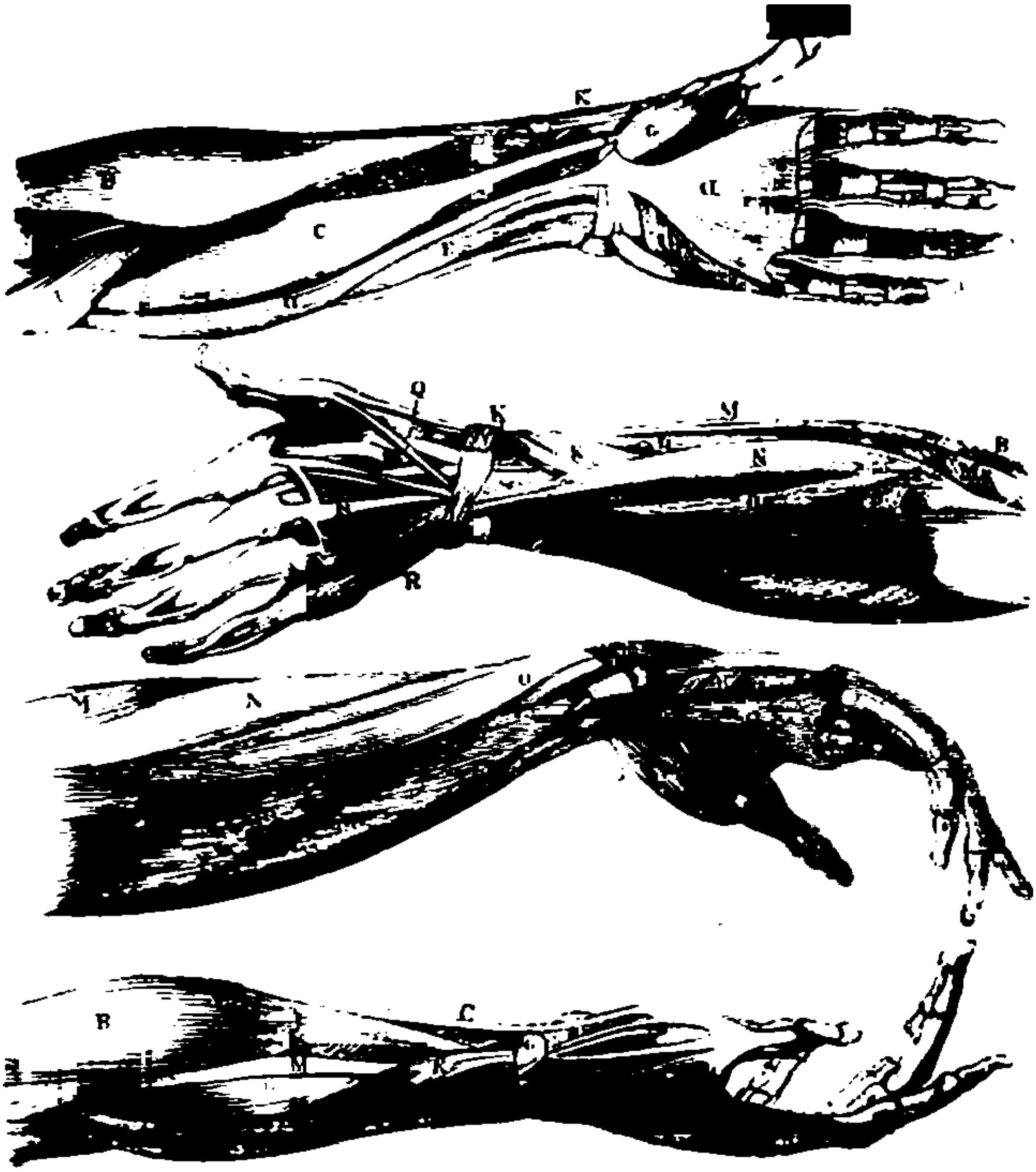
H GLUTÆUS MAXIMUS—largest muscle of the thigh

I SEMITENDINOSUS—half-tendinous muscle.

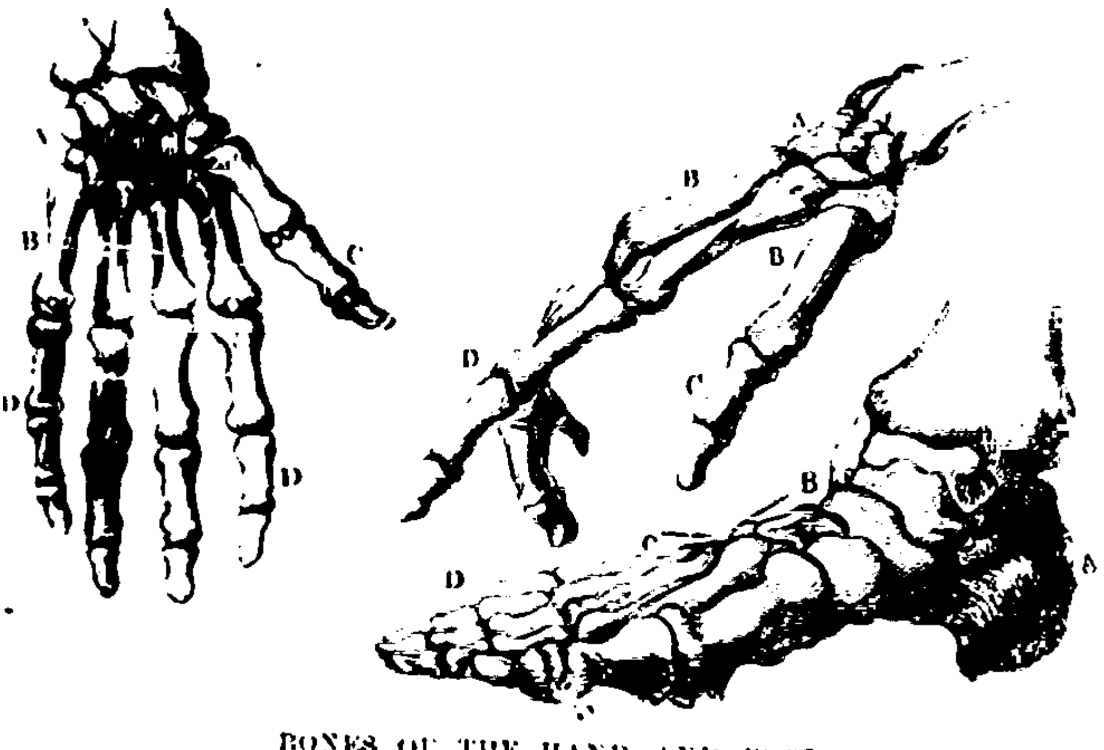
K SEMIMEMBRANOSUS—half-membranous muscle.

L BICEPS FEMORIS—two-headed thigh muscle.

M GASTROCNEMIUS EXTERNUS—external muscle of the calf.



MUSCLES OF THE FOREARM AND HAND



BONES OF THE HAND AND FOOT.

MUSCLES OF THE FORE-ARM AND HAND.

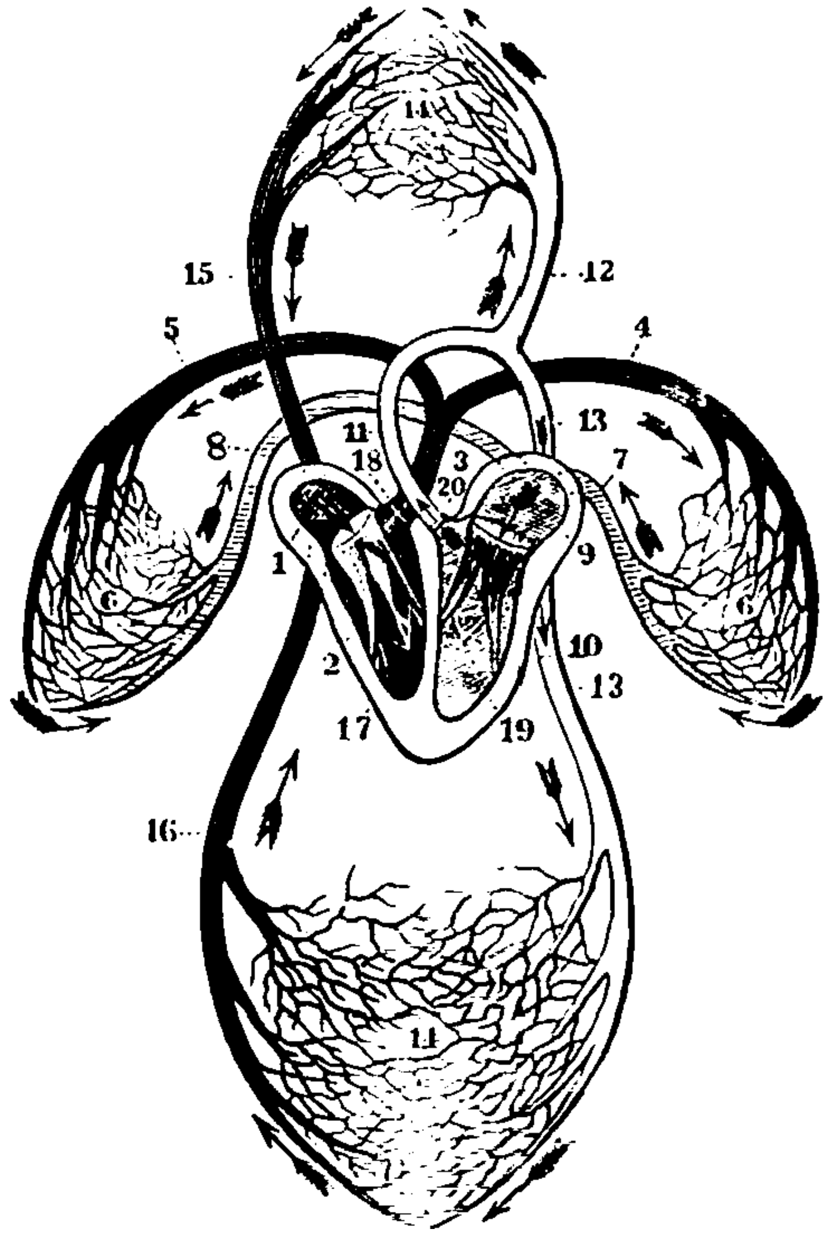
A PRONATOR TERES—long round pronator muscle.
B SUPINATOR RADII LONGUS—long radial supinator.
C FLEXOR CARPI RADIALIS—radial flexor of the wrist.
D PALMARIS LONGUS—long muscle of the palm.
E PERFORATUS, & PERFORANS—perforated, and perforating muscles.
G ABDUCTOR POLLICIS MANUS—abductor of the thumb.
H PALMARIS BREVIS—short muscle of the palm.
K EXTENSOR POLLICIS—extending muscle of the thumb.
K EXTENSOR PRIMI INTERNODII—extensor of the first finger.
L EXTENSOR CARPI RADIALIS BREVIS—short radial extensor of the wrist.
M EXTENSOR CARPI RADIALIS LONGUS—long radial extensor of the wrist.
N EXTENSOR DIGITORUM—extensor of the fingers.
O EXTENSOR CARPI ULNARIS—ulnar extensor of the wrist.
P ANCONEUS—muscle of the elbow.
Q EXTENSOR SECUNDI INTERNODII—supinator and extensor of the thumb.
R EXTENSOR MINIMI DIGITI—extensor of the little finger.
S FLEXOR CARPI ULNARIS—ulnar flexor of the wrist

BONES OF THE HAND.

A CARPUS—bones of the wrist.
B METACARPUS—bones of the hand.
C DIGITUS PRIMUS—bones of the thumb
D PHALANGES—bones of the fingers.

BONES OF THE FOOT.

A OS CALCIS—heel-bone.
B TARSUS—bones of the instep.
C METATARSUS—bones of the foot.
D PHALANGES—bones of the toes.



PURIFICATION OF THE BLOOD.

PURIFICATION OF THE BLOOD.

The figure is an ideal view of the circulation in the lungs and system. From the right ventricle of the heart (2), the dark, impure blood is forced into the pulmonary artery (3), and its branches (4, 5) carry the blood to the left and right lung. In the capillary vessels (6, 6) of the lungs, the blood becomes pure, or of a red color, and is returned to the left auricle of the heart (9) by the veins (7, 8). From the left auricle the pure blood passes into the left ventricle (10). By a forcible contraction of the left ventricle of the heart, the blood is thrown into the aorta (11). Its branches (12, 13, 13) carry the pure blood to every organ or part of the body. The divisions and subdivisions of the aorta terminate in capillary vessels, represented by 14, 14. In these hair-like vessels the blood becomes dark colored, and is returned to the right auricle of the heart (1) by the vena cava descendens (15) and vena cava ascendens (16). The tricuspid valves (17) prevent the reflow of the blood from the right ventricle to the right auricle. The semilunar valves (18) prevent the blood passing from the pulmonary artery to the right ventricle. The mitral valves (19) prevent the reflow of blood from the left ventricle to the left auricle. The semilunar valves (20) prevent the reflow of blood from the aorta to the left ventricle.

To effect the complete purification of the whole mass of blood, in an adult of ordinary size, requires a pint of atmospheric air to be taken into the lungs at each inspiration; and as the usual number of inspirations is about eighteen per minute, the daily supply amounts to three thousand two hundred and forty gallons, or one hundred and thirty-five gallons per hour.

PREFACE.

In the infancy of a system, so comprehensive in its principles and so multitudinous in its details as to embrace all the laws of hygiene, and all the facts of anatomy, physiology, and organic chemistry, it can hardly be expected that its literature will be otherwise than crude and incoherent.

Of the many valuable works extant on Water-Cure, no one embodies all the departments of science relating to the cure of disease and the preservation of health, into a consistent and philosophical system; nor do all of them together treat of, or even mention, the majority of subjects or diseases inseparably connected with, and forming parts of a complete plan of hydro-therapeutics.

In attempting to supply this desideratum, the author has, through the kindness and liberality of the publishers, been enabled to avail himself of nearly all that has been published in this country and Europe directly or remotely connected with Hydropathy, as well as an extensive range of private correspondence, and written but unpublished experience in domestic practice.

The great number of topics embraced in the scope of the work, rendered the utmost brevity of language indispensable; hence, in advancing new doctrinal propositions, and in controverting positions deemed erroneous, but little space was left for details and explanations.

For imperfections in style and arrangement, the only available apology is, the many cares incident to the medical direction of two hydropathic establishments during the whole time occupied in the preparation of the work.

New York, 15 *Laight Street*, 1852.

ANALYSIS OF THE CONTENTS.

INTRODUCTION.

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PART II.—PHYSIOLOGY

PART III.—HYGIENE.

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HYDROPATHIC ENCYCLOPEDIA.

INTRODUCTION.

Before the prevailing medical practice can be revolutionized, and a system introduced at variance with established usages—in direct antagonism with the general habits, customs, education, and prejudices of the people; in utter contempt of the teachings and practices of great and venerable names, and opposed to the pride, interest, reputation, and even conscientious convictions of a learned, honorable, and influential profession—the intelligent portion of the community will demand reasons the most profound and evidences the most conclusive, while the illiterate will require an accumulation of facts and details absolutely overwhelming.

The philosophy of life and health, the laws of the human organism, and its relations to surrounding nature, have been, in my judgment, already sufficiently demonstrated to satisfy the intellectual mind of the former class, and their application to the preservation of health and cure of disease amply demonstrated by actual experiment for the exercise of the faith of the latter class. All that seems necessary now, in order to achieve that great reform in human society, which shall restore to the individuals who compose it "sound minds in sound bodies," and that exalted state of happiness which human nature is susceptible of, even in this world, is, to commend these great truths to the thoughts and feelings of human beings in such a manner that they shall be exemplified in their lives.

A short sketch of the origin and progress of what is called medical science will exhibit the baseless fabric we are laboring to demolish; and a brief review of the history of bathing, as it has been employed remedially in all ages of the world, will prove that the Water-Cure, though in its infancy as a system of the healing art, has had, in all its essentia particulars, the sanction of the most learned men of all professions in all ages. These topics, therefore, present themselves as forming a pertinent introduction to this work.

Many of the historical data relative to these subjects are collected from Bostock's History of Medicine, and Bell's work on Baths and the Water Regimen. In the application and generalization of these data, and in relation to the principles to which they refer, I have, however. differed often and widely from these authors

HISTORY OF MEDICINE.

Writers generally agree that medicine first became a profession among the Egyptians. Its origin, however, is involved in fabulous and impenetrable obscurity. In Egypt and in most of the earlier nations the priests were the practitioners of the healing art; and unfortunate was it for the human race when medicine was "elevated to the dignity of a distinct profession." To me the priest appears to be the proper person to teach the body as well as the soul "the straight and narrow way." The functions of mind and body are so intimately related, all the powers of the one and organs of the other constantly acting and reacting on each other, that I cannot imagine how it is possible for the spiritual or physiological teacher to do full justice to man in either relation of his existence without understanding the laws of both. Nay, I would have the same person exercise the function of priest, doctor, lawyer, and schoolmaster; and that individual who can present to his fellow-creatures the most harmonious whole of a human being—who can best teach in theory, and most faithfully exemplify in practice, the laws of being in his moral, physiological, legal, and social relations, should belong to *the* learned profession and be a leader among men.

THE EARLIEST ANCIENT PHYSICIANS.—The Egyptian priests practiced the healing art by means of magical incantations, which, of course, produced their good or bad impressions through the medium of the imagination, the efficacy of their prescriptions bearing a pretty exact ratio to the superstition and credulity of their patients. The medical practice of the Assyrian priests consisted mainly of magical arts, while the actual learning they possessed was carefully concealed in a mystical technicality. Among the early Jews the priests, who were the physicians also, treated the leprosy and other diseases with various ceremonies to affect the imagination, at the same time enforcing judicious regulations to avoid the sources of contagion, and promote personal cleanliness.

THE EARLY GRECIAN PHYSICIANS.—In Greece the genius of Hippocrates first caused medicine to be regarded as a science, though Chiron, who lived about 1300 B.C., is accredited for having introduced the healing art to his countrymen. Æsculapius, a pupil of Chiron, is considered the first person who made medicine an *exclusive* study and practice. His sons, Machaon and Podalirius, are celebrated in Homer's Iliad for their medical skill, though, as they were employed principally as surgeons in the Greek armies, their medication was doubtless mostly confined to crude yet simple methods of dressing wounds and recent injuries, which were exceedingly common in that warlike age. The descendants of Æsculapius, called Asclepiadæ, were the priests of the temples; and the temples were the hospitals to which the sick were brought, where the priests performed numerous imposing ceremonies to inspire confidence, and gave various directions conducive to temperance, cleanliness, and simplicity of diet. The temples were located in the most salubrious places, and in them frequent ablutions were recommended for the sick; these were, no doubt, the real curative agencies.

We have no knowledge that Æsculapius, or his immediate successors, ever conceived the idea of curing diseases by drugs administered internally. Ablutions, bandages, fomentations, ointments, mechanical support, and the application of balsamic and astringent herbs, with the occasional use of wine or other stimulating substances, constituted their whole and their ample materia medica; and these were all employed *externally*.

THE DOGMATIC AND THE EMPIRICAL PHYSICIANS.—For several centuries succeeding the age of Æsculapius and his sons, we have no records that medicine made the least progress. Numerous temples were erected in honor of Æsculapius, who was deified as the god of medicine; and in these temples a practice obtained among the patients of recording on a tablet, for the benefit of others, a statement of their diseases and the means by which they were relieved, thus converting the temples into schools of medicine. But then there were men of superior sagacity and inordinate selfishness, who desired to turn the common knowledge to individual advantage. The temples of Cos and Gnidos became rival establishments. One assumed to be philosophical, by uniting reason with experience, while the other professed to be governed solely by facts and observations. Thus arose two medical sects—the Dogmatists and the Empirics, who long divided the medical world, and whose influence is not yet extinct, for we find at this day many physicians who follow wherever theory leads, regardless of facts or consequences; and another set of practitioners who are merely routine imitators, without a particle of pretension to any rational system.

Medical Philosophers.—Pythagoras, in the sixth century before Christ, was the pioneer of a class of scholars of general information and philosophical mind, who gave much attention to the investigation of the structures, functions, and diseases of the human body. He established a school at Crotona, to which students resorted from most parts of Greece and Italy. More than twenty years of his life were spent in Egypt, Chaldea, and Eastern Asia, and he prosecuted the study of comparative anatomy by dissecting animals. His pupils were not exclusively devoted to medical studies, but were among the men most celebrated for general erudition in that and in the succeeding age. Among the most illustrious of his followers were Democritus and Heraclitus, the former being regarded as the first person who attempted the dissection of a human subject. Acron is mentioned by Pliny as among the first who undertook to apply philosophical reasoning to medicine. Herodicus is considered the inventor of gymnastic exercises, which the Greeks regarded as an important branch of the healing art.

Hippocrates.—One of the most sagacious, observing, and industrious men that ever lived was the "Coan Sage," who has been entitled the "Father of Medicine." Hippocrates was a pupil of Herodicus, brought up among the Asclepiadæ, in the temple of Cos. He traveled much in foreign countries, devoting himself to the study and practice of medicine with untiring energy, and his works became text-books for many ages; even to this day his leading doctrines are extensively recognized. His practice has been called a rational empiricism; in other words, a careful observation of facts, and a reasoning process based upon their consequences. His first philosophical proposition regarded fire as the primitive source of all matter, the four elements being a result of the collision and combination of its ever-moving particles; and his leading physiological proposition was, the existence of a general presiding principle of vitality for the whole body, and a special vital power in each organ. If we substitute the modern term, electricity, for his "fire," and the modern phrases, organic sensibility, and special centre of organic perception, for what he calls "nature" and "power," we shall very nearly harmonize his ideas with those entertained by some of the ablest living physiologists. His doctrine that the fluids were the primary seat of disease was never disputed, save by some small factions of medical men, until about the commencement of the eighteenth century; and even now it has at least as many advocates as opponents. In his system the combinations of the four elements of fire, air, earth, and water, with their four qualities of hot, cold, moist, and dry, gave rise to the four humors of the body, blood, phlegm, bile, and black-bile, which originally tended to produce the four temperaments, and which in their turn contributed to the excess or defect of each of the humors. These speculations, crude and fanciful as they may be, at least indicate a powerful tendency in the mind to analyze and systematize.

The doctrine of crises originated with Hippocrates. He noticed that fevers evinced a tendency to terminate on particular days, which he called critical; and he observed that there is a tendency in all diseases to a cure by some eruption or evacuation. His practice was consistently founded on the indications presented by these phenomena. Modern physicians have been most unfortunate in overlooking or disregarding these fundamental truths, which happily are now being re-established by the water-treatment. His materia medica was derived wholly from the vegetable kingdom, the horrid chemicals, metallic salts and oxides, acids, and spirituous compounds, which have since "demonstrated the efficiency of our arms," in killing pain and patients, being then unknown. Purgatives, sudorifics, diuretics, and injections were his principal internal remedies, while externally he employed bleeding, issues, ointments, plasters, and liniments. The following extract from Bostock shows a remarkable congruity between the leading practical idea of Hippocrates, and the doctrine universally acted upon by hydropathic practitioners:

"The great principle which directed all his operations was the supposed operation of 'nature,' in superintending and regulating all the actions of the system. The chief business of the physician is to watch these operations, to promote or suppress them according to circumstances, and perhaps, in some rare cases, to attempt to counteract them. The tendency of this mode of practice would be to produce extreme caution, or rather inertness, on the part of the practitioner, and we accordingly find that Hippocrates seldom attempted to cut short any morbid action, or to remove it by any decisive or vigorous treatment. Considering the state of knowledge on all subjects when he lived, it must be admitted that this plan of proceeding was much more salutary than the opposite extreme, and that it had likewise the good effect of enabling the practitioner to make himself better acquainted with the phenomena of the disease, and, by observing the unaided efforts of nature, to form his indications with more correctness, and to determine to what object he ought more particularly to direct his attention."

It must be admitted that the bleedings, active purgatives, the sweatings and diuretics of the Hippocratean practice were inert compared with the more profuse bleedings of the moderns, and their hundreds of mineral poisons; but the constantly accumulating number of chronic diseases, and the greater fatality of acute, certainly favor the idea that our modern Æsculapians, though much *more powerful* doctors, are much *less successful* ones.

THE FIRST "IRREGULAR" PHYSICIAN.—Subsequent to the age of Hippocrates, medicine remained stationary for several centuries. His sons, Thessalus and Draco, his son-in-law Polybus, Diocles of Carystus, and Praxagoras of Cos, are the only names distinguished among his immediate successors. One of their contemporaries was a Dr. Chrysippus, who opposed bleeding and the employment of active purgatives; he was, however, regarded as a sort of "irregular," who did not pay due deference to the authority of great names.

Plato and Aristotle, like most of the ancient Greek philosophers, were conversant with the medical doctrines of their day, though not practicing physicians. The latter published the first works on anatomy and physiology, and all his writings, though full of refined vagaries, held a strong influence over the public mind for many centuries after his death.

THE ALEXANDRIAN SCHOOL.—The Ptolemies founded a medical school at Alexandria about 300 B.C. The most famous of its professors were Erasistratus and Herophilus, who dissected bodies of criminals obtained of government. Erasistratus, having been a pupil of Chrysippus, adopted his opinions against bleeding and violent remedies, professing to trust nature more and art less. Herophilus paid particular attention to the action of the heart, and was the first to give any thing like an accurate description of the various kinds of pulse.

Soon after the institution of the Alexandrian school a division of medical men occurred, by which the practice of physicians proper, or dietetics, and druggists, and surgeons, became distinct vocations; and not long after this event the great schism occurred which divided medical men into two sects, the Dogmatists and Empirics, already mentioned. All the medical men of the day, and for several succeeding ages, were attached to one or the other of these rival parties.

THE REGULARS BANISHED FROM ROME.—After the decline of Grecian literature, medicine, as a distinct pursuit, made no progress for a long time. During the warlike days of Rome, she was, for six hundred years, without a physician who made the healing art a profession. The superstitions and ceremonies of the Greeks were transoorted to Rome, and plagues and other epidemics were attempted to be stayed by such rites as would propitiate the offended deities. Pliny states that about two hundred years before the Christian era, the first regular physician, by the name of Arcagathus, established himself as a practitioner at Rome. He was received at first by the people with respect and even reverence, but so severe was his practice, and so unsuccessful its results, that disgust succeeded admiration, and caused the citizens to prohibit the practice by law, and banish its professors from the land.

About a century after, Asclepiades, of Bithynia, a pupil of Epicurus, went to Rome as a teacher of rhetoric. Being unsuccessful, he turned his attention to medicine, by which he acquired great popularity. His practice was very mild and cautious, and as he denounced with vehemence the harsh measures of some of his predecessors, he was then regarded by his contemporaries, and is now by medical historians, as a sort of irregular, or quack. He was the first to arrange diseases into the classes of acute and chronic. His pupil, Themison, of Laodicea, founded a third medical sect, called the Methodic, who adopted a kind of eclectic system, combining parts of the systems of the Dogmatists and Empirics. Like his master, his philosophical notions were mainly derived from Epicurus. Diseases he referred to states of contraction and relaxation, and remedies were divided into two classes, astringents and relaxants. The Methodic theory regards the solids as the primary seat of disease, thus opposing directly the Hippocratic doctrine, or humoral pathology.

THE FIRST HEROIC PRACTITIONER.—The next individual of note whose discoveries or vagaries have had an important bearing on medical practice was Thessalus, who lived half a century later than Themison. By pompous pretensions, swelling self-sufficiency, and abundant cunning, he acquired great reputation and wealth; he treated all his predecessors and contemporaries with the utmost contempt, and even took to himself the modest title of the Conqueror of Physicians. He introduced a new method of medical treatment, called *metasynocrisis*, which, unhappily for mankind, has been too much followed by the medical world. It consisted in producing an entire change in the state of the body, instead of merely regulating, correcting, and removing morbid actions and symptoms after the Hippocratic plan. It may possibly startle the non-medical reader to be informed that a principle so manifestly absurd, and promulgated by its author or fabricator for no other purpose than to get gold and fame, was generally adopted by subsequent medical writers, and is now the principal corner-stone of orthodox medical practice. Until the advent of Thessalus, the physicians were content to study the indications of nature, aid and assist her efforts, and remove obstacles in her way. Since his time faith in the integrity of nature has steadily declined, and reliance on the power of art as steadily advanced, until we behold a body of learned professors of the healing art sending the most deadly and destructive agents to ravage within the domain of vitality, heedless of, or faithless to, the great truth that nature, and nature alone, is the true physician.

Soranus and C. Aurelianus are the next Roman physicians of celebrity. They were strict Methodics, and their writings did much to dvance the particular notions which they had imbibed; their remedial neasures were, however, very mild, and hence generally successful. But it is worthy of especial remark, as evidence of the powerful influence of a preconceived theory over the exercise of judgment, that modern writers, who have generally adopted the heroic notions of Thessalus, condemn the practice of these Methodics for its want of vigor and promptness. Its success was no argument in its favor so long as it wanted power! Abstinence, the bath, frictions, and external applications were their leading remedial measures. Topical bleeding was also employed, though general blood-letting was rarely resorted to; narcotics and oleaginous applications were frequently used, and great attention paid to pure air; sometimes a moist air was enjoined.

The Pneumatics and Eclectics.—During the first two centuries of the Christian era the Methodic sect prevailed, yet the peculiar speculations of different individuals were gradually introduced, causing at length the formation of several subdivisions, or new sects, of medical practitioners, the most prominent of which were the Pneumatics and the Eclectics, or Episynthetics. Pneumatology and eclecticism are not therefore quite as modern notions as many have supposed.

The Pneumatics evidently had a glimpse of the true idea of vitality, yet were incapable of expressing it rationally. They taught that the human body was composed of solids, fluids, and spirits. Their ideas of the spiritual agency in the production and cure of disease were strikingly analogous to the modern doctrine of the nervous influence. The most eminent writer of this sect was Aretæus. His practice was more active and less expectant than that of the Methodics.

The most celebrated of the Eclectics was Archigenes, of Appamea, who practiced at Rome in the time of Trajan. His writings are extremely obscure and chimerical, yet he acquired great popularity and influence; perhaps he is as much indebted to the unintelligible character of his works as to any other circumstance for his fame.

Celsus is the first native Roman physician of whom we have any account. He wrote several books on medicine, which show that surgery and pharmacy had made considerable progress. It is difficult to class him with either of the sects of his day; in practice he pursued mainly the method of the Asclepiades. His origin, or the age in which he lived, are not precisely known, though it is conjectured that he lived in the reigns of Augustus and Tiberius.

THE FIRST PHARMACOPŒIA.—In the reigns of Claudius and Nero a class of writers became famous by their pharmaceutical preparations. The most notorious among them were Scribonius Largus, who made a book of nostrums and indiscriminate formulæ, and Andromachus, who compounded a medicamentum of sixty-one ingredients. It was called the *theriaca*, and its most essential constituent, from which its name was derived, was the dried flesh of vipers! This preparation has since been recommended, by regular physicians, for almost every known disease, and was even retained in the pharmacopœias of the schools until the beginning of the present century. In fact, the cod-liver oil of this day has not been a greater hobby with modern physicians, than with the ancients was the viperous compound of Andromachus, who, for his marvelous learning and skill in mixing together the most incongruous articles in the most nonsensical manner, was honored with the title of Archiator, or Principal Physician—a title bestowed by the Roman emperors, and continued for several centuries.

Pliny, though not practically a medical man, was, nevertheless, familiar with all that was taught on the subject in his time. He represents the prevailing practice as essentially empirical, consisting of various vegetable and animal mixtures, administered with scarcely any inquiry whatever into their mode of operation.

Dioscorides was a distinguished author at the same period. An elaborate treatise which he wrote on materia medica was the standard production for many ages subsequently. It contains descriptions of all articles then employed in medicine, with an account of their supposed virtues, much more curious, however, than useful.

GALEN.—The name and history of Galen are more familiar to modern practitioners of the healing art than are any other ancient physicians. Thoroughly educated in all the schools of philosophy, he selected from them all, except the Epicurean, which he totally rejected. He was a native of Pergamus, but, after traveling extensively, at the request of the Emperor Aurelius, settled in Rome. His works number nearly two hundred treatises on all subjects directly or remotely connected with medicine. In the formation of opinions he was entirely independent, paying very little respect to authority; and so great was the reputation he acquired for learning, skill, and wisdom, that his opinions were regarded by many as oracles. In theory he was with the Dogmatists, and in practice he professed to venerate and act upon the principles of Hippocrates.

In Galen's time the Roman empire began to decline; and the general decay of science and literature in the middle ages succeeding, has left little to record in the shape of innovation. Sprenzel has pithily characterized the medical writers of the third and fourth centuries as "frigid compilers, or blind empirics, or feeble imitators of the physician of Pergamus." Oribasius, who lived in the fourth century, Aëtius in the fifth, and Alexander Trallianus and Paulus Ægina in the sixth, wrote books which professed but little more than to be compilations of, and commentaries on, the works of Galen

THE ARABIAN SCHOOL.—With the death of Paulus, about the middle of the seventh century, terminated the Greek school of medicine. The Arabians, who conquered a large portion of the semi-civilized world, destroyed the immense Alexandrian library, yet the Arabian physicians had adopted the opinions of Galen, and followed his practice implicitly. But a new school soon arose among them, owing to the invention of chemistry, and its being made subservient to medicine. One of the most celebrated Arabian physicians was Rhazes, born at Irak, in Persia, in the ninth century. His writings, though mostly comments on Galen and the Greek physicians, contain an original and elaborate treatise on the theory and treatment of small-pox and measles. In his writings on surgery and pharmacy are found indications of the employment of chemical remedies, which formed so important and so disastrous an era in medical history soon after.

After Rhazes flourished Ali Abbas, a physician and writer, who obtained the title of magician; and about a century later appeared on the stage Avicenna, who acquired a reputation among his countrymen not inferior to that of Galen. He was born at Bokhara, A.D. 980, and was carefully educated in the schools of Bagdat. His published works were numerous, and his "Canon Medicinæ," a kind of encyclopœdia of existing medical sciences, was the text-book in most of the Arabian, and even European, schools for several centuries.

Mesue the elder, Mesue the younger, and Albucasis were among the last Arabians of distinction who wrote much on medical subjects. Avenzoar, and his pupil Averroes, natives of Spain, wrote voluminously in the Arabic language, and enjoyed great celebrity, but their works have added nothing substantial to those of their predecessors.

With Averroes terminated the Arabic or Saracenic school of medicine, the great reputation of which is mainly owing to the circumstance that, from the eighth to the twelfth centuries, when all Europe was sunk in deep barbarism, the principal remains of a taste for literature and science existed among the Moors and Arabs. Medical historians give the Arabians credit for having added many vegetable products, and a few metallic salts and oxides, to the catalogue of remedies. The spirit of the age, then, among those eminent in the profession—not unlike the spirit of the present day—was that of emulation in writing the greatest number of books, and finding out new substances which could be taken into the stomach and applied externally, and called medicines. The intelligent reader will not fail to perceive that thus far, in medical history, the merit of successful practice, amid all the conflicting notions that have by turns prevailed, is fairly attributable to hygienic regulations, particularly as regards diet and bathing; while the necromancy and the drugging may be regarded as having been accidentally useful or injurious, according to circumstances. This principle, which is the true key to the interpretation of medical testimony, will become more and more apparent as we proceed.

The Monks and Alchemists.—From the twelfth to the fifteenth centuries the practice of medicine, in those countries best known to us, was principally in the hands of the monks, whose healing resources were mainly drawn from magical arts and astrological superstitions. The mystery of this system enabled the practitioners to acquire an unbounded influence over the ignorant masses. Chemistry, or, rather, alchemy, was then prosecuted with much ardor, with the view of discovering a method of transmuting the baser metals into gold, and of preparing a universal medicine—conceits which seem to have been very generally entertained by the learned of that period; and the pursuit of them led to many experiments and the introduction of many chemical preparations into the materia medica, and, indeed, laid the foundation of the mineral drug system of the present day. Most of the alchemists and medical pretenders were knaves of the lowest character, or dupes of the most marvelous credulity, and a few were, according to Bostock, "compounds of knavery and folly."

The only medical schools of any note were the Neapolitan, of Monte-Cassino and of Salerno. The latter, which was the first to grant diplomas, maintained some reputation until eclipsed by those of Bologna and Paris, in the thirteenth century. About this time anatomy was attentively studied by dissections. The first English physician of note was Anglicanus, who published a work in the early part of the fourteenth century, entitled, "Medicinæ Compendium," made up of trifling disquisitions on insignificant topics.

The European feudal system now began to be shaken by the crusades; Constantinople was captured by Mahomet the Second, about the middle of the fifteenth century; about thirty years after the ruin of the Byzantine empire the Reformation occurred; and about the same period the art of printing was invented; all of which events tended to give a powerful impulse to the world of mind, and re-awaken investigation in all the departments of science, literature, and the arts. Still, the great body of medical writers, for want of philosophical prem ises by which to direct scientific researches, and in utter destitution of all ascertained principles to which they could refer the facts developed by anatomical, pathological, and chemical knowledge, busied themselves in collecting, arranging, republishing, expounding, and commenting on the multitudinous works of Hippocrates and Galen. Their labors only tended to multiply books already too numerous, and mystify ideas already too confused.

The alchemic art was at length transferred from Arabia into the European countries, where it was pursued with as much assiduity as by the Arabs themselves. Medical chairs were established in various universities in Europe during the thirteenth century; medical lectures were given in the universities of Vienna and Paris, and schools were established in Padua, Pavia, Milan, Rome, and Naples. Linacre, who was educated at Oxford, spent some time in Italy and at the court of Florence, and on returning to England succeeded in establishing medical professorships at Oxford and Cambridge, and laid the foundation of the London College of Physicians.

THE CHEMICAL PHYSICIANS.—The next important event in medical history was the formation of the chemical sect. Chemistry, after having been employed in various pharmaceutical processes, was applied to physiology, pathology, and therapeutics; hence the origin of chemical doctors. The chemical physicians advanced their theories, which were as wild and extravagant as any preceding ones, with great boldness and assurance, and for a long time the Galenists and Chemists were the rival sects of the medical world. But the Galenists had an ever-present champion in the very name of Galen, who may well be called the Prince of Medical Philosophers. He *was* a philosopher—a *natural* philosopher; for he studied nature closely, deeply, profoundly, and deduced his principal indications of cure from an accurate observation of her laws. But his system was destined to be overthrown by an adventurous vagrant, who, in all the mental, moral, and physical elements and proportions of a complete and thorough quack, never had his equal on earth.

The Prince of Empirics.—And now appeared upon the stage of action an individual—Paracelsus by name—whom the whole medical world denounces as a base, impudent, and unprincipled charlatan, yet to whom the same medical world is more indebted for the present system of allopathic drugging than to all other physicians who have ever lived. It is to him that we owe the introduction of the antimonial and mercurial practice which constitutes the great strength of the popular materia medica, and, I may add, its terribly devastating power on human constitutions.

Aureolus Phillippus Paracelsus Theophrastus Bombast de Hohenheim, as he delighted to style himself, was born at Enseidlen, in Switzerland, in 1493. His father, who was a physician, took great pains in his education, and he became a proficient in physic and surgery; but becoming charmed with the study of alchemy, his father committed him to the instructions of Trithemius, abbot of Spanheim, who was renowned for knowledge in the secrets of alchemic art.

Paracelsus, by bold pretensions, and a few lucky adventures in the field of medical practice, became celebrated among the learned of his day, and was made a medical professor in Basil, in 1527, where he received for a short time a large salary. In the "pride, pomp, and circumstance" of this honored position, he burned, with great solemnity, the works of Galen and Avicenna, declaring to the astonished and probably admiring multitude that, as he had found the philosopher's stone, mankind had no further use for the medical works of others.

It is recorded of Paracelsus that he performed some great cures. It is certain that some of his great cures were the exact prototypes of many great cures performed daily among us at the present time, and not very much to the advantage of the patients. For example, he cured the celebrated printer of Basil, Jerohemns, of a pain in the heel, after "every thing else had been tried in vain." There is, however, a qualification of the story. The treatment moved the pain from the heel to the toes, which became entirely stiffened, and although the patient had no more pain, he soon died of apoplexy!

How far a certain accident had to do with his singularly erratic and profligate life, is worthy of a passing thought. In early childhood he was made a eunuch from an unfortunate mutilation by a sow, and as he grew up he became a perfect hater of womankind, while a love of mere notoriety seemed to have become the passion by which he was ruled.

His principal doctrine, that the human body is composed of the three elements of salt, sulphur, and mercury, was *stolen* from the writings of Valentine, and his principal remedies in all diseases were mercury, antimony, and opium. If the reader fail to discover any relation between such theory and such practice, he is in no worse predicament than he will find himself, in most cases, if he attempt to trace the connection between most of the medical theories and practices in this more enlightened day.

The medical life of Paracelsus may be stated in few words. He surreptitiously appropriated another man's invention as his own, practiced the vilest arts of charlatanry, assumed the most pompous titles, proclaimed that he had discovered a universal panacea, the long-sought *elixir vitæ*, by which life could be prolonged to an indefinite period, lived a dissipated vagabond, and died prematurely at the age of forty-eight.

The Regular and Irregular Controversy.—Although Paracelsus introduced a new era in medical practice, and had, like most other noted characters of lofty-sounding pretensions and brazen-faced impudence, abundance of followers, still many of the "old-school" physicians held out against the innovations of his disciples. Thus originated a contest between the Galenists and Chemists, which was prolonged through the sixteenth century. The Galenists were the regulars, and the Chemists were the empirics, of that period The former dealt out prodigiously multitudinous compounds, and the latter made a bold stand with fewer but much more potent agents, while each sect accused the other of killing their patients, I fear with too much truth. The Paracelsian doctors ultimately triumphed, and, as a singularly striking exemplification of the strange inconsistency between the fancies and facts of misnamed medical science, it may be told that the medical world has long since repudiated every vestige of the arts, pretensions, and doctrines of Paracelsus and his apostles, yet retained, imitated, and greatly extended their practice; for, notwithstanding modern chemists have added several hundreds of other chemical preparations to the materia medica of the great Quicksilver Quack, there is hardly a disease in the catalogue of human ailments in which the employment of mercury, antimony, and opium is not recommended by the standard authors and living teachers of the drug system.

The Anatomical Physicians.—While the discussions between the contending parties just noticed were gradually extending the influence of the empirical practitioners, and circumscribing that of their adversaries, the science of anatomy began to be more accurately cultivated, which circumstance gave rise to a sect of physicians called the Anatomists. Vesalius, about the middle of the sixteenth century, prosecuted this department of knowledge with unwearied assiduity. He was followed by Eustachius and Fallopius, who acquired great reputation for anatomical skill. The anatomical physicians, however, did not introduce any thing original in relation to the theory or the practice of medicine. They were divided concerning the opinions of Galen, and may be subdivided into his defenders and his opposers; between these sub-sects long and acrimonious discussions occurred, not concerning what was true or what was false, but whether the notions of Galen were right or wrong.

Revival of the Hippocratean Doctrine.—During the seventeenth century the doctrines of Hippocrates again became the prevailing medical philosophy. Anatomy made rapid progress; Harvey discovered the circulation of the blood; Asselli, Rudbeck, and Bartholine traced out the absorbent system; and Malpighi, Hooke, and others, explained the structure and functions of the lungs. Boyle disengaged chemistry from the mystery by which it was surrounded, and explained its true province to be, not the manufacture of solid gold, nor liquid nostrums, nor gaseous theories, but "an investigation into the change of properties which bodies experience in their actions upon each other."

Still the chemical physicians kept up the popularity of their practice by mixing with it not a little of the magical ceremonies and astrological pretensions so rife a few centuries before. Some of them acquired extraordinary popularity, and many of them, particularly in England, become apparently sincere fanatics to their own system. Among these were Fludd, who manifested implicit faith in astrology; Kenelm Digby, a man of rank and refined education, who published an account of the mystical virtues of the "sympathetic powder;" and Valentine Greatrix, who cured all diseases by the imposition of the hand. "These circumstances," says Bostock, "are interesting, not merely as forming a part of the history of medicine, but as displaying a singular feature in the history of the human mind; demonstrating the difficulty which exists in eradicating from it errors and follies, even the most gross and palpable, when they have once become deeply rooted."

Although the discoveries alluded to in anatomy had turned the attention of medical men more to vital actions, as affording a better explication of the phenomena of disease than chemical changes, and had generally restored the humoral pathology of Hippocrates, the practice of medicine did not undergo a corresponding change. The Anatomists were anxious of course to have their pharmacopœia include "all the modern improvements," hence they pursued a mixed or compound practice, by adding the mercury, antimony, and opium of Paracelsus, and other drugs of more recent production, to the bleeding, purging, sweating, etc., of the earlier physicians. In fact, they incorporated nearly all that was known of a poisonous or destructive nature among their therapeutical agents, and omitted nearly all that was really worth preserving—attention to diet, regimen, bathing, cleanliness, etc.

THE FERMENTATIONISTS.—Another sect of physicians now arose, or, rather, a branch of the Chemists, who attempted to blend the crude chemistry of the day, and the cruder physiology, into a compound philosophical system. The leading doctrine adopted by this sect was, that certain fermentations in the blood, and other fluids, were the causes of the different states of health and disease; certain humors were acid; others alkaline; and, as one or the other predominated, a corresponding specific disease was the result. Thus fever was an acidulous disease, requiring alkaline remedies, etc. This notion was eloquently advocated by Sylvius, who filled the medical chair at Leyden, and became the fashionable doctrine in France and Germany for a considerable time. Willis, of England, was also an able defender of the chemical doctrines; he published a work in 1759 on fermentation and fever, wherein he attempted to prove that every organ in the body had its own peculiar fermentation, a morbid state of which constituted disease.

Sydenham, who has been called the English Hippocrates, agreed with Willis in the theory of chemical fermentation, but adopted the Hippocratic doctrine, that the primary changes in disease take place in the fluids instead of the solids. He also agreed with Hippocrates that disease was an effort of nature to get rid of noxious matters, and, like his great prototype, adapted his remedial agencies mainly to the regulation of the actions of the system. Though his practice has been called feeble and inert, it would be difficult to name an equally successful physician among the bolder practitioners who have wielded more potent drugs since his day.

Notwithstanding numerous discoveries had been made, and many facts accumulated up to this date in chemistry, anatomy, and physiology, it is at least questionable whether any more rational views were entertained of the true nature of disease than were advanced by Hippocrates nearly three thousand years before; and it is positively certain but none among the most eminent of the new schools or sects of more modern date, have been more successful in curing diseases than were Hippocrates, Galen, and Sydenham.

THE MATHEMATICAL PHYSICIANS.—Mathematical science having made considerable progress during the latter part of the sixteenth century, the medical theorizers of the day seized upon its facts to effect another doctrinal revolution; hence arose a sect whose members composed the Mathematical school. Borelli, a profound mathematician, undertook to explain certain functions of the body on mechanical principles; and his pupil, Bellini, maintained that all the actions of the body were under the influence of gravity and impulse, and that all the vital functions could be elucidated by an application of the principles of hydraulics and hydrostatics. The new hypothesis soon ranked among its converts many of the most learned men of the age, and the Mathematical physicians became formidable rivals to the Chemical. The phenomena of disease were accounted for by, or, rather, referred to, the mechanical terms of *derivation*, *lentor*, *obstruction*, *friction*, *resolution*, etc.; but, as has been the case in most instances from the creation of the world to A.D. 1851, the practice had little or no relation to the theory. Diseases were treated by the Mathematical physicians with the remedies of the Chemists and Galenists. Indeed, the practical part of medicine was regarded then, as it had been long before and has been long since, of secondary importance to the theory. The minds of medical men were mainly devoted to theoretical speculations, and vastly more talent was wasted in endeavoring to establish and promulgate favorite dogmas, of no earthly use, except to render the authors of them famous, than was expended in investigating truth or curing diseases.

THE VITALISTS.—The next medical sect in order was the Vitalists. It originated with Van Helmont, and finally triumphed over both the Chemical and Mathematical sects. Van Helmont at first belonged to the Chemical school; but to its doctrines he added the idea of a specific agent residing in, or attached to, the system, which controls its own spontaneous actions, and also the actions of remedial agents. This conception was doubtless the ideal germ of the vital principle of later physiologists, and the *vis medicatrix naturæ* of the present day; nor is it radically different from the idea of the efforts of nature as entertained by Hippocrates.

Van Helmont proposed nothing new in the way of curing diseases, contenting himself with mere matters of opinion; and the communication of his doctrines did not allay the wordy warfare still waged between the Chemists and Mathematicians, until it was revived and refined by the genius and energy of the next successful adventurer in the field of medical theory.

This was Stahl, who was born at Anspach, in 1660. He undoubtedly saw the sad deficiencies and gross errors in the prevailing theories. and, perceiving that neither chemical nor mechanical reasoning, nor both, could ever explain the phenomena of life, he referred vital actions to the operation of a principle he called *anima*. From a close observation of the influence which the mind exercises over the body, he came to the conclusion that all the vital functions were produced and sustained by the influence of an animating and superintending spiritual principle. This principle prevents or repairs injuries, counteracts or removes morbific causes, and, in fact, appears to be the aggregate of what modern physiologists speak of as the *organic instincts*.

But, as an exception to the general rule, the theory of Stahl did influence his practice very considerably, for, instead of the rash and dangerous potencies and processes then in vogue, his views, in the language of an eloquent historian, "tended to repress the energy of the practitioner still more than the pathological doctrines of Hippocrates. They did, indeed, cause him to trust more to his presiding deity—the great physician, Nature—and less to artificial drugs and destructives. Happy would it have been for the human race if a more inert practice had continued to this day, to "repress the energy of the practitioner," for sad experience, and the constantly accumulating catalogue of human ills and chronic maladies, unheard of in former days, sufficiently demonstrate that success in curing disease holds a much nearer relation to the inertness than to the energy of the practitioner, as far as active poisons are concerned.

The doctrines of Stahl, and the extraordinary metaphysical acuteness with which they were supported, had an extensive influence on medical opinions; but about that period there were so many rival medical schools evolving new theories, each advancing their claims to notice with great zeal and ability, that it was impossible for any one hypothesis to be generally received.

THE SOLIDISTS.—Hoffman, the contemporary of Stahl, was also his colleague in the University of Halle, as well as his rival, and an equal aspirant for name and fame. He wrote voluminously, and the principal theoretical notion which he originated was a modification of the Stahlian doctrine of vitality. Instead of referring the operations of the animal economy to an anima, he imputed them to a *nervous influence*.

This was almost a distinction without a difference, but it served his purpose. The details of his practice were essentially those of the Chemical and Mathematical physicians, possessing no new feature whatever. His pathology united the notions of the Humoralists and Solidists, and he advanced the doctrine of *tone and atony*, or *spasm and relaxation* of the moving fibres—a doctrine which long influenced the writings of his successors, and which was, no doubt, derived from the ancient notion of constriction and relaxation. His writings are said to abound in inconsistencies and contradictions.

In 1671 Glisson published a treatise, in which he advocated the doctrine of muscular irritability, explaining it as a specific property attached to the living fibre, in opposition to the humoral pathology of Hippocrates, which until this time had generally prevailed. Toward the close of the seventeenth century, Bagliva, an eminent medical scholar, systematically opposed the Hippocratic pathology, placing all the causes of disease in an altered condition of the solids. These two writers laid the foundation for the overthrow of the humoral pathology and the introduction of solidism, which has been very generally received by the medical profession to the present time. It is now, however, decidedly on the decline.

But this revolution in theory had no perceptible effect on the practice. Whichever hypothesis the physician adopted was the same to the patient. The prescriptions were alike in either event.

THE METAPHYSICAL PHYSICIANS.—Soon after the revival of letters, the greatest scholars among medical men were incessantly laboring to apply the inductive philosophy introduced by Bacon, and found so successful in advancing other departments of philosophy, to the study of medicine as a science. How signally they failed, let the record of innumerable theories which have come and gone, like the changes of the moon, testify. This failure was not owing to a want of learning, or ambition, or industry, or integrity of purpose. It is attributable purely to the want of the true starting-point. The learned world was full of book-made philosophies, brain-racked theories, and closet-engendered metaphysics. The minds of medical authors were all more or less warped and beclouded with the speculations of their predecessors and teachers. There was no one of sufficient originality of intellect and independence of mind to cast off the tremendous incubus of venerated authority, and go directly to the truth itself for the evidence of truth—to ask nature to interpret her own laws. Destitute of all demonstrable premises upon which to predicate their investigations, and from which to extend their inquiries, each one seems to have conceived a hypothesis, or detected an error, and then studied and wrote to maintain the one or refute the other. The direction of men's minds was too mystically metaphysical for the prosecution of true philosophical research. How few men have ever lived who had mental capacity even to think of a first principle!

BOERHAAVE.—No one ranks higher in the annals of modern medical history than Boerhaave, who was contemporaneous with Stahl and Hoffman. He was a professor at Leyden, and in practical judgment has been justly regarded as superior even to Galen. But in groping among the dark chimeras of his predecessors he was unable to find any thing more enduring than mere conjecture and gratuitous assumption upon which to establish a new system. He attempted, however, to form and fashion out of the discordant materials before him a theory and practice which should combine the excellences of all systems, and be truly eclectic. But any system, embodying such conflicting opinions as were found in the speculations of the different schools, must necessarily contain the seeds of early dissolution; and accordingly we find that the system of Boerhaave did not long survive him. His nephew, Kauw Boerhaave, his successor, Gaubius, and Gorter, a professor of Harderwyc, wrote extensively on medical subjects, but to little account, save to restore the vital agency in explaining the phenomena of disease, which Boerhaave had nearly discarded.

Van Swieten, professor in the medical school at Vienna, was a follower of Boerhaave, and the ablest supporter of his views. He wrote extensive commentaries on the multitudinous aphorisms of his predecessor, but they were of little practical value.

HALLER.—This distinguished scholar, who has been called the father of modern physiology, was a pupil of Boerhaave. He possessed a mind singularly original and comprehensive, and after long and patient research into the nature of the functional powers of the human body, made a substantial improvement in physiological science. Disregarding all the authority of learned names and mere theories, he established the doctrine of the irritability and sensibility of the muscular and nervous systems. His Elements of Physiology "introduced a new era into medical science." His peculiar views were warmly controverted by many distinguished writers, and as warmly supported by others.

THE SEMI-ANIMISTS.—While Haller's doctrines were strengthened and confirmed by numerous experiments instituted by Zimmerman, Caldani, Fontana, Tissot, Zinn, and Verschuir, they were powerfully opposed by Whytt and Porterfield, of Scotland, whose reasonings, however, though able and acrimonious, have been characterized as much more metaphysical than physiological. Whytt succeeded in founding a sect called the Semi-Animists, whose principal distinctive tenet was a vital or sentient principle, compounded of the doctrines of Stahl and Haller, evidently intended as a middle theory between the two.

Sauvages, professor at Montpelier in 1734, was one of the main supporters of the Semi-Animist sect. He was the first to arrange diseases into classes, orders, genera, and species, constituting a methodical nosology. Still we have no evidence that these controversies, modifications, revolutions, or improvements materially affected the prevailing method of treating diseases at the bedside.

CULLEN.—William Cullen, who was the successor of Whytt in the University of Edinburgh, achieved as brilliant a reputation as Haller, and effected as great a revolution in medical practice as Haller did in physiology. In discriminating the phenomena of disease, Cullen was unrivaled; and he was the first medical innovator for ages whose theory and practice were consistent with and strictly related to each other. His "First Lines of the Practice of Physic" were in fact text-books in our medical schools less than a quarter of a century ago. His works on nosology and materia medica have never been excelled in rigid powers of analysis and accuracy of observation, and his opinions are often quoted as high authority by medical journals of the present day. But his carefully elaborated theories were wanting in the one thing needful for an enduring system—an ascertained first principle, and hence were destined to pass away like the baseless fabrics of a thousand other theoretical visions which preceded and succeeded him. No one now pretends to acknowledge or defend his theories, though many physicians, perhaps a majority, follow essentially his practice, thus exhibiting another of those glaring absurdities which stamp with inconsistency almost every page of medical history.

The Cullenian system of treating diseases may be resolved into a single indication, that of counteracting the symptoms. Thus in a fever he would reduce by bleeding, nitre, and other antiphlogistics, in the hot stage; stimulate with bark, wine, tonics, etc., in the cold stage; and obviate spasm, putrescency, etc., with narcotics, alkalies, acids, etc., in the intermediate or sweating stage. Nothing can be more absurd than such a practice in a fever which passes through all these stages once a day, or every other day for several weeks, for it keeps one hand continually working against the other It amounts to nothing but treating temporary and ever-changing symptoms on a plan of antipathy or antagonism, without any regard to the permanent state of the constitution, or natural course and termination of the disease. Yet, as already intimated, it is the prevailing allopathic practice.

It should be mentioned that Cullen recognized the self-preserving and self-regulating principle of vitality; but he improved on the notions of Stahl, Van Helmont, and Hoffman, in explaining it as an inherent property of organization, which he called the *vis medicatrix naturæ*, or remedial power of nature, rather than a superadded sentient principle.

THE BRUNONIAN SYSTEM.—The Cullenian school found a rival in the bold vagaries of what has been called the Brunonian theory, in an early period of its existence. A Dr. Brown, of Edinburgh, who had been a personal and professional friend of Cullen, became, from some cause—probably spleen, jealousy, or disappointment—his bitter antagonist, and a vehement opposer of his doctrines. To effect his purposes of ambition and opposition he advanced a new medical doctrine. He did not trouble himself about authorities, facts, experiences, or reasons, but simply assumed his principles, announced his doctrines, laid down his practice, supported the whole with lofty pretensions, and found many followers among men of learning and science, and in many medical schools whose professors adopted his doctrines.

Brown maintained that life was a forced state, analogous to the flame of a candle; that any thing which affects the living body acts as an excitant or stimulant upon a specific property it possesses, which he termed excitability. Thus defective excitement or stimulation produces accumulation of excitability, or indirect debility, while excessive stimulus produces exhausted excitability, or direct debility; and that all diseases are referable to one or the other of these states, requiring stimulating or reducing measures, as the excitability is exhausted or accumulated. The practice that naturally results from such a theory or phantasy is bleeding in one class of diseases, and brandy in the other; and, in truth, the world is much indebted to the genius or the impudence of John Brown for the extensive use of alcohol and alcoholic mixtures in modern medical prescriptions.

The poetical and refined Darwin deserves a passing notice here, as a fruitless theorist and elaborate speculator. His "Zoonomia" is certainly a monument of genius, but destitute of any sound philosophical principles, and his medical notions are now universally regarded as purely fanciful.

MEDICINE AT THE END OF THE EIGHTEENTH CENTURY.—At the conclusion of the eighteenth century, the physicians on the continent of Europe generally pursued the eclectic plan of Boerhaave. Among the French, Lieutaud, who published in 1749 a great work called "Synopsis Universæ Praxeos Medicæ," was the most celebrated. In Germany, De Haen published a work equal to Lieutaud's, called "Ratio Medendi," but he bitterly opposed all the new notions of that period, and warred against Haller's doctrines, and against the practice of inoculation. The most celebrated medical schools in Europe were those of Paris, Vienna, and Leyden. The medical schools of Italy also enjoyed a high reputation. Bonet and Mangel there introduced the study of pathological anatomy, which was followed up by Valsalva and Morgagni, who made extensive post-mortem examinations, and recorded the anatomical appearances of the structures. One source of error, however, pervaded all their observations, as it does post-mortem investigations at this day. It is this. Structural appearances after death denote the *effects* of disease; and these morbid changes were and are often mistaken for or confounded with the *causes* of disease.

Burserius was the only theorist of any note that Italy produced at this time, but his works are only admired for the elegance of the language in which they are written. The Italians adopted the Brunonian system; but the fatality attending its practical application caused its utter abandonment, and a return to the equally irrational theory but somewhat less fatal practice of the Cullenian school. The Egyptian physicians were more disposed to prosecute anatomical and physiological researches than to form systems of any kind.

With the progress of chemistry during the eighteenth century, many of the feebler articles and more complicated compounds of the pharmacopœias were substituted by more simple yet more powerful metallic and mineral preparations and vegetable extracts—powerful in the sense of the strength or force of the impression, not in reference to the quality, or kind, or utility of that impression; and if this was an improvement in pharmacy, as medical historians usually inform us, there was assuredly some progress made in the *dealing*, if not the healing art. It was an improvement by which apothecaries have profited to the extent of many millions of dollars.

MEDICINE IN THE PRESENT CENTURY.—The historian who carefully and without prejudice surveys the present state of the medical profession will observe one of the strangest anomalies which the human mind can contemplate. He will observe a learned profession, adorned with as bright a galaxy of names—scholars, philosophers, and philanthropists—as any profession in any age of the world could ever boast, devoting themselves, with a zeal and industry worthy of all praise, to the study and practice of medicine, yet having no confidence at all in their own system, and, stranger still, wondering and complaining that the great masses of the people have no confidence in it!

Bostock has admitted that "our actual information does not increase, in any degree, in proportion to our experience." The solution of this remarkable problem will be found as we proceed.

Never was any department of human knowledge prosecuted with greater assiduity and energy than have been all the sciences collateral to the practice of physic, during the last fifty years. Anatomy, chemistry, and operative surgery have, indeed, made wonderful and substantial progress. Pathology has been greatly advanced. Physiology has been diligently studied, but unfortunately with little success. True, facts in physiology have multiplied exceedingly, and hypotheses into which they have been woven have added greatly to the numerical strength of medical libraries; but as far as demonstrating the laws of life, or increasing our means for the cure of disease, I may safely assert what Bostock admits, viz., "So far as the practice of medicine is concerned, the benefit is rather in anticipation than in existence."

In anatomy, surgery, and materia medica, Great Britain and America have produced many illustrious names, among whom may be mentioned Hunter, Munro, Bell, Cooper, and Pereira, of the old, and Wistar, Horner, Physick, Mott, Eberle, and Dunglison, of the new, world. In physiology, analytical chemistry, and anatomy the Germans have taken the lead; and pre-eminent among those who have acquired distinction are Camper, Blumenbach, Soëmmering, Meckel, Tiedeman, Sprengel, Rosenmüller, Müller, and Liebig. In pathology and pharmacy the French have outstripped all other nations, and the labors of Pinel, Andral, Breschet, Broussais, Corvisart, Cruveilhier, Dupuytren, and Laennec have obtained a world-wide celebrity; while in physiology the French school has given us the works of Bichat, Cuvier, Richerand, Majendie, and others. Italy is far behind the other countries named, yet it has produced a few eminent medical scholars, among whom are Scarpa, Mascagni, Ronaldo, and Tommasini.

But while this tribute is due to the talents and acquirements of the medical philosophers of this age, it must be remembered that all their vast array of learning, and all their multitudinous writings, have done nothing toward placing the healing art on a true philosophical foundation. They have rather tended to render the confusion of ancient dogmas worse confounded by modern speculations.

If a gangrenous limb is to be amputated, a tumor removed, a cancer excised, or a toe disjointed, Professors Mott, Parker, Dudley, Rogers, Detmold, etc., etc., can perform the operation with all the skill and judgment the case admits of. Operative surgery has well nigh reached perfection. If it is desirable to know in what proportion of cases in choleras, typhoid fevers, dysenteries, etc., there was nausea, or vomiting, or headache, or pain in the back, or chills, or rigors, or pain in the limbs, among the premonitory symptoms, or what precise shades of color and consistence the various structures manifested after death, we have in the present state of pathological science nearly all the information we shall ever know what to do with. If we would inquire what particular phenomena of symptoms follow the administration of any given mineral preparation or vegetable drug, the materia medicas of the day, though extremely contradictory with each other, give us all the details that can possibly be of any service. And if we would understand exactly what proportion of ultimate or proximate elements enter into the composition of any solid or fluid, of matter organic or inorganic, animate or inanimate, the present state of chemical science gives us as accurate a knowledge as can be of any advantage, so far as the practice of medicine is concerned.

The reader may now naturally ask, Why has not success in treating diseases kept pace with the extraordinary progress of knowledge in the collateral medical sciences? The answer is ready. A philosophical, and hence successful, practice of the healing art must be based upon the laws of life, the economy of vitality. The only foundation, therefore, of a true medical practice is correct physiological principles; and here is precisely where the whole orthodox medical system of the present day fails—utterly and totally fails. It has no physiological science upon which to practice truly the healing art. In the language of one of the greatest of modern physiologists, Majendie, "there is scarcely a sound physiological principle extant."

When I intimate that there is no physiology in the world, I mean, of course, the medical world. Out of the regular profession this science has been more prospered. Untrammeled by the theories of the schools, individuals, not of the order of medical men, have, as I shall hereafter show, demonstrated the true science of life, and laid the true foundation for a medical practice, whose most powerful remedies, so far from being the most potent poisons known on the surface or dug from the bowels of the earth, are the very agencies by which the whole vegetable and animal creations are developed and sustained.

Medicine in the United States.—In no part of the world are medical schools more numerous, medica writers more prolific, and medical periodicals more abundant, than in the United States. And no age of the world presents a medley of medical scribblers in the regular profession more biased and bigoted in their notions, more visionary in their speculations, more puerile in their theories, and more inconsistent in their practices, than is furnished by the history of the present state of the medical profession in this country. This is not because medical men in this country are not as talented as those of any other country, nor because medical men, as a class, are not as intelligent, honest, and philanthropic as men of any other class. It is simply because there is *no medical science in existence.* The practice of the popular system is purely empirical. From establishing new systems and building new theories, the attention of medical men now seems mainly directed to the discovery of new remedies and the concentration of old ones. The critic who will take pains to examine the standard works of the most popular authors on theory and practice—Good, Watson, Wood, Thacher, Eberle, Elliotson, Dunglison, Dickson, and others—will find, on almost every page, the most contradictory theories supported by equal authority, and the most opposite practices recommended on equal testimony. Well might the celebrated Dr. Rush, of Philadelphia, after a life-long experience in witnessing the effects of drugs upon the human constitution, declare to his medical brethren, "We have done little more than to multiply diseases and increase their fatality."

The diligent student of medical history cannot fail to discover that the ancient and more ignorant practitioners were more successful in curing diseases than are the modern and wiser physicians. The remedial agents of the ancients were comparatively inert and comparatively harmless, and, while they inspired their patients with a due degree of confidence and hope, by the charms and ceremonials of magic and mystery, they really relied on judicious hygienic regulations to "aid and assist nature" in effecting the cure. Modern intelligence repudiates the arts and incantations of a less civilized age; and in their stead has substituted the stronger potencies of modern invention, while the habits of living and thinking, with medical as well as with other men, have become so unnatural and artificial that, in managing diseases, voluntary habits and hygienic agencies are almost wholly overlooked.

The general plan pursued at the bedside of the patient, by regular physicians of this country, and, I believe, of all countries, is intended to be eclectic. While they disown all the theories that have ruled the world by turns, they endeavor to preserve and incorporate in their prescriptions all the remedial means which those rejected theories have brought into favor. The only point of skill is to discriminate the exact disease, state, stage, condition, temperament, age, or other circumstance, which renders this, that, or the other, or all together, the most advisable in the experimental prescription. The only acknowledged guide now is experience. But unfortunately the guide points all ways at the same time. There is no common agreement in the testimony of medical men respecting the indications of the most common diseases, nor the properties or operative effects of the most common articles of the materia medica.

To illustrate: Bleeding has been extensively employed in typhus fevers for three hundred years, yet physicians are divided in opinion whether it is good or bad practice. Opium has been in use over two thousand years; but medical men cannot agree whether it operates primarily as a sedative and secondarily as a stimulant, or exactly the contrary, primarily as a stimulant and secondarily as a sedative. Mercury has been employed more or less for about three hundred years, and extensively during the last fifty years; and some authors consider it a tonic, others a stimulant, others a deobstruent, or alterative, others a sedative, and yet others an antiphlogistic. Brandy has been freely administered in the city of New York and elsewhere in the treatment of the cholera during two epidemics; the result of the experience is, about half of the physicians commend it highly, and the other half condemn it utterly. Within the last fifty years no less than four different methods of treating ordinary fevers have prevailed: the bark and wine practice, the cold affusion practice, the bleeding and saline practice, and the mercurial and opium practice. In about the same period. some scores of specifics for some of the most formidable diseases have been discovered, tried, proved, and then laid aside, to be followed by others which experienced a similar rise and fall of reputation. Digitalis, the effluvia of cow-stables, and a preparation of nitric acid and opium, have been among the vaunted cures for consumption. Twenty years ago iodine was found to be a specific for scrofula; but no one now thinks of it save as an occasional auxiliary; and two years ago cod-liver oil was literally flooding the country under the auspices of the allopathic medical journals, and the right wing of the great medical army, the apothecaries, as a remedy for consumption and scrofula; but its brief day is already drawing to a close.

These facts are enough to show the utter fallacy of medical experience, and the unsatisfactory nature of medical testimony, unless based upon some intelligible principle to which we can refer the phenomena they present. I cannot more appropriately conclude these remarks than by the following extract from Bostock's history: "In modern times, and more remarkably in Great Britain, no one thinks of proposing a new mode of practice without supporting it by the results of practical experience. The disease exists, the remedy is prescribed, and the disease is removed; we have no reason to doubt the veracity or the ability of the narrator; his favorable report induces his contemporaries to pursue the same means of cure; the same favorable result is obtained, and it appears impossible for any fact to be supported by more decisive testimony. Yet in the space of a few short years the boasted remedy has lost its virtue; the disease no longer yields to its power, while its place is supplied by some new remedy, which, like its predecessor, runs through the same career of expectation, success, and disappointment."

HISTORY OF BATHING.

A complete record of the bathing customs of all nations, and of the remedial uses to which water has been applied by medical men, would furnish us with many more examples of what has been done amiss, than of what is worthy of imitation. Somehow or other at some time or other, the idea came to possess the minds of practitioners of the healing art, and through them the minds of the people generally, that impure waters were more healthful for sick persons than pure. Consistently with this ridiculously absurd vagary, those springs of water which contain the greatest amount and variety of impurities, are the most celebrated as resorts for health-seeking invalids. And this silly conceit regarding the remedial influence of drugged waters has extended to their external as well as internal employment; hence all manner of artificially medicated, mineralized, saline, alkaline, acid, oleaginous, spirituous, gasified, and compound baths and fumigations have found advocates in the ranks of the medical profession. It seems to be inconceivable to the book-biased minds of most regular physicians that *pure* water can dissolve and wash away the *impurities* of the body better than *impure* water. In their view some foreign agent, something extraneous, something powerful must be taken or applied to destroy the morbid entity, or counter-irritate the diseased condition, or "force a healthy action." When it is considered that the solvent property of water is exactly proportioned to its freedom from all extraneous ingredients held in solution, the strange hallucination that prefers sulphur, iodine, iron, saline, and other unclean springs, to the pure element as it distils from the clouds of heaven, for medical purposes, will have to be put down to the account of those things on this earth which are wholly unaccountable.

ANCIENT BATHING.—Almost as far back as we can trace historical data, we find accounts of various domestic baths. The earliest Bible account of bathing speaks of the daughter of Pharaoh and her attendants going down to the Nile. Homer speaks of the bathing habits of many of his heroes. Hercules was indebted to Minerva and Vulcan for the refreshing influence of warm baths. Althenæus informs us that it was the custom of antiquity for women and virgins to assist strangers in their ablutions. Among Oriental nations the means for bathing were provided as an act of hospitality for travelers.

Both the Old and New Testaments frequently mention bathing as a sanatary and healing process, and as a religious rite. With all the ancient nations frequent ablutions or immersions were typical of moral purity. Moses, Jacob, Aaron, Job, as well as the more ancient patriarchs, enjoined and practiced bathing as a means of both bodily and spiritual purification. Jews, Christians, Mahometans, and Pagans have all agreed in one tenet, the baptism of personal cleanliness. Elisha the prophet directed Naaman the leper to bathe seven times in the Jordan. Our Saviour commanded the blind man to wash in the pool of Siloam. Many of the sick were sent to the healing waters of Bethesda. The Greek and Egyptian priests washed themselves in cold water several times a day.

Bathing in the Middle Ages.—But in process of time, as the customs of societies and nations became more complicated and sensual, bathing degenerated almost into a means of mere luxury and sensuous indulgence. Though the Egyptians first reduced bathing to a systematized part of the medical practice of their day, and for ordinary purposes recommended cold ablutions in preference to warm baths, as the habits of the people became luxurious and enervating, the cold ablution for health was substituted by the warm immersion for pleasure.

The Greeks adopted the bathing customs of the Egyptians, and attached public baths to their gymnasia; and a bathing room for guests was a common apartment in their private houses. Socrates, Aristotle, and Plato speak of baths as in common use. Hippocrates, the "father of medicine," recommended them for many hygienic and therapeutic purposes.

The Spartans were in the habit of plunging their new-born infants into cold springs. The members of their adult population were certainly fair specimens of vigorous health and powerful frames. But medical theorizers have explained this fact in another way. They assert that the practice *killed* all the tender children, the robust only being able to survive it; so that all who lived through it and grew up to manhood were robust and healthy *in spite* of the bathing. But the assertion is wholly gratuitous, and, notwithstanding it is the prevailing opinion of the medical faculty, there is not a particle of evidence to sustain it. I have seen too many children in New York city who have been bathed in cold water from birth, every one without exception becoming remarkably robust and healthy compared with non-bathed or warm-water-washed ones, to give the least credence to a statement which seems to have been made on mere theory, without any investigation at all.

The ancient Germans were much addicted to cold bathing. The Gauls, the powerful progenitors of the British race, had *sacred fountains*, which were resorted to for the purpose of bathing and healing diseases; and in England many cold springs have been celebrated for their curative virtues.

In the days of Roman pride and luxuriance public and private baths were constructed on a magnificent scale; and the agriculturists, soldiers, and laborers would frequently bathe in the Tiber. After the aqueducts were built, by which an abundant supply of water was introduced to Rome, warm baths became general; and, instead of being employed for cleanliness and health, they were soon regarded as a mere source of luxury, and thus became a means of physiological degeneration and effeminacy. Public buildings, called thermæ, for warm bathing, increased rapidly, and in the days of Nero, who erected a most sumptuous one, they numbered eight hundred or more. With the baths were connected grounds for sporting and athletic exercises, and extensive libraries. The baths of Caracalla had sixteen hundred marble seats, capable of seating three thousand persons, and were ornamented with two hundred pillars. But surpassing all others in size and splendor were those of Diocletian. It is related that in their construction he employed forty thousand Christian soldiers, whom he caused to be massacred as soon as the work was completed. Such are the consequences of perverting the practice of bathing for the sake of that "cleanliness which is next to godliness," and that health of body which contributes so powerfully to a sound mind, to a mere lustful enjoyment. The warm bath degenerated into the hot, and feasting and gluttony became parts of the purpose for which a Roman bathing establishment was frequented.

The Greeks, too, constructed immense bathing establishments, and furnished them with all the appliances of health and luxury, as cold, warm, hot, and vapor baths; but unfortunately, as in most cases where good and evil are placed before the judgment and sensuality of human nature, the latter proved victorious. Lounging in warm water, and anointing the body with an immense profusion of oils, soaps, and perfumes, became favorite amusements, followed, of course, by indolence and enervation.

When Alexandria was conquered by the Moslems it contained four thousand baths, constructed on the Roman plan; and when the Spaniards conquered Granada the bathing habits of the Moors, and also their language and dress, were prohibited, as a means of their conversion.

In most of the large European towns, in the "barbarous ages," public baths were erected, where the people bathed each Saturday evening. The early Christians of Gaul had baths constructed in their convents. Pope Adrian I. recommended the parochial clergy to visit the baths, in grand procession, every Thursday. The institutions of chivalry required the knight to be subjected to a complete ablution before receiving his armor. The Order of the Bath, still retained in England, originated from the circumstance that the candidate was knighted while immersed to the chin in a highly decorated bath.

Bathing Habits of Different Nations.—The people of Switzerland are said by Marcard to bathe more generally than those of any other country. The baths at Baden have been as celebrated for their abuses as for their uses, having been resorted to during the sitting of the Council of Constance, more for luxury and debauchery than for health. Such is not the case, however, at present.

In Italy the numerous warm and mineral springs are much resorted to, especially in the northern part, where immersion and douche bathing are common. To most of their celebrated springs the poor are allowed free access; and attached to some of them are hospitals for invalid soldiers.

The Germans have long been accustomed to warm bathing. Charlemagne had a bath constructed, capable of accommodating one hundred persons at a time, and it was his custom to sit in council in a large warm bath of the waters of Aix. During the prevalence of leprosy, in the middle ages, bathing was enjoined as a religious duty; and as diseased persons commenced frequenting the public watering-places, the people generally resorted more to the rivers. At present bathing at the regular establishments is quite systematized, yet the people are more generally negligent in regard to the practice than formerly.

In Russia vapor baths have long been and are still celebrated. In their establishments the vapor is obtained by pouring water on heated stones, and the temperature is raised to 122°, and even 133°. The vapor bath is followed by tepid, and then cold ablutions, and sometimes a lake or river plunge or a rolling-in-the-snow bath. Rubbing the body and lathering it with soap are usually parts of the Russian process.

The Finlanders resort often to the dry and moist sweating baths, the vapor for the dry being 122°, and for the moist 140° to 167°. The latter process is painfully suffocative and extremely debilitating. Most of the peasantry have bath-houses, used by men and women promiscuously. They are constantly in the habit of passing from the atmosphere of their bathing-rooms, which are heated to 167°, to the open air out-doors, where the thermometer is down to 24° below zero, transitions, which, astonishing as they appear, do not seem to produce any immediate inconvenience.

Throughout Sweden, Norway, and Lapland baths are very common.

The Oriental nations have the most numerous and splendid bathing establishments of the present day.

The public baths of Turkey are spacious edifices of hewn stone. The temperature of the rooms is about 100°, where the bather soon gets into a perspiration by the heated air, and is rubbed, kneaded, stretched, lathered, and perfumed, and finally washed with tepid or cold water to his liking. Smoking and coffee succeed the operation. The long-continued warm and hot bathing gives to their females a peculiarly pale, peach-like softness of skin, indicative of lassitude and debility rather than health and strength. In fact, luxury, mere animal gratification, seems to be the only purpose thought of in most of the bathing establishments of the East.

The Persians rival the Turks in magnificence, if not in convenience. But the manner of bathing differs materially from the Turkish. The toilet is the leading idea of a Persian bath. Instead of rubbing, shampooing, etc., the attendant, or operator, is mainly occupied in staining the beard and hair black, the feet and hands yellow, and the nails of the fingers and toes of a deep red.

In Egypt and India bathing is practiced in a manner very similar to that of the Turks. In Cairo there are about seventy public baths. In addition to the manipulations of a Turkish bath, the attendant of the Egyptian bather rubs the soles of the feet with a kind of rasp, made of baked clay. It is customary for betrothed females to go in grand procession to the bath a day or two before marriage, accompanied by intimate friends and relatives. The three stages of the bathing process consist of sweating, rubbing, and washing. Aromatic unctions are generally employed, and the Persian fashion of dyeing the nails with a preparation of henna is very much in vogue.

The East India baths are conducted similarly to those of the Egyptian. The women of quality spend much time in them, and seem to realize in their use only a source of sensuous pleasure.

The Mahometans are required to bathe three times a day. Among them a depilatory pomatum, to remove the hair, is often applied; it is composed of sulphuret of arsenic and quick-lime mixed with fat.

The Bramins are under the same religious injunction to bathe as the Mahometans.

The Hindoos of all classes perform their devotional pilgrimages to the Ganges and the Jumna, to bathe in their sin-absolving waters.

Among the North American Indians bathing, especially in rivers, has always been a general practice. Some tribes in the vicinity of the Rocky Mountains use the sudatory or hot sweating bath, followed by the cold plunge. Some of the extreme northern tribes make a square mud box on the edge of the river, in which they sit and enjoy a vapor bath, with steam raised by means of hot stones and jugs of water. This is rather a fashionable recreation among them, and is often practiced in parties for social amusement. On the frontiers a bath is constructed of wicker-work, the tip of which is covered with skins. William Penn saw an Indian chief, in the "colony of Pennsylvania," entirely cured of an attack of fever, by a thorough steaming, followed by several plunges in the river, for which purpose a hole was cut through the ice.

The Peruvians have numerous public baths, both from hot springs and from their hundreds of miles of aqueducts.

The Abysinians are represented by the traveler, Bruce, as in the habit of treating the violent fevers of that country with cold water externally and internally.

The Mexicans originally bathed in a sort of oven, into which the bather crept when sufficiently heated, and, by pouring water on the hot stones, raised a vapor and produced copious sweating. Kentish affirms that this bath is resorted to as a remedy for stings of insects and bites of poisonous reptiles; it is employed also by women after childbirth.

The French were long ago generally accustomed to bathing. Vapor and other baths were numerous in Paris at an early period of its history. Lately the vapor baths, which are frequent along the banks of the Seine, are employed as preparations for the warm-water bath. That they are visited, however, more for entertainment than from any sense of hygienic virtue is evident from the fact, that they have been occasionally closed for a time by the public authorities, and were once prohibited during the prevalence of a contagious disease. In Paris there are at present many warm, cold, and vapor bathing establish ments, some of which are very properly connected with the hospitals. Cold baths and swimming schools, for each sex separately, abound on the banks of the Seine.

In England bathing institutions arose and declined with those of Rome. Soon after the conquest of England by the Normans the leprosy made its appearance, when bathing habits revived again, and in treating the disease the cold bath was generally resorted to. About the middle of the sixteenth century the bathing practices of the people again degenerated to mere luxury; and, up to the present time, its warm, hot, mineral, and sulphurous springs have been quite a fashionable resort for that class of fashionable invalids whose complaints are closely connected with fashionable indolence. Now, however, cold bathing is increasing in favor, and promises to become general. Dr. Bell thinks it has already been carried to an extreme for medical purposes!

The people of the United States have never yet been overmuch given to bathing in any manner. The more wealthy in our cities resort to the bathing-houses occasionally, and in the warm season many of the city and country people amuse themselves by swimming in our rivers, lakes, ponds, and at various places on the sea shore. Some persons content themselves with washing the whole body once a week; others once a year; and a few are satisfied without washing at all. Every well-wisher of the human race will hope they will remain as they are in this respect, rather than imitate the sensualizing bathing customs of the old world. But attention to the general subject of bathing is fast awakening among us, and there is every reason to believe the great masses will ere long become sufficiently intelligent to adopt daily bathing as a physiological, hygienic, moral, social, and eminently Christian duty and privilege. Our largest cities, New York, Philadelphia, and Boston, have within a few years supplied themselves with an abundant supply of good soft water; many other cities and villages are about following the example, and the people in our country places are fast turning their attention to the benefits of having pure water for both bathing and drinking purposes. Bath-rooms, in the cities above named, are beginning to be regarded as indispensable apartments of public buildings and private dwellings. The numerous hydropathic establishments springing up in all parts of the country are perhaps the most efficient instrumentalities in indoctrinating individuals and families into the theory of personal cleanliness; and with all the agencies named we may regard the prospect for this nation to become "redeemed, regenerated, disenthralled," from obstructed pores and foul secretions, as very promising.

MEDICATED BATHS.—A brief notice in this place of the various methods of *impure* bathing, invented by superstitious ignoramuses and learned Æsculapians, may serve a better purpose than mere amusement for the reader.

A medicated bath, in the popular medical sense, is water or hot air charged with some drug or extraneous ingredient. In ancient times medicinal baths of oil, oil and water, milk, milk and wine, and even of blood, were employed. More recently, baths made of the steepings of the husks and other refuse matters of grapes, and of olives, after the expression of their juice and oil, have been employed; and still later gelatine, dissolved in water, has been recommended by physicians, probably as a *nutritious* bath!

Mud baths or *earth baths* have been employed in Germany, France, Italy, and other places. The process of a mud bath is technically called *illutation*. A kind of artificial illutament—presuming mud to be the *natural* one—for anointing the body, was made of oil and the perspirable matter scraped off the skins of the Greek athletæ. Doubtless it possessed as much virtue as any of the "all-healing ointments" of the present day.

Warm dung baths are not unknown among medical prescriptions on the continent of Europe.

Bees-eggs baths, made of wax, honey, and the excrement of bees, have been among the acknowledged outward medicaments, and probably have worked their due proportion of wonderful cures.

The *Sand bath*, called *arenation*, is known to many Eastern civilized and semi-civilized nations. The body is covered up with the warm sand and exuvial matters on the sea shore, so as to produce active sweating. Other substances, as earth and sulphur, salt and grain, have been used for arenation.

Insolation baths have enjoyed a high reputation. The body is wrapped up in the hide of an animal, or in leather, and then exposed to the heat of the sun until sweating takes place. Occasionally the body is turned so as to expose all sides to the sun about equally, not very unlike the operation of roasting a goose on a spit before the fire. The process is followed by washing in alum or sulphur water. Sometimes the patient is laid on a bed of wormwood, chamomile, sage, pennyroyal, or other herbs.

Epithems, *poultices*, and *fomentations*, which are really local baths, have been employed extensively both in ancient and modern times. Bags of heated sand, ashes, salt, oats, barley, etc., have each been supposed to possess peculiar virtues; while carrots, hard soap, basswood roots, flaxseed, Indian meal, bread and milk, yolk of eggs, scraped potatoes, with a great variety of barks, roots, and herbs have in thousands of instances filled the spectator with amazement by producing effects very like those of a common rag dipped in common water.

Sulphur fumigations were among the ancient baths; and several modern authors have written learned treatises on their employment for the itch. It is not many years since the administration of the Civil Hospitals of Paris appointed a commission of learned men to examine into the merits of the sulphur fumigating treatment in this disease. It may excite the risibles of those who have seen the itch effectually cured by a single soap-suds bath, to be told that among the many satisfactory conclusions to which the jury of investigation arrived was the fact that, "on an average, thirteen fumigations and a period of seven days were sufficient to cure the disease."

Vinegar fumigations have been employed since the days of Hippocrates. *Resinous, aromatic,* and *emollient herbs* have been employed in fomentations for 3000 years, and are in repute still.

General fumigations to the whole body, with a variety of mineral preparations, are now recognized processes of the allopathic materia medica. The articles in most common use are the mercurials—calomel, corrosive sublimate, and cinnibar—the protoxide of zinc, and deutoxide of arsenic.

Sulphuretted hydrogen gas, or *hydro-sulphuric acid*, is also employed in the same way.

Nitro-muriatic acid, for foot and other local baths, is a common prescription.

Pulmonary insufflation, called by some *atrimatrics*, has been lauded as a curative process in consumption and other diseases of the lungs. It consists mainly in inhaling some kind of foul air, made filthy by animal excrementitious matters, or by burning or smoking certain substances, so as to fill the room and the patient's lungs with their fumes, as turpentine, tar, gum, resin, styrax, vinegar, sugar, old leather, old rags, etc.

The terminal point of the ridiculous in this line of practice was reached when Dr. Beddoes published his book, recommending patients to sleep in cow stables, and inhale the fresh stench of that delectable locality, or, to speak learnedly, the "factitious gases," which are the common air mixed with exhalations from the skin, lungs, kidneys, and intestines of the animals. But Dr. Beddoes stands not alone in the glory of finding out cures for consumption. Almost all conceivable kinds of impure and disease-producing airs, as well as impure and disease-producing waters, have had the sanction of the medical profession as *remedies!*

Professor Reid gives us a list of thirty-four "factitious atmospheres," to be employed for medicinal purposes. The catalogue is worth recording, if for no other purpose, to aid some future virtuoso in making up a museum of obsolete medical curiosities: 1. Dry air; 2. Dry and hot air; 3. Dry and cold air; 4. Rapid and hot air; 5. Rapid and cold air; 6. Moist air; 7. Moist and warm; 8. Moist and cold; 9. Rapid, moist, and warm; 10. Rapid, moist, and cold; 11. Steamed air; 12. Highly oxygenated, by an admixture of oxygen; 13. Less oxygenating, by diluting air with nitrogen; 14. Deoxidating, by adding agents to abstract a part of the oxygen; 15. Nitrous oxide—intoxicating gas; 16. Nitrous acid; 17. Nitric acid; 18. Chlorinated; 19. Sulphurous; 20. Carbonic; 21. Ammoniacal; 22. Prussic; 23. Acetic; 24. Arsenical; 25. Mercurial; 26. Alcoholic; 27. Ethereal; 28. Benzoic; 29. Camphoric; 30. Lavender; 31. Orange; 32. Cinnamon; 33. Creosotic; 34. Hydro-sulphate of ammonia.

Iodine has lately found a place in medical books as a fumigator, or atrimatric agent.

Iodine with alcohol was introduced by Sir Charles Scudamore, who also employed the *tinctures of opium, conium, ipecac, deadly nightshade, digitalis, Prussic acid*, and *chlorine*.

The *hydriodate of potassa*, which is so frequently the efficiently evil agent in the sarsaparillas of the shops and the newspapers, is considerably employed atrimatrically.

Chlorine inhalation has had its day of fame in curing consumptions, the only drawback to which is the fact that the patients died.

Tobacco has had its merits confessed by the faculty. The smoke of tobacco cigars and camphor cigarettes has been recently recommended for affections of the throat, chest, and lungs, by the professors of our New York medical schools.

Peruvian bark, oak bark, myrrh, preparations of *iron, subnitrate of bismuth, hepar sulphuris, white vitriol, blue vitriol, alum, sugar of lead*, and *lunar caustic*, all reduced to impalpable powder, and applied by inhalation, are among the methods at the present time commended to us by living medical teachers, for the treatment of diseases of the air passages.

Gas baths are rather a modern notion. *Chlorine gas baths* have been exhibited for diseases of the liver, and *carbonic acid gas baths* are recommended for "every thing in general."

Soap baths are mentioned in medical books. They are certainly useful to those who do not wash frequently, and among medicated baths ought to rank as number one.

Medicinal water baths, made of the waters of our fashionable adulterated springs, are employed more or less, and many imitations of them are manufactured at home. They are merely water impregnated with various mineral, earthy, alkaline, and saline ingredients. Any person, by throwing a handful of dirt, a shovelful of coal or wood ashes, a spoonful of salt, and a piece of chalk into a barrel of pure Croton water, can make as good a medicated bath, or as healthful a medicated drink, as can be found at Saratoga, Avon, or Cheltenham.

The *anæsthetic* agents, *ether* and *chloroform*, which are properly atrimatrics, are now well known, and, except for surgical purposes, are destined to have a short-lived popularity.

Finally, we have the *grease bath.* This is the very latest external application which has emanated from the allopathic school. It consists in rubbing the whole surface of the body frequently with various unguents, as fat bacon, hog's lard, suet, tallow, etc., etc. It originated with Dr. Schneeman, physician to the King of Hanover, and in treating eruptive fevers, and many other diseases, is highly recommended by Dr. Taylor, of England, and a Dr. Lindsly, of Washington City. As a species of factitious unction it deserves to rank with the factitious atmosphere practice of Dr. Beddoes.

Medical Testimony in Favor of the Remedial Use of Water.—From the days of Hippocrates to Priessnitz, the most eminent physicians of all countries have spoken almost as extravagantly in praise of the medicinal employment of water as do the hydropaths—the hydro-maniacs, as they are sometimes called, of the present time. Yet directly in the face of this testimony its employment as a remedial agent had steadily declined, until recently revived by the wonders told of Graefenberg.

Hippocrates wrote much in favor of the good effects to be derived from water both in health and disease. He declared that the bath, in cases of pneumonia, soothes the pain in the side, chest, and back, concocts the sputa, promotes expectoration, improves the respiration, and allays lassitude. He advised pouring cold water on inflamed and swelled joints, in gout and rheumatism, and in spasms, luxations, and fractures.

Galen placed water in the highest rank of his materia medica. He regarded the bath, followed by exercise and friction, as one of the chief parts of a system of perfect cure. He has left the following record: "Cold water quickens the actions of the bowels, provided there be no constrictions from spasms, when warm water is to be used. Cold drink stops hemorrhages, and sometimes brings back heat. Cold drinks are good in continued and ardent fevers. They discharge the peccant and redundant humors by stool, or by vomiting, or by sweat." In biliousness, spasms, headache, fever of the stomach, hiccup, cholera morbus, obstinate ophthalmia, plethora, he recommended tepid and warm water-drinking, with the transition bathing—hot followed by tepid or cold.

Celsus, in treating affections of the head, directs a warm sweating bath, followed by the tepid and cold bath, with an additional quantity of cold water to the head. He recommends water in fullness of the stomach, headache, weak vision, deafness, tremors, sinking, pains in the joints, diarrhea, piles, and in hysterical and hypochondriacal affection; and praises the bath in low fevers, digestive disorders, and diseased kidneys. He also advises cold immersion in skin diseases and in hydrophobia.

Asclepiades, of Bithynia, though regarded as an empiric by the orthodox doctors of his day, advocated cold water internally and externally in hiccup, sour eructations, and nocturnal emissions.

Oribasius testified to the value of water-treatment in a manner similar to that of Galen.

Ætius directed baths in protracted fevers, convulsions, retention of urine, lassitude, and nervous pains, although he added to the water one fifth part of heated oil.

Rhazes advocated bathing in nearly all diseases. His water-treatment of small-pox was far more successful than any drug practice has proven since.

Avicenna was also a strenuous advocate for the watery regimen in a multitude of diseases, especially asthma, colics, and dropsy, He recommended infants to be bathed daily in tepid water. It is a sad pity that Avicenna, the Arabian Galen, has not more imitators in this respect among modern physicians.

Hoffman pronounced water a universal remedy. His language is: "We assert that water is a remedy suited to all persons, at all times; that there is no better preservative from distempers; that it is assuredly serviceable both in acute and chronic diseases; and, lastly, that its use *answers to all indications*, both of preservation and cure."

Boerhaave has written: No remedy can more effectually secure health and prevent disease than pure water.

Haller, as a testimonial of its value, drank nothing but water; and the same is recorded of *Demosthenes*, *Milton*, and *Locke*.

Floyer certifies: Water resists putrefaction and cools burning heat and thirst, and helps digestion. He recommended cold bathing in a variety of diseases.

Baynard supposed good water to possess healing and balsamic properties. He was a strong advocate for bathing as a remedy.

Gregory regarded water as a tonic to the digestive organs.

The celebrated *Cheyne* exclaimed: Without all peradventure, water was the primitive original beverage, and is the only simple fluid fitted for diluting, moistening, and cooling.

Macquart in an especial manner recommended men of science and letters to make water their favorite drink, assuring them that their ideas would be more precise, their judgment sounder, and their senses more delicate.

Londe, and *Levy*, French authors on hygiene, speak emphatically in favor of the utility of water in preserving health.

Sir John Ross, *Miller*, and other Northern navigators, have testified that exclusive water-drinkers endure the rigors and withstand the diseases of the frigid zone better than any other persons.

Dr. Jackson, and *Mr. Marshall*, of the British army, and *Drs. Mosely*, and *James Johnson*, of London, assure us that the dangers of living in tropical climates are the least for the pure water-drinkers, and that these are far less liable to the diseases of acclimation.

Haly Abbas, and *Mesues*, Arabian writers, prescribed bathing in most diseases, and their directions for conducting the processes were generally singularly judicious.

Alsahararius, Arabian, recommends bathing to moisten the body, open the pores, dispel flatulence, remove repletion, procure sleep, relieve pain, fluxes of the bowels, and lassitude, restore lean bodies to plumpness, soften contracted limbs, etc.

Lanzani, Italian, commended large doses of cold water internally as the best remedy for fever, and wrote two elaborate books to explain the grounds of his practice.

Fra Bernardo, Sicilian, acquired, in the early part of the last century, the title of "cold-water doctor," and won a high reputation for curing affections of the chest, palpitations, convulsions, obstinate dyspepsia, diarrhea, dropsy, hemorrhages, gout, and rheumatism, by water-treatment. He used iced-water freely internally, and applied ice to hot and inflamed parts. All food was withheld during the first four days—a point in practice which our beef-tea, mutton-broth, and chicken-soup slopping and stuffing doctors would do well, for their patients, to imitate.

Cirillo, Neapolitan, in 1720, treated a malignant fever, which prevailed at Naples, with what he called "the watery diet." He administered a pint or two of water, cooled by snow, every two hours for several days, permitting no kind of aliment whatever. When free perspiration took place the drink was omitted, and very light food allowed. He directed cold applications of snow to painful and inflamed parts, but did not prescribe general bathing.

Rovida, of Arragon, is said to have practiced the water-treatment extensively on the plan of Cirillo and Fra Bernardo.

Samoilowitz, Russian, in 1771, experienced signal success in treating the plague at Moscow, by means of cold acidulated drinks, and frictions to the whole body, with pounded ice.

Rev. John Hancock, an English clergyman, in 1722, published a tract in advocacy of water as the best remedy for fevers and the plague. He cured agues, scarlet fever, small-pox, measles, jaundice, and coughs, by copious water-drinking.

John Smith, C.M., English, wrote a book about a century ago, which is full of testimonials to the curative powers of water in nearly all the prevalent diseases of the day. Its title was, "The Curiosities of Common Water," and a large proportion of its pages is a compendium of the opinions of many celebrated physicians in favor of the employment of water as a general remedy. Among his authorities are *Manwaring*, *Keill*, *Prat*, *Duncan*, *Elliot*, *Allen*, *Harris*, *Van Heyden*, and *Pitt*, all eminent in the medical profession.

Geoffrey, French, more than a century ago, advocated the free use of water as a preventive of the plague.

Hecquel, French, about the same time, advocated the use of water as an almost universal specific.

Pomme, French, at a later period, wrote in favor of cold water-drinking and warm bathing for various remedial and hygienic purposes, and particularly for the treatment of hysterical and hypochondriacal disorders.

Rondeletius, French, published cases of gout cured by cold water as a beverage, as also did his countryman, *Martinus*.

Riverius, French, treated female complaints, particularly mismenstruation, successfully by the use of water alone.

De Hahn, German, directed free bathing and cold water-drinking during an epidemic fever at Breslau, in 1737, and his practice was far more successful than that of his competitors, who persisted in the employment of active drugs.

Theden, German, employed cold water and ice successfully in strangulated hernia, inflammations, malignant fevers, and small-pox.

Sturm, a Polish surgeon, testifies to the successful treatment of epidemic cholera, by means of as much warm water as the patients were able to drink, a glassful being administered every ten or fifteen minutes.

Those celebrated medical philosophers and physicians, *Harvey*, *Lourel*, *Cocchi*, *Sanctorius*, *Marziano*, and *Barthez*, advocated and practiced cold applications to gouty swellings, and inflammations.

Ambrose Pare declared that the true vulnerary, or dressing for wounds, was water alone.

Michael Angelo Blondi, Italian, wrote an essay, in 1542, on water as a remedy for gun-shot wounds.

Gabriel Fallopius, of Venice, *Felix Palatius*, of Trebia, and *Joubart*, *Martel*, and *Lamorier*, of France, strongly advocated water-dressings in surgical cases, instead of the more mystified and often mischievous plasters, balsams, liniments, lotions, or poultices.

Larrey, the most celebrated operative surgeo France ever produced, used water-dressings generally.

Kern, of Austria, praised the uses of water in the treatment of wounds, and even laid claim to the discovery of its superior merit.

M. Jose, of Amiens, recommended cold water in the treatment of wounds, burns, phlegmons, erysipelas, and gangrene.

Macartney, of Dublin, advises the free and methodical employment of water-dressings in wounds With him *irrigation* was a favorite mode of application.

Lancassani, in 1753, *Caldani*, in 1767, *Leanter*, in 1780, and *Percy*, in 1785, published conclusive evidences of the superiority of water alone to all the medicated fluids and compounds known, for surgical diseases.

Dr. Wright, of England, in 1777, employed cold ablutions extensively and successfully in the treatment of fevers.

Dr. Currie, of Liverpool, commenced the treatment of fevers by cold affusions in 1787. For several years he treated scarlet and typhus fevers, small-pox, and other diseases, principally by bathing, and with a success universally admitted to have been far greater than that of the ordinary drug-treatment. His work on the subject was published in 1797.

Dr. Robert Jackson, of the British army, had equal success in the same practice, the facts of which he published in 1791, at which time he had been in the habit of treating fevers by cold affusions for nearly twenty years.

Giannini, of Milan, strongly recommends cold immersion in typhus and petechial fevers.

Dr. Thaer, of Prussia, in 1825, treated measles by cold bathing, and with remarkable success, as compared with his drugging contemporaries.

Dr. N. Smith, of New Haven, Conn., was in the habit of dashing cold water on the bodies of patients in cases of typhoid fever, so as to drench both the body linen and bedding.

Dr. Forbes, present editor of the ablest medical journal of Europe, and one of the physicians to her Majesty Queen Victoria, confesses that in a large proportion of the cases of gout and rheumatism the Water-Cure seems to be extremely efficacious. He says further: "In that very large class of cases of complex disease, usually known under the name of chronic dyspepsia, in which other modes [Why wait to try "other modes?"] of treatment have failed, or been only partially successful, the practice of Priessnitz is well deserving of trial. In many chronic nervous affections and general debility we should anticipate great benefit from this system. In chronic diarrhea, dysentery, and hemorrhoids the sitz bath appears to be frequently an effectual remedy."

Dr. John Bell, author of the ablest historical work on bathing extant, has treated scarlatina in the Pennsylvania Hospital for many years by cold bathing, with the most satisfactory success. Although he does not entirely reject all other remedies, he admits that there is no other remedy than water which unites, to any thing like the same extent, efficacy with safety and immediately pleasurable results. He says: "How often have I seen the little sufferer, with burning heat and delirium, and unable to obtain sleep or repose of any kind, tranquillized immediately by the cold affusion, and fall into a sweet and refreshing sleep immediately afterward."

Such is a part of the testimony volunteered by the regular profession in favor of the system we advocate. The reader will bear in mind that nearly all the authorities thus far quoted are eminent authors, professors and practitioners of the allopathic school. After examining such a flood of evidence in favor of nearly all that is claimed by the hydropathists, the question naturally arises, Why is it, if regular physicians, in all ages, and of all countries, have found water-treatment so superior in the great mass of human maladies, that the medical faculty of the present day, as a body, employ it so little, in fact almost wholly neglect it, nay, bitterly and vehemently oppose it? This is indeed a strange problem, but it can be solved.

The minds—professional minds—of medical men of this day are as mystified and twistified, as superstitious and fantastical, as irrational and absurd, so far as *medical* logic is concerned, as were the minds of medical men in that by-gone age when charms, magic, incantations, and necromancy were among the remedial resources. And so their minds will remain until they have some fixed basis, some settled principles to reason from. A man may be in possession of any amount of book knowledge, he may know all the facts of all the sciences in existence, yet if he does not recognize the principles to which those facts relate, his writing and his talking may be unintelligible jargon, and his practice a promiscuous medley of truth and error. A man may understand all the letters of the alphabet, and all the words of the dictionary, and yet make bad words and sentences unless he is also acquainted with the principles of the construction of language.

The ancient priests and monks placed their patients in airy, salubrious situations, enjoined strict abstemiousness or the simplest food, gave water for drink, and prescribed sufficient washing or bathing for thorough cleanliness, and then performed their magical ceremonies. Their patients recovered; nature worked the cure, and the doctor got the credit.

Our more learned modern physicians, more abundantly supplied with disease-killing missiles, permit or recommend the grossest food, give poisoned or drugged waters instead of pure, pay scarcely any attention to hygienic regulations, bathe insignificantly, empirically, or not at all, and pour down the powerful remedies. Their patients die; nature gets the blame, and the doctor is excused, for surely no one could have done more!

The rock on which the water-treatment has ever been wrecked is eclecticism. Few minds, such is the bias of education, seem able to comprehend how it can be possible for a disease to be removed without a *little* medicine of some sort. It may be *very* little, infinitesimal, the thirtieth dilution, or a ten-millionth part of a drop of the tincture of a shadow, or the weakest decoction of catnip or canary seed; still it must be something *un*natural, or nature cannot be assisted! And if medicine of any kind or any strength is employed as an auxiliary, notwithstanding the use of water is regarded as the leading medication, the little, charming, mysterious influence of the drug will gradually gain upon the imagination, and in the end expel the water part of the practice as surely as weeds will run out flowers in an uncultivated field. It is like mixing brandy and water to make a beverage. Every one will admit that in such an admixture the water is the only strictly necessary and useful part of the drink; yet by employing them in combination no man ever had his taste for water increase, and that for brandy decrease. The contrary has always been the fact. The safety and the ultimate triumph of the Water-Cure system depends on keeping it clear of all "entangling alliances," and on that alone.

PART I.

ANATOMY.

Definitions.—Anatomy is the science of the structures of an organized body. An *organized* body consists of an assemblage of parts, each of which is called an *organ*, and all mutually related to, and dependent on, each other. All organized bodies are either *animal* or *vegetable* *Comparative anatomy* teaches the structures of animals. Human anatomy contemplates a knowledge of the structures of all the organs and parts of the human body, and their relations to each other.

Those structures which exist in all parts of the body are called *general*; those which are found only in particular parts are termed *special*. The entire organism consists of *solids*, in different degrees of density, and *fluids*, which circulate through them. The solids are *bones*, *teeth*, *cartilages*, *ligaments*, *muscles*, *nerves*, *vessels*, *viscera*, *membranes*, *skin*, *hair*, and *nails*. The fluids are *blood*, *chyle*, *lymph*, *saliva*, *gastric juice*, *pancreatic juice*, *synovia*, *mucus*, and *serum*. Bile, sweat, urine, etc., are excretions.

Organic Elements.—Reduced to their *ultimate* constituents by chemical analysis, almost the entire bulk of the body, except the bony tissue, is found to consist of *oxygen*, *hydrogen*, *nitrogen*, and *carbon* The bones and teeth contain a large proportion of *phosphate* and *carbonate of lime*. A very small proportion of other substances, considered to be elementary, are regarded by chemists as essential constituents. These are *phosphorous*, *sulphur*, *silicon*, *chlorine*, *iodine*, *bromine*, *fluorine*, *potassium*, *sodium*, *calcium*, *magnesium*, *iron*, *manganese*, and *aluminum*. To this list some late chemists have added *arsenic* and *copper*; and even *lead* and *gold* have quite recently been found in organized bodies, and have quite absurdly been put down as constituents.

Some of these elements, however, are only occasionally found in the human body, particularly arsenic, copper, lead, and gold; hence a more rational inference is, that they are accidental ingredients, instead of elementary constituents.

When it is considered how extensively metallic substances and mineral preparations are employed as medicines, and how generally metallic vessels, liable to oxidation, are used in cooking, to say nothing of the casual admixtures of drugs kept about dwellings, for various domestic purposes, with the articles of food and drink, it need not be surprising that chemists should now and then detect ingredients in the solids and fluids of the human body which have no natural relation to the organism, save as incidental poisons.

PROXIMATE PRINCIPLES.—The combination of the ultimate elements in various proportions forms the different organic substances called *proximate* elements, or principles. The most important are *albumen*, *fibrin*, and *gelatin*, which form the basis of the nervous, muscular, and cellular tissues. The refinements of chemical analysis have added or produced several other substances, which are put down as proximate. Most prominent among them are *osmazome*, procured by steeping muscular flesh in water or alcohol; *pepsin*, found in the gastric glands, *globulin*, in the blood corpuscles; *spermatin*, in the semen; *keratin*, in the hair and skin; *hematin*, in the bile, etc.

Most of these are probably mere products of the process of analysis; and there is no end to the "elements," proximate or ultimate, that could be produced by subjecting animal matters to chemical actions and re-agents. Thus chemists, in experimenting upon the bile, have already "found," as distinct principles, *bilin*; *fellinic acid*; *cholinic acid*; *taurin*; *dyslysin*; *cholepyrrhin*; *biliphæin*; *biliverdin*; *bilifulvin*; *cholesterin*; *oleate*, *mangarate*, and *stearate of soda*; *chloride of sodium*; *sulphate*, *lactate*, and *phosphate of soda*; *phosphate of lime*. I can see no reason why a hundred or a thousand others may not be developed by similar experiments, which certainly tend much more to the complication of scientific words and phrases than to the demonstration of true science.

TISSUES.—Each distinct solid structure is called a *tissue*. All tissues, however diversified in form, are produced from cells originating in a mass of soft, liquid matter, and they present the same general characteristics in all parts of the body. Every portion of the animal organism is formed of nucleated cells, which are constantly maturing, and as the body is undergoing continual decay and reproduction, they are always found in various stages of development.

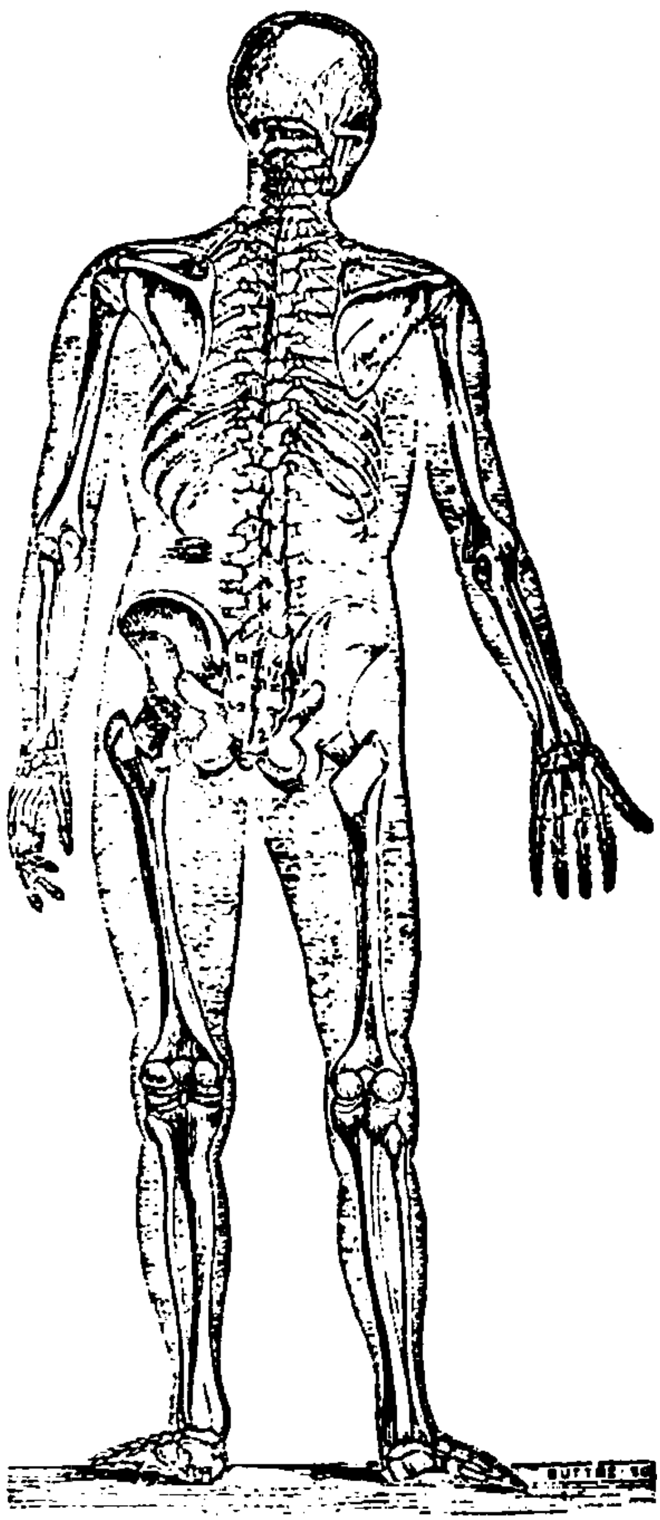
The divisions of tissues, and their vital properties, will be treated of in the physiological part of this work.

CHAPTER I.

OF THE BONES—OSTEOLOGY.

THE osseous structure constitutes the framework of the body. It gives form, firmness, and individuality to the physiological character, and affords surfaces and points for the connection of ligaments which hold the bones in position, and the attachment of muscles which move them. The proportion of the bony structure to the general bulk may be seen at a glance in Fig. 1.

Fig. 1.



RELATION OF BONES TO BULK.

The proximate constituents of bone are—

Cartilage	(parts)	32.17
Blood-vessels		1.13
Phosphate of lime		51.04
Carbonate of lime		11.30
Fluate of lime		2.00
Phosphate of magnesia		1.16
Soda, chloride of sodium		1.20
		100.00

STRUCTURE OF BONE.—The bony structure is a dense, compact, subfibrous basis, filled with minute cells, and traversed in all directions by branching and inosculating canals, called Haversian, which give passage to vessels and nerves. These cells are irregular in form and size, and give off numerous branching tubes, which, by communicating with each other in various directions, constitute a very delicate network.

Fig. 2.

MINUTE STRUCTURE OF BONE.

A microscopic view of the minute structure of bone is shown in Fig. 2. 1. One of the Haversian canals, surrounded by concentric lamellæ. 2. The same, with the cells and tubuli. 3. Area of one of the canals. 4 4. Direction of the medullary, or central canal. The upper part of the cut represents several long corpuscles, or cells, with their tubuli, the lower part exhibits the outlines of several other canals.

INVESTING MEMBRANE.—All the bones are invested with a dense fibrous membrane, called *periosteum*, except at their articulating surfaces, which are lined by a thin layer of cartilage. That portion of the periosteum which covers the skull bones is called *pericranium* ; and when it is prolonged over external cartilages, it is termed *perichondrium*.

The internal cavities of long bones, and the canals and cells of others, are lined by a membrane called *medullary*, and filled with an oily substance, called *medulla*, or marrow.

DEVELOPMENT OF BONE.—The osseous, like all organized structures, is found to exist primordially in a state of extremely minute vesicles, or cells. Each cell is composed of a thin membrane, enclosing a fluid matter, in which is a small, denser mass, constituting the *nucleus* around which the cell itself was originally developed. Within each nucleus may usually be found one or more smaller granules, or cells, called *nucleolus*, or *nucleoli*. And whether there are within these nucleoli yet smaller vesicles, and within them more minute nucleoli still, and so on, must be left to imagination. The human mind must grasp infinity before it can comprehend the primal atom, or starting-point, of vital organization.

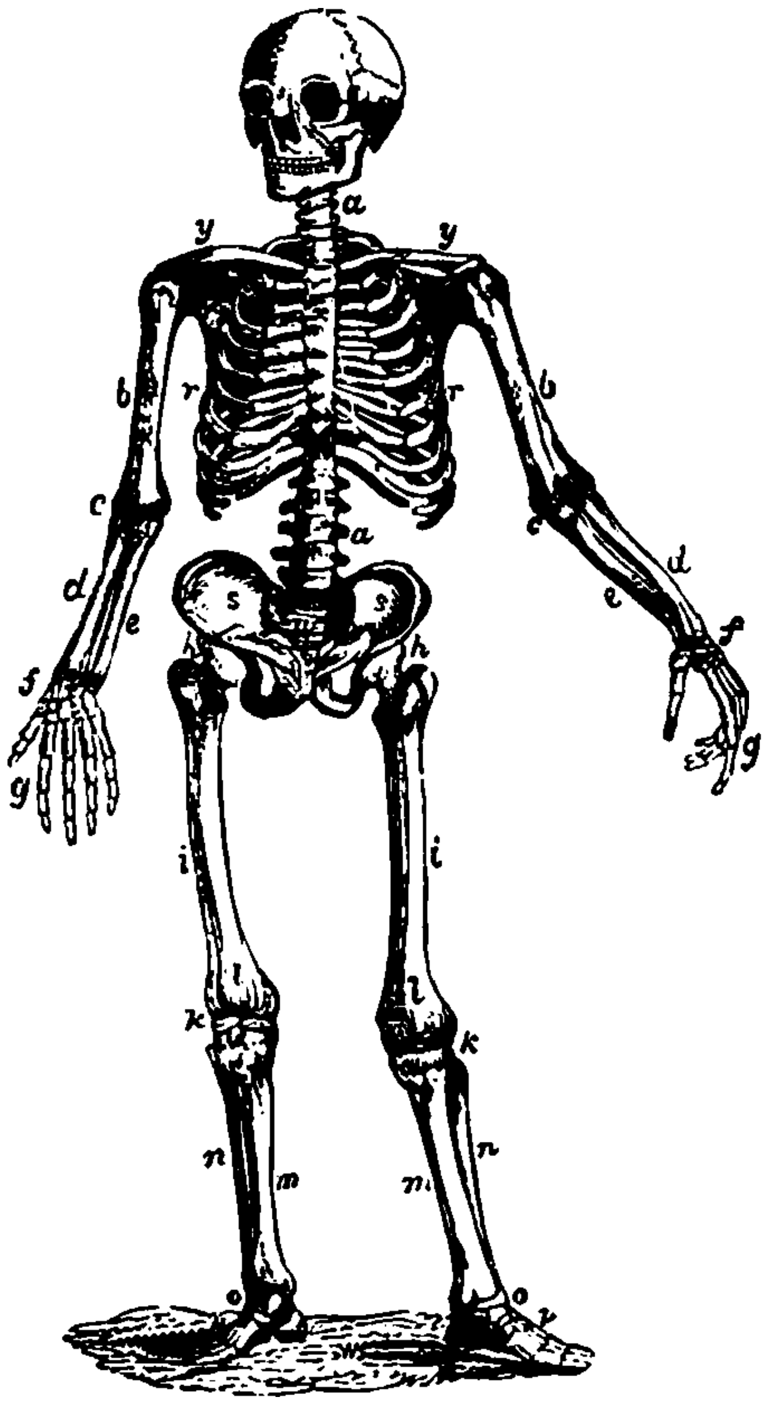
STAGES OF OSSIFICATION.—The first recognizable change of ordinary vesicles toward bony structure is an assemblage of minute cells, of a *gelatinous* or jelly-like consistence. In the process of growth these cells are separated by *intercellular substance*, which is transparent and fluid at first, but gradually becomes condensed and opake. Then the *cartilaginous* stage of ossification exists. In the cartilaginous substance vascular canals are formed by a union of cells in rows, and the liquefaction of the adhering surfaces. The next distinct change is into osseous substance. This is effected by the concentration of all the vascular canals to central points, each one of which is called *punctum ossificationis*. As the earthy particles are deposited around the central point, the surrounding cartilaginous cells become elongated, and within each cell two or three nucleoli are developed. Each of these secondary cells soon attains the size of the parent cell, the membrane of which disappears, and the newly-formed cells are separated by freshly effused intercellular substance. Still progressing, each newly-formed cell produces four, five, or six young cells, which destroy the parent membrane, and attain a larger size than the parent cell, being $\frac{1}{1600}$ of an inch in diameter, all the cells being separated as before by intercellular substance. This process of reproduction is repeated yet again, each cell producing as many as its parent before, which form in clusters of from thirty to fifty. The clusters are oval in figure, and are disposed longitudinally to the axis of the bone, while the cells themselves are arranged transversely. Very fine and delicate fibres, within the intercellular substance, commencing at the ossifying point, and extending through every part of the bone, longitudinally in long, and radiatingly in flat bones, are, lastly, formed, and complete the process of ossification. These fibres embrace each cluster of cells, and send branches between the individual cells of each group, by which the network of bone is formed, while the *areolæ* and Hervasian canals are formed by the conjunction of the cells. A highly magnifying power shows the ossific fibres to be composed of minute cells, of an elliptical form, and having central nucleoli.

THE SKELETON.

The skeleton of an adult person consists of two hundred and forty-six distinct pieces:

Bones of the head	8	Breast—sternum	1
Ear—ossicula auditûs	6	Pelvis—hip, sacrum, and coccyx	4
Face	14	Lower extremities—leg, instep, and toes	60
Teeth	32	Sesamoid—kneepan, and bones in tendons	8
Back—vertebral column	24		
Ribs—twelve pairs	24		
Tongue—os hyoides	1		
Upper extremities—arm, wrist, and fingers	64		246

Fig. 3.



OSSEOUS SYSTEM.

Anatomists distinguish three kinds of bones: the *long*, *flat*, and *irregular*. The long appertain to the limbs, the arms, legs, fingers, and toes; the flat enclose cavities, as the brain and pelvis; the irregular are mostly found about the base of the skull, face, trunk, wrist, and instep.

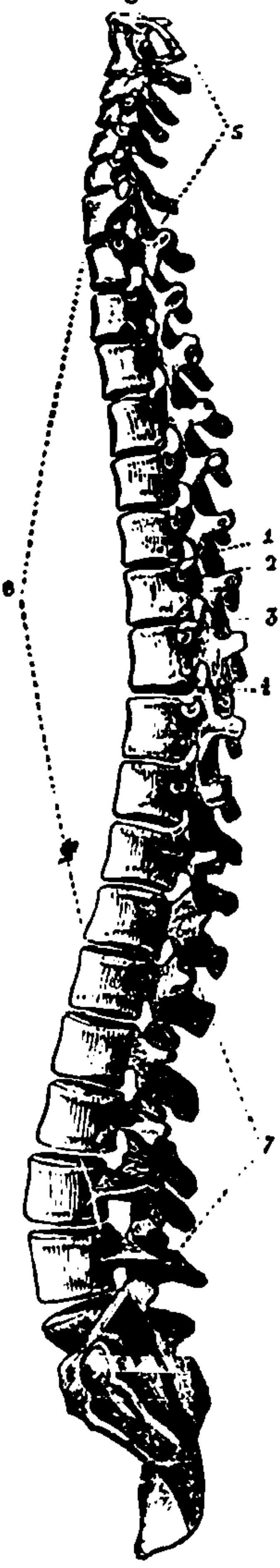
VERTEBRAL COLUMN.

The bones of the back, constituting the vertebral column, are divided into thirty-three pieces in the young person, but in advanced life the nine lower pieces unite into two. Each piece is called a *vertebra*. The whole are divided into *true* and *false*. The *true* are the twenty-four upper ones, and the *false* are the nine lower ones. The true are subdivided into *seven cervical*, belonging to the neck, *twelve dorsal*, forming the central portion of the back proper, and *five lumbar*, pertaining to the loins. The *false* are divided into the *sacrum*, which consists originally of five pieces, and the *coccyx*, originally consisting of four pieces.

The vertebral column is the central axis of the body, and the part of the skeleton first developed in all vertebrated animals.

Each vertebra, except the upper cervical, which has no body, consists of a *body*, by which it is articulated with the adjoining vertebræ; two *laminæ*, or plates, which arch backward and enclose the passage for the spinal cord; a *spinous process*, which projects backward for

Fig. 4.



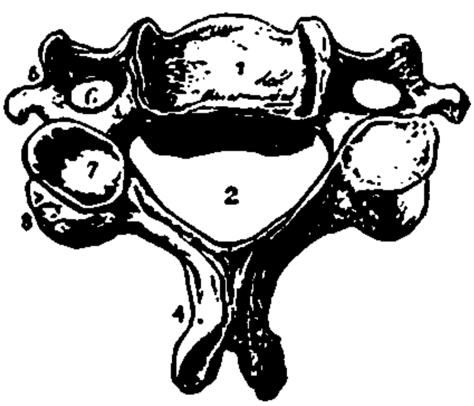
VERTEBRAL COLUMN.

the attachment of muscles; *two transverse processes* projecting laterally from each side of the laminæ for the attachment of muscles; and *four articular processes*, which project upward and downward from the laminæ, for articulation with adjoining vertebræ

Fig. 4 represents the vertebral column entire, seen from the left side. 1. Two semi-facettes, which articulate with the head of the rib. 2. Spinous process. 3, 4. Two foramina, each resulting from the union of two vertebræ. 5. Cervical region and its corresponding curve. 6. Dorsal region and its corresponding curve. 7. Lumbar region and its corresponding curve. 8. Sacrum.

The distinctive parts of a vertebra are seen in Fig. 5. 1. The body, concave in the centre, and rising into a sharp ridge on each side. 2. The lamina. 3. The part called pedicle, rendered concave by the superior intervertebral notch. 4. Spinous process, its extremity bifurcated. 5. Transverse process. 6. Vertebral foramen. 7. Superior articular process. 8. Inferior articular process.

Fig. 5



A CERVICAL VERTEBRA.

The *first cervical vertebra* supports the head, from which circumstance it is called the *atlas*. It is a simple ring of bone, and moves laterally, as well as forward and backward to some extent on the second cervical, which is called the *axis*.

The *axis* has a large body, and a strong, tooth-like process, called *odontoid*, which rises perpendicularly, and is articulated with the anterior arch of the atlas, while its posterior surface is firmly bound by a strong transverse ligament.

The atlas (turning on the axis) moves the head, as though it were turning on a pivot.

The *seventh cervical* is called *prominens*, because its spinous process projects backward beyond the others, forming the prominent part of the back of the neck. This prominence is terminated by a tubercle, to which the strong ligament of the neck *ligamentum nuchæ*, is attached.

The *dorsal* vertebræ are marked on each side by articulating surfaces, *facets*, for receiving the head of the ribs. In size the dorsal are midway between the cervical and lumbar.

The *lumbar vertebræ* are the largest; their bodies are thicker before than behind; their spinal cavity is large and oval, and their spinous processes are thick and broad.

The *sacrum* is of a triangular figure, concave in front and convex posteriorly. It is marked by four transverse ridges, which indicate the consolidation of five separate pieces.

The *coccyx*, which terminates the vertebral column below, is composed of four small pieces, which gradually unite in one; and this one becomes consolidated to the sacrum soon after the middle period of life.

The *whole vertebral column* represents two pyramids, with bases applied to each other; the sacrum and coccyx constituting the lower, and all the vertebræ, except the atlas, forming the upper. The *bodies* are broad in the cervical region, narrower in the middle of the dorsal. and again broad in the lumbar region. The *spinous processes* are horizontal in the cervical, gradually becoming oblique in the upper part of the dorsal, nearly vertical and inbricated in the middle of the back, and again horizontal toward the lower part. The *transverse processes* gradually increase in length from the axis to the first dorsal vertebra; in the dorsal region they project obliquely backward, and diminish suddenly in length in the eleventh or twelfth, where they are very small. The *intervertebral foramina* are openings formed by the juxtaposition of the vertebral notches; they are smallest in the cervical region, gradually enlarging to the lumbar. The *vertebral groove* extends the whole length of the column on either side of the spinous processes, for lodging the principal muscles of the back.

BONES OF THE SKULL.

They are divided into those of the *cranium*, and those of the *face*. The cranial, like all flat bones, are formed with two plates, or tables, and an intervening cellular network, called *diploe*, which contains an oily, medullary substance. This structure is admirably calculated to protect the brain from shocks, blows, etc. The cranial bones are eight in number, and the facial fourteen:

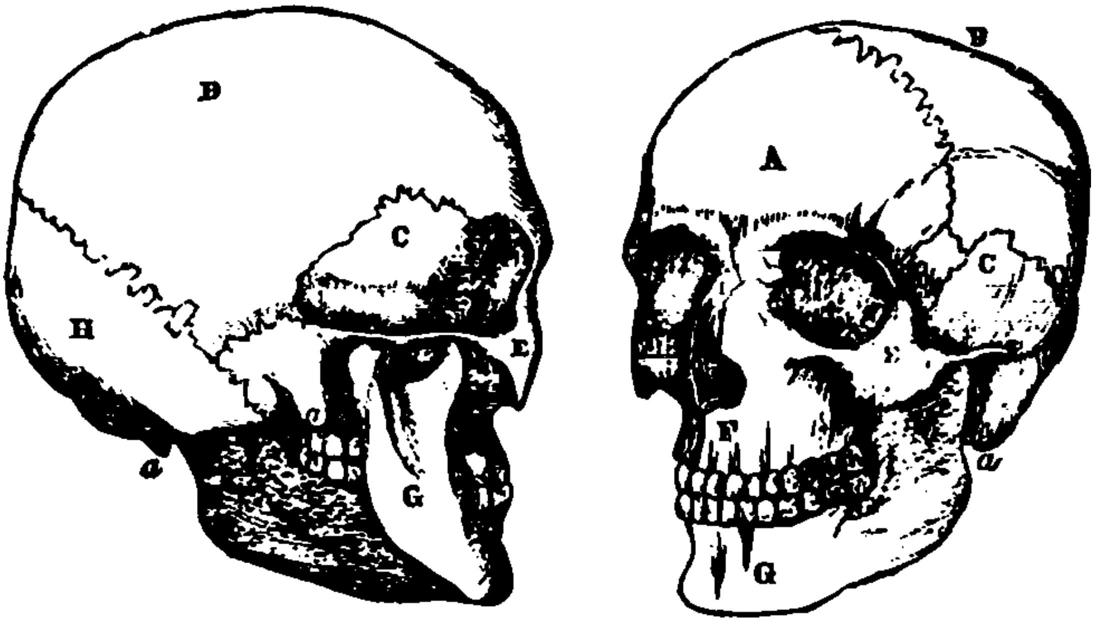
Cranial Bones.

Occipital,	Frontal,	Sphenoid,
Two parietal,	Two tempora.	Ethmoid.

Facial Bones.

Two nasal,	Two palate,
Two superior maxillary,	Two inferior turbinated,
Two lachrymal,	Vomer,
Two malar,	Inferior maxillary.

Fig. 6.



BONES OF THE HEAD.

In Fig. 6, A represents the frontal bone. B B. Parietal. C C. Temporal. D D. Sphenoid. E E. Malar. F F. Superior maxillary. G G. Inferior maxillary. H. Occipital. I. Nasal. *a a.* Mastoid process of the temporal bone.

The *Occipital bone* forms the base and back part of the cranium. Its external surface is marked by *two transverse ridges;* in the middle of the upper one is a projection, at which point the bone is very thick and strong. Tyros in phrenology have sometimes mistaken this projection for the *bump of parentiveness.* About an inch below this projection is the *foramen magnum*, a large opening for the connection of the spinal cord with the brain. On each side of this orifice are processes, called *condyles*, for articulating with the atlas. The internal surface of the occipital bone is divided by a *crucial ridge* into four *fossæ.* In the upper fossæ are lodged the posterior lobes of the cerebrum, and in the two inferior the lateral lobes of the cerebellum. In front of the foramen magnum is a projection called the *basilar process*, on which rests the medulla oblongata.

The *Parietal bones* are quadrilateral in form, situated at the side and vertex of the skull, and connected with each other by a straight suture, called *sagittal.* On the external surface of each bone is an arched line, called the *temporal ridge*. The internal surface is marked by numerous furrows, which lodge the ramifications of the middle meningeal artery, and by *digital fossæ*, corresponding with the convolutions of the brain.

The *Frontal bone* is situated at the anterior part of the cranium, forming the forehead, and a part of the roof of the nostrils and orbits of the eyes. Each lateral half of the bone projects forward, forming the *frontal eminences*. Below these points are the *superciliary ridges*, which support the eyebrows. Between these ridges is a rough projection, called *nasal tuberosity*, behind which is a canal, called the *longitudinal sinus*. On the side of the bone is the *temporal ridge*, and below this is a depression, called the *temporal fossæ*. The sharp, prominent arches, which form the upper part of the orbits are called the *internal* and *external angular processes*. Between these processes is a rough excavation, which receives the nasal bones, and a projection, called the *nasal spine*. The internal surface is divided by a grooved ridge; in the groove the longitudinal sinus is lodged, and to the edges of the ridge the *falx cerebri* is attached. On the orbital portions are *fossæ* corresponding to the convolutions of the anterior lobes of the cerebrum.

The *Temporal bones* are situated at the side and base of the skull, and are divided into squamous, mastoid, and petrous portions.

The *squamous* portion forms the anterior part of each bone, and the thin, translucent part of the temple. A long, arched process projects from its external surface, called the *zygoma*. Its internal surface is irregularly depressed by the convolutions of the cerebrum.

The *mastoid* portion forms the back part of the bone. Beginners in phrenological science, on feeling behind the ears, have often mistaken its projection for an enormous "combativeness." It is thick, rough, and pierced with numerous holes for the passage of very small arteries and veins. Interiorly, a part of it is excavated into numerous cells, which belong to the organ of hearing. In front of it is the *meatus auditorius externus*, or external ear passage.

The *petrous* portion is extremely hard and dense. In shape it is a three-sided pyramid. Near the middle of its posterior surface is the entrance of the *meatus auditorius internus*, about one third of an inch in depth. At the bottom of the meatus is a fossa, called *reniform*; it is divided by a sharp ridge into an upper and lower compartment; this ridge is prolonged for some distance upon the anterior wall of the meatus, and marks the situation of the facial and auditory nerves, which constitute the seventh pair, and enter the meatus.

The *basilar surface* is rough and irregular, and assists to form the under surface of the base of the skull. To a smooth fossa, called *glenoid*, the condyle of the lower jaw is articulated. At the inner angle of this fossa is the foramen of the Eustachian tube.

The *Sphenoid bone* is situated at the base of the skull, and enters into the formation both of the cranium and face. Its shape has been compared to a bat with its wings extended. It is divided into a central portion, or *body; lesser wings*, consisting of two small triangular plates projected from the anterior and upper part of the body; *greater wings*, expanding laterally from each side of the body; *spinous processes*, extending backward from the base of the greater wings; and *pterygoid processes*, extending downward from the greater wings. On the *superior surface* of its body are seen the *optic foramina*, which transmit the optic nerve and ophthalmic arteries. The *posterior surface* is flat, rough, and articulated with the basilar process of the occipital bone. The *lesser wings* form the posterior parts of the roof of the orbits, and are traversed by the optic foramina. The *greater wings* form part of the middle fossæ of the base of the skull, and assist in forming the outer walls of the orbits. The external border of the *spinous process* is articulated with the squamous portion of the temporal bone; its internal border is grooved for the reception of the Eustachian tube. The *pterygoid processes* form the lateral boundaries of the posterior nares.

The *Ethmoid bone* (sieve-like) is a square, cellular bone, between the orbits at the root of the nose. It is named from a number of small openings which perforate the surface. It consists of a thin *central plate*, which assists in forming the septum of the nose, and *two lateral masses*. From the upper part of the septum a strong process projects into the cavity of the skull, called *crista galli*, to which the falx cerebri is attached. On each side of the crista galli is a grooved plate perforated by numerous openings, the *cribriform lamella*, which supports the bulb of the olfactory nerve, and gives passage to its filaments, and also to the nasal branch of the ophthalmic nerve.

The *lateral masses* are composed of cells. The internal surface forms the external boundary of the upper part of the nasal fossæ. The external surface enters into the formation of the inner wall of the orbit. What is called the *superior turbinated bone* is a thin, curled plate of the internal surface, constituting the upper margin of a narrow fissure—the *superior meatus* of the nose. Below the meatus another thin plate curls outward; it is called the *middle turbinated bone*.

The *Nasal bones* are small, quadrangular pieces, forming the bridge and base of the nose They are convex superiorly, and slightly concave on their under surface, which is grooved for the nasal branch of the ophthalmic nerve.

The *Superior Maxillary bones* form the whole of the upper jaw, and assist in forming the orbit, nose, cheek, and palate. The *body* of each is triangular; its interior is hollow, forming the *antrum;* and its lower part presents the *alveolar processes,* for containing the upper teeth. The *posterior surface* forms part of the *zygomatic fossa,* over which a projection extends to the malar bone, called the *malar process.* A process called *nasal* articulates with the frontal and nasal bone. Between the opening of the antrum, which is an irregular hole on its nasal surface, and the nasal process, is a deep vertical groove, called *sulcus lachrymalis,* which is formed into a canal by the lachrymal and inferior turbinated bones, constituting the nasal duct. The margin of the nasal process is marked by a small tubercle, which serves to guide the knife of the surgeon in operating for fistula lachrymalis. The *palate process* projects horizontally inward—its upper surface forming the floor of the nares, and its under surface a part of the roof of the mouth.

Each *Lachrymal bone* is a thin, oval plate, situated at the anterior and inner angle of the orbit of the eye. A portion of its *external surface* assists in forming the orbit; another portion is concave, and lodges the lachrymal sac. The *internal surface* assists in forming the nasal fossæ and nasal duct.

The *Malar bones* are the quadrangular pieces which form the prominences of the cheeks. The *external surface* of each has many small openings for the passage of filaments of nerves and minute arteries. A process, called *frontal,* ascends to articulate with the external angular process of the frontal bone, and form the outer border of the orbit. It is united to the zygoma of the temporal bone by a process called *zygomatic,* and to the superior maxillary by the *maxillary process.*

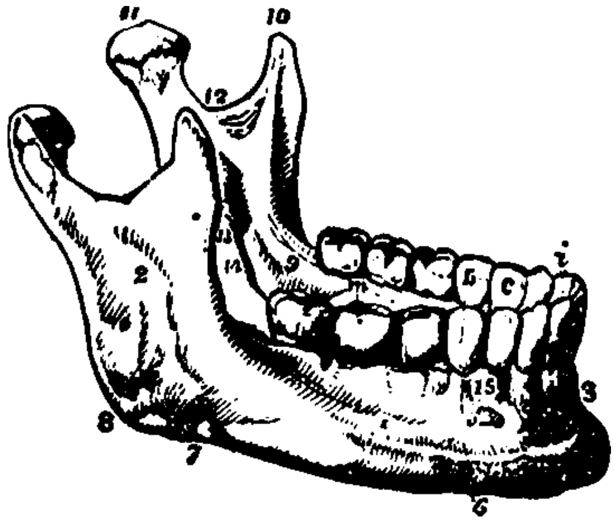
The *Palate bones* are situated at the back part of the nares, and enter into the formation of the palate, side of the nose, and the posterior part of the floor of the orbit. Each bone resembles the letter L, the perpendicular and horizontal portions presenting each two quadrilateral surfaces.

The *Inferior Turbinated bones* are light, spongy, irregularly curved bones, projecting inward toward the *septum narium,* or partition of the nose. Each one is attached to the maxillary bone in front, and the palate bone behind.

The *Vomer* is a thin quadrilateral piece, forming the back and lower part of the septum of the nose

The *Inferior Maxillary bone*, or lower jaw, is an arch of bone containing the under row of teeth. Its distinctive parts are shown in fig. 7.

Fig. 7.



LOWER JAW.

1. The body. 2. The ramus. 3. The symphisis, or point of union. 4. Fossa for the depressing muscle of the lower jaw. 5. Mental foramen. 6. External oblique ridge. 7. Groove for the facial artery. 8. The angle. 9. Extremity of the milo-hyoidean ridge. 10. Coronoid process. 11. The condyles, which articulate with the glenoid cavity of the temporal bone. 12. Sigmoid notch. 13. Inferior dental foramen. 14. Milo-hyoidean groove. 15. Alveolar process. *i.* The middle and lateral incisor tooth of one side. *l.* The canine tooth. *b.* The two bicuspids. *m.* The three molars.

SUTURES OF THE SKULL.

The bones of the skull are connected with each other by sutures (*sutura*, a seam), of which anatomists distinguish several varieties; the most important are *serrated*, saw-teeth-like; *squamous*, or scaly; *harmonia*, or apposite; and *schindylesis*, fissure-like.

The most prominent cranial articulations are the *coronal*, *sagittal*, and *lambdoidal* sutures, all of which are serrated. The *coronal* extends transversely across the crown of the skull, uniting the frontal bone with the two parietal. The *sagittal* forms the longitudinal seam along the vertex, and unites with two parietal bones. The *lambdoidal* diverges at an acute angle from the posterior extremity of the sagittal, uniting the occipital and parietal bones. The *squamous* unites the squamous portion of the temporal with the parietal and sphenoid bones. Other sutures are named according to the bones, or parts of bones, which they connect.

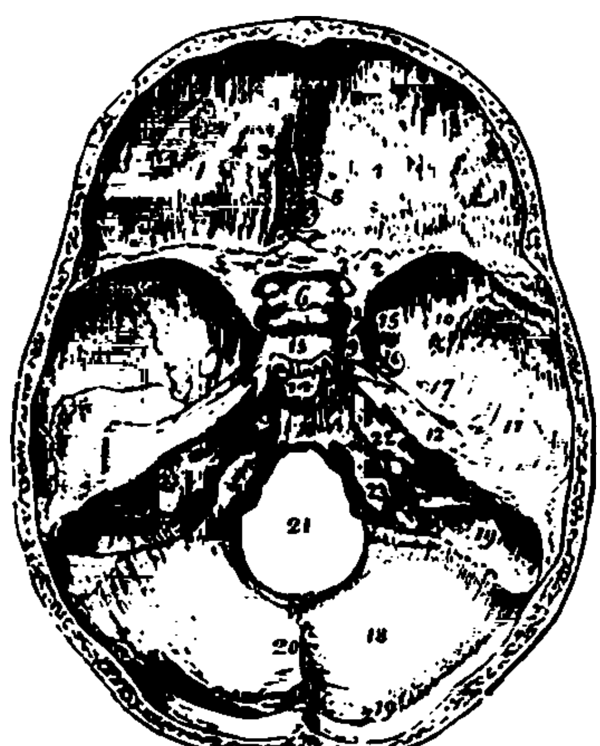
Regions.—The skull is divisible into four regions—superior, lateral, inferior, and anterior; or, vertex, side, base, and front. The *superior region* is bounded by the frontal eminences in front, temporal ridges and parietal eminences on each side, and by the upper curved line and protuberance of the occipital behind. The *lateral* is subdivided into *temporal*, *mastoid*, and *zygomatic* portions. The *inferior region* is subdivided into a *cerebral*, or internal, and a *basilar*, or external, surface. The cerebral surface is again subdivided into *anterior*, *middle*, and *posterior fossa*. The face constitutes the *anterior region*.

Fig. 8.

FRONT VIEW OF THE SKULL.

Fig. 6 exhibits several minute peculiarities of structure not described in the text. 1. The frontal portion of the frontal bone. 2. Nasal tuberosity. 3. Supra-orbital ridge. 4. Optic foramen. 5. A fissure, called sphenoidal. 6. Another fissure, called spheno-maxillary 7. The lachrymal fossa. 8. Opening of the anterior nares, the vomer in the centre, on which the figure is placed. 9. Infra-orbital foramen. 10. Malar bone. 11. Symphisis, or point of union of the lower jaw. 12. Mental foramen. 13. Ramus of the lower jaw. 14. Parietal bone. 15. Coronal suture. 16. Temporal bone. 17. Squamous suture. 18. Upper part, or greater wings, of sphenoid bone. 19. Commencement of temporal ridge. 20. Zygoma of temporal bone, forming, with the malar, the zygomatic arch, under which is the zygomatic fossa. 21. The mastoid process.

Fig. 9.



INNER BASE OF THE SKULL.

Fig. 9 represents the cerebral surface of the base of the skull. 1. One side of the anterior fossa. 2. Lesser wing of the sphenoid. 3. Crista galli. 4. Foramen cæcum. 5. Cribriform lamella of the ethmoid. 6. The process called *olivary*. 7. Foramen opticum. 8. Anterior clinoid process. 9. The carotid groove on the side of the sella turcica, for the internal carotid artery and cavernous sinus. 10, 11, 12. Middle fossa of the base of the skull: 10 marks the great ala of the sphenoid; 11, the squamous portion of the temporal bone; 12, the petrous portion. 13. The sella turcica. 14. Basilar portion of sphenoid and occipital bones. The uneven ridge between 13 and 14 is called *dorsum* ephippii, and the prominent angles of the ridge constitute the posterior clinoid processes. 15. Foramen rotundum. 16. Foramen ovale. 17. Foramen spinosum; a small opening between 17 and 12 is called *hiatus Fallopii*. 18. Posterior fossa of the base of the skull. 19, 19. The groove for the lateral sinus. 20. The ridge upon the occipital bone, to which the *falx cerebelli* is attached. 21. Foramen magnum. 22. Meatus auditorius internus. 23. Jugular foramen.

ORBITS OF THE EYE.

These are hollow cones for the lodgment of the eyeballs, with their muscles, vessels, and nerves, and the lachrymal glands. The *superior* boundary is formed by the orbital plate of the frontal bone, and by part of the lesser wing of the sphenoid; the *inferior* by part of the malar bone, and by the orbital process of the superior maxillary and palate bones; the *internal* by the lachrymal bone, the external surface of the ethmoid, called *os planum*, and part of the body of the sphenoid; and the *external* by the orbital process of the malar bone, and the great ala, or wing of the sphenoid. Communicating with the orbit are *nine* openings for the transmission of arteries, veins, and nerves.

The *Nasal Fossæ* are irregular cavities in the middle of the face, bounded *above* by the nasal bones, ethmoid and sphenoid; *below* by the palate processes of the palate and superior maxillary bones; *outwardly* by the superior maxillary, lachrymal, inferior turbinated, superior and middle turbinated bones of the ethmoid, palate, and internal pterygoid plate of the sphenoid. The partition between them is formed by the vomer and the perpendicular lamella of the ethmoid.

Each nasal cavity is divided into three irregular longitudinal passages, called *meatuses*, by three projecting processes of bone from the outer wall—the superior, middle, and inferior turbinated bones. The inferior or lower meatus is much the largest.

THE TEETH.

The human animal is provided with two sets of teeth: the first are those of childhood, called *deciduous*, or milk teeth. The second are *permanent*. The teeth of childhood are twenty: *eight incisor*, or cutting, *four canine*, and *eight molars*, or grinding teeth.

Fig. 10.

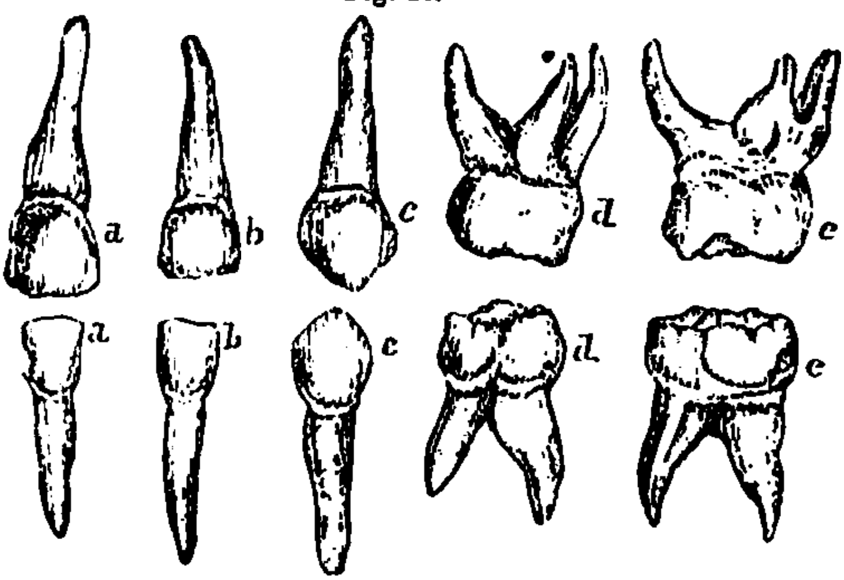
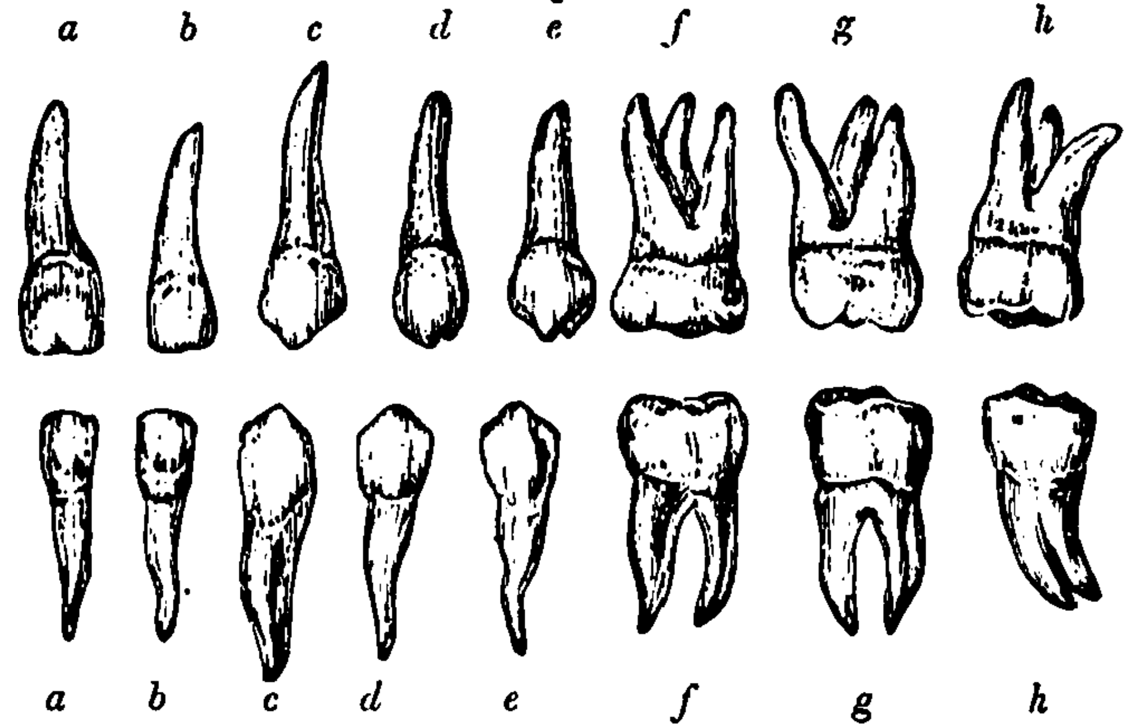


Fig. 10.—*a.* Central incisor. *b.* Lateral incisor. *c.* Canine. *d.* First molar. *e.* Second molar.

TEMPORARY TEETH.

The permanent teeth are thirty-two, sixteen in each jaw. The *eight* central are called *incisors*, or cutting; next are the *four canine*, or eye teeth; then the *eight bicuspids*, or small double; and lastly, *twelve molars*, or grinding. Each lateral half of each jaw, reckoning from the centre, contains two incisors, one canine, two bicuspids, and three molars.

Fig. 11.

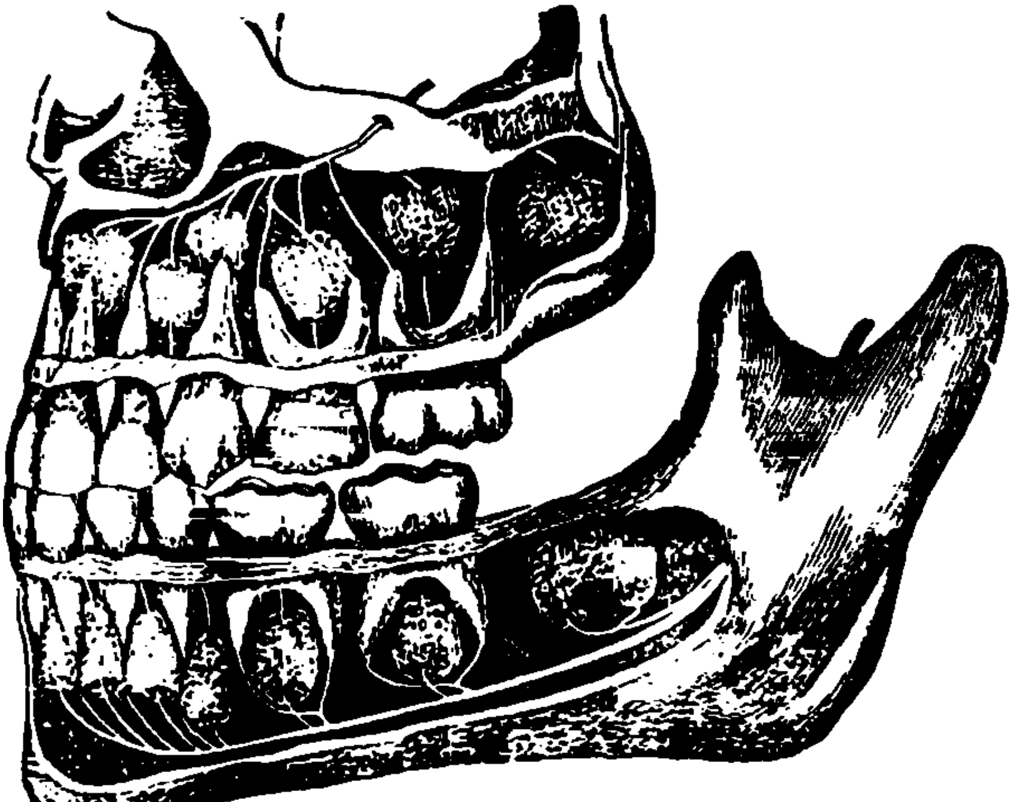


PERMANENT TEETH.

In Fig. 11, *a* is the central incisor. *b*. Latera. incisor. *c*. Cuspid, or canine. *d*. First bicuspid. *e*. Second bicuspid. *f*. First molar. *g*. Second molar. *h*. Third molar.

A tooth is composed of a firm external crust, called *enamel;* the tooth bone proper, called the *ivory;* and a cortical substance, called *cementum*. The enamel covers the exposed surface of the crown, and

Fig. 12.



INFANT TEETH, AND RUDIMENTS OF THE PERMANENT the cementum forms a thin coating over the root of the tooth. Its structure is similar to bone, and exhibits numerous calcigerous cells and tubuli. The cementum becomes thicker in old age, and gives rise to appearances in old persons called *exostosed;* the same appearances are also produced by mercury and other drugs.

In Fig. 12 are seen the number, arrangement, and nervous connection of a complete set of infant teeth, with the rudiments of the second set, or permanent teeth. The cut represents the jaws of a child at the age of about four years.

Periods of Dentition.—The temporary teeth usually appear in the following order, the lower teeth generally preceding the upper: In the *seventh* month the two middle incisors; in the *ninth* the two lateral incisors; in the *twelfth* the first molares; in the *eighteenth* the canine; and in the *twenty-fourth* the two last molares. This order, however, is subject to considerable irregularity.

The permanent teeth generally appear:

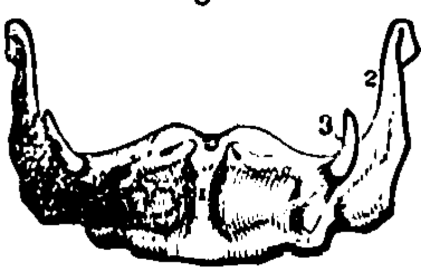
First molares, at 6½ years.	Second bicuspids, 10th year.
Two middle incisors, 7th year.	Canine, 11th to 12th year.
Two lateral incisors, 8th year.	Second molares, 12th to 13th year.
First bicuspids, 9th year.	Last molares, 18th to 21st year.

The last grinding tooth, from its late development, is called *dens sapienta,* or wisdom tooth. Occasionally it does not appear till twenty-five or thirty years of age, or even later.

The *Hyoid,* or tongue bone, called *os hyoides,* is situated at the base of the tongue, supporting it and the upper part of the larynx. It consists of a central body, two processes, which project backward, called the *greater cornua,* and two *lesser cornua,* ascending from its angles.

Fig. 13 is a front view of it. 1. The convex or antero-superior side of the body. 2. Greater cornua of the left side. 3. Lesser cornua.

Fig. 13.



OS HYOIDES.

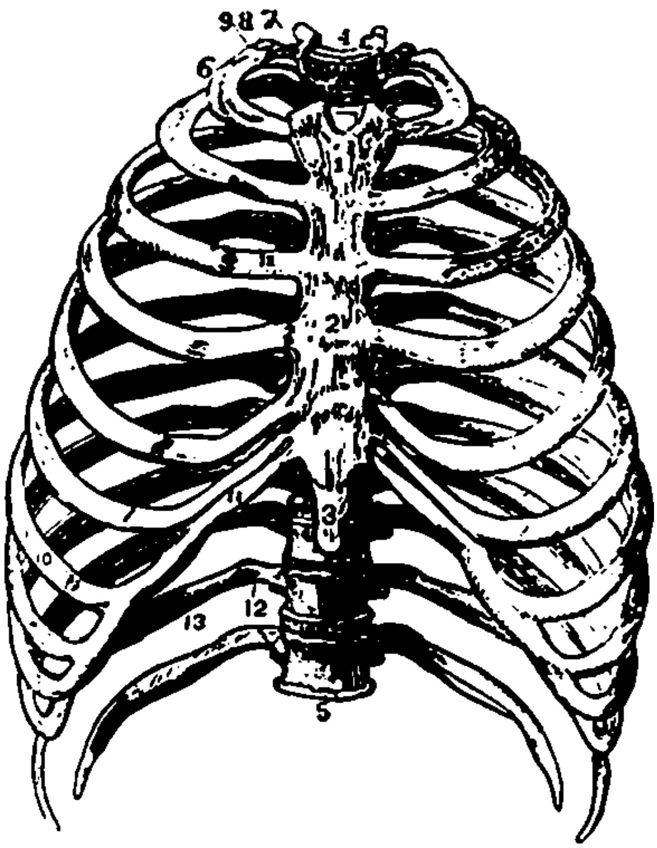
In early life the cornua and body are connected by cartilages and ligaments which become ossified in old age.

BONES OF THE CHEST.

The sternum, or breast bone, in front, and the twelve pairs of ribs on the sides, constitute the *thorax.*

The *Sternum* is situated in the central line of the front part of the chest; its upper end lies within a few inches of the vertebral column, while its inferior extremity projects considerably forward. Its upper end is called *manubrium*, to each side of which the clavicle is attached. The middle portion is called the *body*, and the inferior extremity terminates in the *xiphoid*, or *ensiform cartilage*.

Fig. 14.



THE THORAX.

An anterior view of the thorax is represented in Fig. 14. 1. The manubrium. 2. Body. 3. Ensiform cartilage. 4. First dorsal vertebra. 5. Last dorsal vertebra. 6. First rib. 7. Head of first rib. 8. Its neck. 9. Its tubercle. 10. Seventh rib. 11. Costal cartilages of the ribs. 12. Last two false ribs. 13. The groove along the lower border of each rib.

THE RIBS.—The first or upper seven pairs are called *sternal*, or *true* ribs, because they are articulated with the sternum. The five lower pairs are called *false*, or *asternal*, and are connected with each other in front by cartilages.

The ribs increase in length from the first to the eighth, and then diminish to the twelfth. In breadth they diminish from the first to the last, excepting the two lower ones. The first is horizontal, and all the rest oblique, the anterior end falling considerably below the vertebral end. Each rib is curved to correspond with the arch of the thorax, and twisted upon itself. Near the vertebral extremity the rib is bent upon itself, forming an *angle* for the attachment of the tendon of the sacro-lumbalis muscle. Behind this angle is the rough elevation called the *tubercle*. The vertebral end of the rib is expanded into a *head* for articulation with two contiguous vertebræ. The two lower false ribs are much shorter than the others, and are called *floating* ribs.

The sternal ends of the ribs are cartilaginous, thus contributing mainly to the elasticity of the thorax; in old age these *costal cartilages* are more or less ossified. The first seven cartilages articulate with the sternum; the three next with the lower border of that immediately preceding; and the last two lie free between the abdominal muscles. Each rib articulates with two vertebræ posteriorly, and one costal cartilage in front, except the first, tenth, eleventh, and twelfth, which are only articulated with a single verte ra each

BONES OF THE UPPER EXTREMITIES.

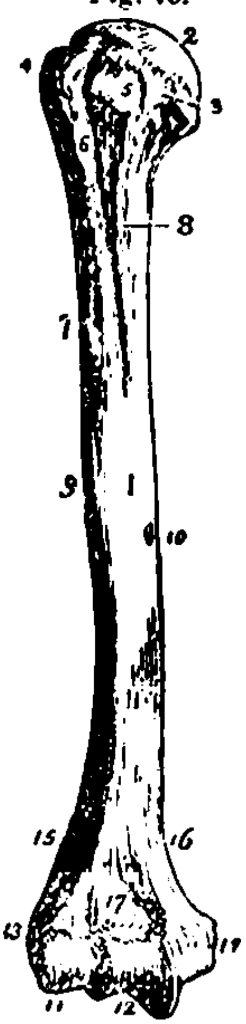
Each upper extremity comprises the clavicle, or collar bone; the scapula, or shoulder blade; the humerus, or arm bone; the ulna and radius, bones of the fore-arm; the bones of the carpus, or wrist; and the metacarpus and phalanges of the fingers.

The *Clavicle*, or collar bone, extends across the upper part of the side of the chest, from the upper end of the sternum to the point of the shoulder, where it is articulated with the scapula. Its position is somewhat oblique, and in shape it resembles the italic letter *f*.

The *Scapula*, or shoulder blade, is a flat, triangular bone, occupying the space from the second to the seventh rib, upon the posterior aspect and side of the thorax. The *anterior surface* is concave, and marked by several oblique ridges. The *posterior surface*, called *dorsum*, is convex, and divided into two unequal portions by a ridge, called the *spine*. The *superior border* is the shortest; one of its terminating extremities is called the *superior angle*, and the other the *coracoid process*. The *anterior angle* is the thickest portion of the bone, and forms its *head*. On this head is a shallow articulating surface called the *glenoid cavity*, which receives the head of the *humerus*. Above and overhanging the glenoid cavity rises a projection called the *acromion*, on the anterior border of which is an oval articular surface for the outer end of the clavicle. A strong, curved prominence rises from the upper part of the neck, called *coracoid process*, which gives attachment to several ligaments and muscles. The position and form of the scapula and clavicle may be seen in Fig. 1.

The *Humerus*, or arm bone, is long, cylindrical, and divisible into a shaft and two extremities. The *upper extremity* is divided into a *head*, which is articulated with the scapula, *neck*, and *greater* and *lesser tuberosity*. The *lower extremity* is divided into two articular surfaces, the external of which is a rounded prominence, called *eminentia capitata*, which articulates with the head of the radius; the internal is concave, and articulates with the ulna.

Fig. 15.



HUMERUS

Fig. 15 is a front view of the right humeral bone. 1. The shaft. 2. Head. 3. Neck. 4. Greater tuberosity. 5. Lesser tuberosity. 6. A groove called bicipital. 7, 8. Bicipital ridges. 9. A rough surface to which the deltoid muscle is attached. 10. A foramen for nutrient vessels. 11. Eminentia capitata. 12. The trochlea. 13. External condyle. 14. Internal condyle. 15, 16. Condyloid ridges. 17. Fossa for receiving the coronoid process of the ulna.

The *Ulna* and *Radius* are the bones of the fore-arm. The *ulna* is a long bone, slender in the middle, and larger at its upper than its lower extremity. The upper end forms principally the articulation of the elbow; the lower end is excluded from the wrist joint by an intervening cartilage. On its upper extremity is a large semilunar concavity, called the *greater sigmoid notch*, for articulation with the humerus; and on its outer side is a *smaller sigmoid notch*, which articulates with the head of the radius. On the posterior side of the greater notch is the *olecranon process*. The lower extremity terminates in a small rounded head, from one side of which projects a process, called *styloid*; on the opposite side of the head is a smooth surface for articulation with the side of the radius.

The *Radius* is the rotatory bone of the fore-arm. Its upper end is small, and its lower large, forming almost the whole of the wrist joint. Its upper extremity presents a rounded head, the side of which articulates with the ulna. The lower end is broad and triangular, having two articular surfaces—one at the side, for the head of the ulna, and the other at its extremity, for connecting with the scaphoid and semilunar bones of the wrist.

Fig. 16.

ULNA AND RADIUS.

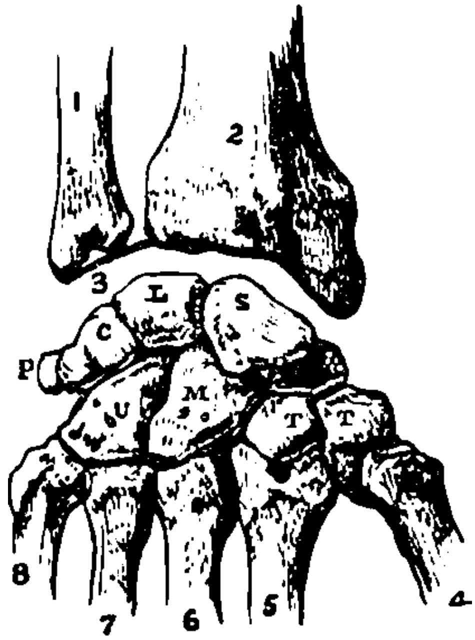
Fig. 16 exhibits the ulna and radius in front. 1. Shaft of the ulna. 2. Greater sigmoid notch. 3. Lesser sigmoid notch. 4. Olecranon process. 5. Coronoid process. 6. Nutritive foramen. 7. Sharp ridges to which the interosseous membrane is attached. 8. Capitulum ulnæ. 9. Styloid process. 10. Shaft of the radius. 11. Its head. 12. Its neck. 13. Its tuberosity. 14. The oblique line. 15. Lower extremity. 16. Its styloid process.

The anterior surface of the radius is somewhat concave superiorly, where the long flexor muscle of the finger is lodged, and flat below where it supports the pronator quadratus muscle. The *nutritive foramen* is seen near the upper third of this surface, directed upward. The posterior surface is round above, where it supports the short supinator muscle, and marked by several shallow, oblique grooves below, where the extensor muscles of the thumb are attached. Most of the tendons of the extensor muscles of the fingers arise from grooves and ridges around the projecting point of its lower extremity, which point is called its *styloid process*.

BONES OF THE WRIST.

These are eight in number, arranged in two rows, which constitute the *carpus*. The first row, counting from the side of the radius, comprises the *scaphoid*, *semilunar*, *cuneiform*, and *pisiform*; the second row, the *trapezium*, *trapezoides*, *magnum*, and *unciform*. Their shape and position are seen in Fig. 17, which represents the outside of the right hand.

Fig. 17.



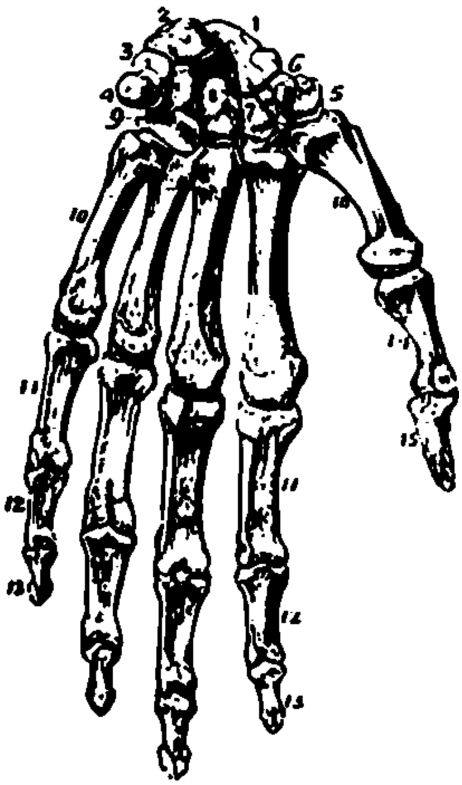
THE CARPUS.

1. Lower end of the radius. 2. Lower end of the ulna. 3. Interarticular cartilages, attached to the styloid process of the ulna, and to the margin of the articular surface of the radius. S. The scaphoid. L. Semilunar. C. Cuneiform. P. Pisiform. T. Trapezium. T. Trapezoides. M. Os magnum. U. Unciform.

BONES OF THE HAND.

These are divisible into the metacarpus and phalanges. The *metacarpus* is composed of the five long bones between the fingers and wrist; that pertaining to the thumb is one third shorter than the others. The *phalanges* are the finger bones; they are fourteen in number, three belonging to each finger, and two to the thumb.

Fig. 18.



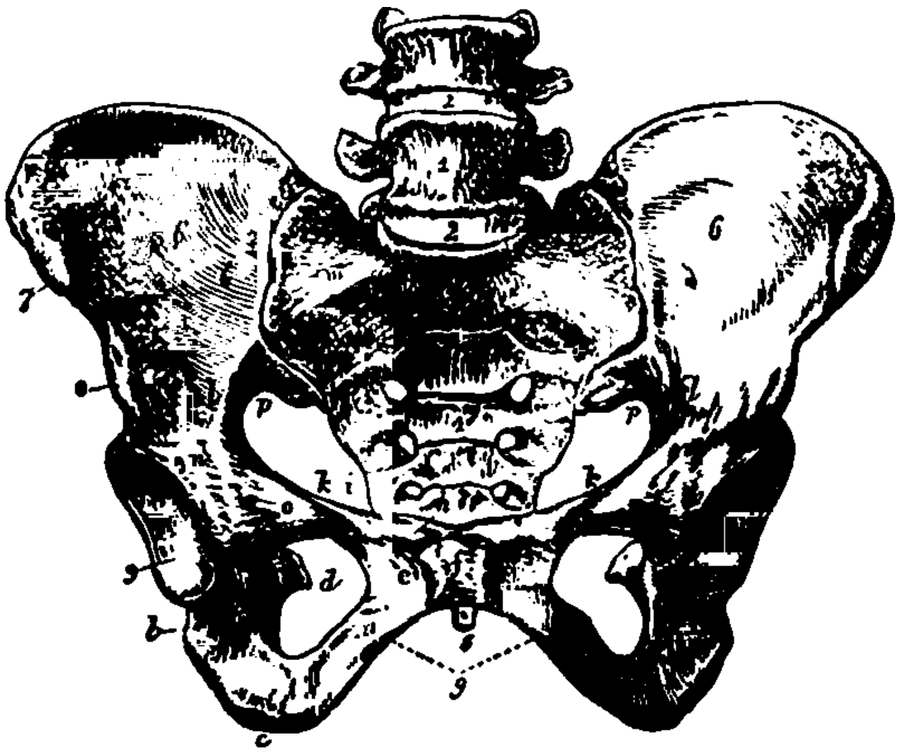
METACARPUS AND PHALANGES.

Fig. 18 shows the aspect of the hand anteriorly. 1. The scaphoid bone. 2. Semilunar. 3. Cuneiform. 4. Pisiform. 5. Trapezium. 6. A groove in the trapezium, which lodges the tendon of the flexor carpi radialis. 7. Trapezoides. 8. Os magnum. 9. Unciform. 10, 10. The five metacarpal bones. 11, 11. First row of phalanges. 12, 12. Second row. 13, 13. Third row. 14. First phalanx of the thumb. 15. Second do.

BONES OF THE PELVIS.

The pelvis is composed of the two ossa innominata, which form its sides and front, and the sacrum and coccyx behind. Anatomists divide it into a *true* and *false* pelvis. The true is the portion beneath a line, called *linea ilio pectinea*, which forms the margin, or brim, of its proper cavity; the false pelvis is the part above, and is in reality the lower part of the abdominal cavity.

Fig. 19.



PELVIS.

Fig. 19 is a front view of a female pelvis, which is broader its cavity more shallow, and the bones lighter than in the male. 1. The last lumbar vertebra. 2, 2. The intervertebral substance connecting the last lumbar vertebra with the fourth and sacrum. 3. Promontory of the sacrum. 4. Anterior surface of the sacrum, on which the transverse lines and foramina are seen. 5. Lower point or tip of the coccyx. 6, 6. The iliac fossæ, forming the lateral boundaries of the false pelvis. 7. Anterior superior spinous process of the ilium—left side. 8. Anterior inferior spinous process. 9. The acetabulum. *a*. The notch of the acetabulum. *b*. Body of the ischium. *c*. Its tuberosity. *d*. The spine of the ischium seen through the obturator foramen. *e*. Os pubis. *f*. Symphisis pubis. *g*. Arch of the pubes. *h*. Angle of the os pubis. *i*. Spine of the pubes; the prominent ridge between *h* and *i* is the crest of the pubes. *k*, *k*. Pectineal line of the pubes. *l*, *l*. The ilio-pectineal line; *m*, *m*, its prolongation to the promontory of the sacrum. The brim of the true pelvis is represented by the line *h*, *i*, *k k*, *l l*, *m m*, *n*. The ilio-pectineal eminence. *o*. The smooth surface which supports the femoral vessels. *p*, *p*. The great sacro ischiatic notch.

The pelvis is situated obliquely in relation to the trunk of the body, the inner surface of the ossa pubis being directed upward to support the superincumbent viscera of the abdomen. Its cavity measures in depth four inches and a half posteriorly, three and a half in the middle, and one and a half at the symphisis pubis. Its inlet has three diameters, *antero-posterior*, *transverse*, and *oblique*. Its outlet has two, the *antero-posterior* and *transverse*.

Each *os innominatum* is divided into three portions, which, in the young subject, constitute separate bones; they are called os ilium, os ischium, and os pubis. The *ilium* is the upper expanded portion forming the prominence of the hip, and articulating with the sacrum. The *ischium* is the inferior strong part of it on which the body rests in sitting. The *pubis* forms the front of the pelvis, and supports the external genital organs.

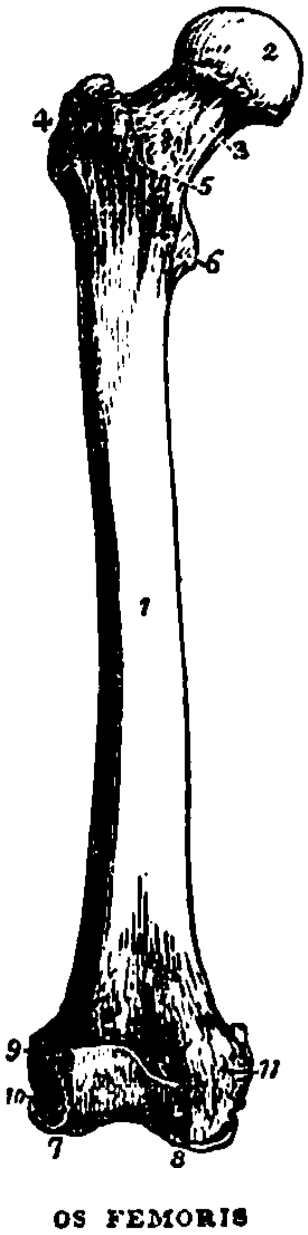
The *acetabulum* is a deep cavity at the junction of the three portions of the innominatum, for receiving the head of the femur, or thigh bone. Between the ischium and pubis is a large oval opening, called *obturator foramen;* it is covered by a ligamentous membrane; a groove in its upper part lodges the obturator vessels and nerves.

BONES OF THE LOWER EXTREMITIES.

These are the femur, patella, tibia and fibula, tarsus, metatarsus, and phalanges.

The *Femur*, or thigh bone, is the longest in the body; it stands obliquely between the hip and knee, this obliquity being greatest in the female, on account of the greater breadth of the pelvis. Its upper extremity is divided into a rounded head, a neck, a large process, called *trochanter major*, situated on the outside, and a smaller projection on the inside, called *trochanter minor*. The lower extremity is broad, and divided into two *condyles*, which articulate with the tibia and fibula.

Fig. 20.



OS FEMORIS

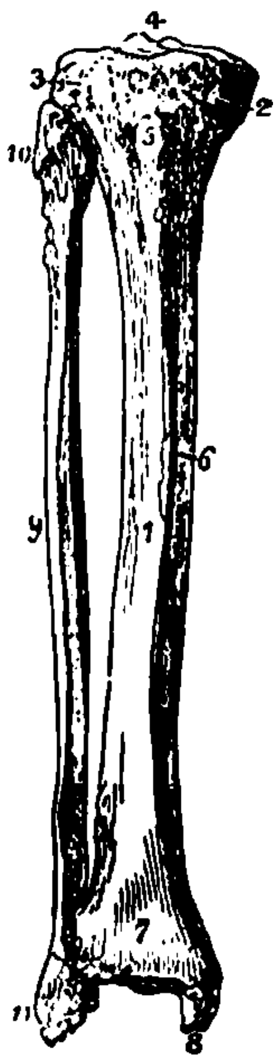
Fig. 20 is the right femur, seen anteriorly. 1. The shaft. 2. Head. 3. Neck. 4. Great trochanter. 5. Anterior intertrochanteric line. 6. Lesser trochanter. 7. External condyle. 8. Internal condyle. 9. The tuberosity to which the external lateral ligament is attached. 10. The fossa for the tendon of the origin of the popliteal muscle. 11. The tuberosity for the internal lateral ligament.

The *Patella*, or knee-pan, is one of the sesamoid bones; it is developed in the tendon of the muscle called quadriceps extensor; its figure is heart-shaped, and it is articulated with the condyles of the femur.

The *Tibia* and *Fibula* are the bones of the leg. The *Tibia* is the inner and largest. Its upper end is expanded into two *tuberosities*, the upper surfaces of which are smooth, for articulation with the femur. On the outer side of the external tuberosity is an articular surface which receives the head of the fibula. A spinous process rises between the articular surfaces, on each side of which are depressions for the attachment of the *crucial ligament.*

The lower extremity is nearly quadrilateral in shape, and prolonged on its inner side into a process, called *internal malleolus.* On its outer side is an articular surface, which unites it with the fibula. Below is a smooth triangular surface, which articulates with the astragalus.

Fig. 21.



BONES OF THE LEG.

A front view of the tibia and fibula, as articulated with each other, is seen in Fig. 21. 1. The shaft of the tibia. 2. Inner tuberosity. 3. Outer tuberosity. 4. Spinous process. 5. The tubercle. 6. Internal or subcutaneous surface of the shaft. 7. Lower extremity of tibia. 8. Internal malleolus. 9. Shaft of the fibula. 10. Its upper extremity. 11. Its lower extremity, called external malleolus. The sharp border between 1 and 6 is called the crest of the tibia.

The *Fibula* is the outer and smaller bone. Its upper end, or *head*, is large and thick, having a concave surface, which articulates with the external tuberosity of the tibia. The lower end is prolonged beyond the articular surface of the tibia, thus forming the *external malleolus*, the internal surface of which is articulated with the astragalus.

THE TARSUS.—The tarsal bones are seven in number: astragalus, calcaneus, scaphoid, internal, middle, and external cuneiform, and cuboid.

The *Astragalus* has a convex surface above for articulating with the tibia and fibula, and a concave surface below, which articulates with the calcaneus and scaphoid.

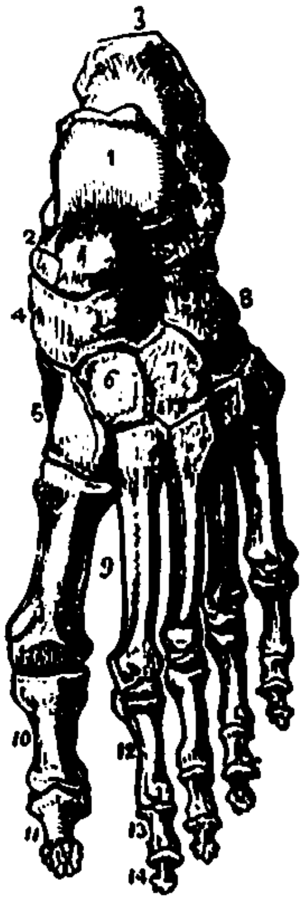
The *Calcaneus*, or heel bone, is of an oblong figure, articulated with the astragalus and cuboid. Into its lower part the *tendo Achillis*, or strong cord of the heel, is inserted, which is sometimes ruptured in dancing, jumping, and other violent exercises.

The *Scaphoid* is boat-shaped, convex before, where it articulates with the three cuneiform bones, and concave behind, to articulate with the rounded head of the astragalus.

The *Cuneiform* bones are wedge-shaped, whence their name. The *internal* is the largest, and its convex internal surface assists in forming the inner border of the foot. It articulates with the scaphoid, middle cuneiform, and the first two metatarsal bones. The *middle* cuneiform is the smallest; it is connected with the scaphoid, internal and external cuneiform, and second metatarsal. The *external* cuneiform is articulated with the scaphoid, middle cuneiform, cuboid, and second, third, and fourth metatarsal.

The *Cuboid* is irregularly cuboid in figure, articulating with the calcaneus, external cuneiform, and fourth and fifth metatarsal.

Fig. 22.



BONES OF THE FOOT.

The dorsal surface of the left foot is shown in Fig. 22. 1. The astragalus; its superior quadrilateral articular surface. 2. The anterior extremity of the astragalus, which articulates with the scaphoid. 3. Os calcis. 4. Scaphoid. 5. Internal cuneiform. 6. Middle cuneiform. 7. External cuneiform. 8. Cuboid. 9. Metatarsal bones of first and second toes. 10. First phalanx of the great toe. 11. Second do. 12. First phalanx of second toe. 13. Second do. 14. Third do.

THE METATARSUS.—The metatarsal bones are five in number, situated between the toes and the tarsus. The *first*, pertaining to the great toe, is the thickest and shortest; the *second* is the largest; the *third* is smaller; the *fourth* still smaller; and the *fifth* has a large tuberosity on its outer side, in place of an articular surface. They are articulated with the tarsal bones posteriorly, and the first row of phalanges anteriorly.

THE PHALANGES.—The phalanges of the toes correspond with those of the fingers, there being two for the great toe, and three for each of the other toes. The *first* row is convex above, concave beneath, and compressed on the sides. The *second* is short, yet rather broader than the first. The bones of the *third* are called *unequal phalanges*, and, including the second phalanx of the great toe, are flattened and spread laterally at the extremities, to articulate with the second row, and support the toe nails.

SESAMOID BONES.

These are small osseous masses, formed in tendons, which exert a degree of force upon the surface over which they glide. They serve to protect neighboring parts from injurious pressure and friction, by furnishing a sort of pulley for the tendons to play upon. The patella is a sesamoid bone. Besides this, there are four pairs found in different parts of the skeleton, as properly belonging to it—two upon the metacarpo-phalangeal articulation of each thumb, and two upon the corresponding joint of the great toe. Sesamoid bones are frequently found upon the corresponding joints of the little finger and little toe, also in the tendon of the peroneus longus muscle, where it passes through the groove in the cuboid bone. Sometimes they are found in the tendons around the malleolar processes; in the psoas and iliacus muscles, where they pass over the body of the os pubis, and in the external head of the gastrocnemius. The *bones of the tympanum*, beonging to the auditory apparatus, are sesamoid.

CHAPTER II.

OF THE LIGAMENTS—SYNDESMOLOGY.

The connection between any two bones constitutes a joint, or articulation. In movable joints the opposing surfaces are coated by an elastic substance, called *cartilage*; this is lubricated by a fluid, called *synovia*, secreted by an enclosing membrane, called *synovial*; while the bones are firmly held together by bands of glistening fibres, called *ligaments*.

The *forms* of articulation are divided into three classes. 1. *Synarthrosis*, or fixed joint, as in the skull, upper jaw, vomer, and teeth. 2. *Diarthrosis*, or movable, the shoulder, hip, elbow, wrist, knee, ankle, carpus, and tarsus. 3. *Amphi-arthrosus*, or intermediate, as in the bodies of the vertebræ.

The *motions* of joints are of four kinds. 1. *Gliding*, the sliding motion of one articular surface upon another. It exists to some extent in all joints, and is the only motion in the carpus and tarsus. 2. *Angular*, which may be forward, called *flexion*; backward, called *extension*; inward, called *adduction*; or outward, called *abduction*. Flexion and extension are illustrated in the knee and elbow, and, more or less, in most other joints; adduction and abduction are seen complete in the shoulder, hip, and thumb. 3. *Circumduction*, which consists in a slight motion of the head of a bone, while the extremity is made to describe a large circle, as in the hip and shoulder. 4. *Rotation*, the movement of a bone on its own axis, as with the radius, the atlas upon the axis, and in the hip and shoulder.

The *structures* in the formation of a joint, in addition to the bone, are cartilage, fibrous tissue, adipose tissue, and synovial membrane.

The *cartilage* of joints serves not only to connect different bones, but also as a separating medium. It forms a thin coating to the articular surface, and has been classed into *true*, *reticular*, and *fibrous*.

Fibrous tissue about the joints exists in the form of ligament, sometimes constituting bands of various breadth and thickness, and sometimes layers, which extend around the joints; these are called *capsular ligaments*.

Adipose tissue is found in greater or less quantities about joints, where it serves to fill up vacant spaces, and probably increase their elasticity.

Synovial membrane is the smooth, polished lining of a joint which secretes the synovia, and enables opposing surfaces to move upon each other with the most perfect ease and freedom.

Fig. 23.

FIBROUS CARTILAGE.

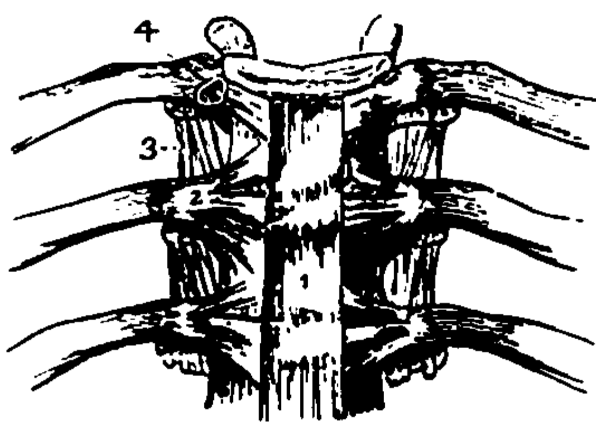
In Fig. 23 is seen a portion of fibrous cartilage, largely magnified. Its development has already been described; the different kinds of cartilaginous structure are owing to subsequent changes in the cells and intercellular substance.

PARTICULAR ARTICULATIONS.

The connecting media of joints are generally named from some prominent circumstance in relation to form, position, points of connection, etc., as *capsular*, surrounding; *transverse*, running across; *occipito-axoid*, attached to and holding together the occipital and axis bones; *lateral*, connecting the sides of articulating bones, etc.; hence, except with the most important ligaments, the name will be a sufficient description

THE VERTEBRAL JOINTS.—The vertebræ are held together by the following ligaments: 1. *Intervertebral substance*, a disc of fibrous cartilage interposed between the bodies of all the vertebræ. This varies in thickness in different parts of the column, which circumstance contributes much to the formation of the vertebral curves. 2. *Anterior common ligament*, a broad, thin band of fibres attached to the bodies of the vertebræ in front, and extending along the whole column from the neck to the sacrum. 3. *Posterior common ligament*, attached to the bodies behind in a similar manner. 4. *Ligamenta subflava*, two thin plates of yellow fibrous tissue, situated between the arches. 5. *Capsular ligaments*, loose synovial membranes surrounding the articular processes. 6. *Inter-spinous ligaments*, thin membranous bands extended between the spinous processes in the dorsal and lumbar regions. 7. *Supra-spinous ligament*, a strong, inelastic fibrous cord, extending from the apex of the spinous process of the last cervical vertebra to the sacrum, being attached in its course to each spinous process. 8. *Inter-transverse ligaments*, connecting only the transverse processes of the lower dorsal vertebræ.

Fig. 24.



VERTEBRAL LIGAMENTS.

The connection of the anterior ligaments and those of the ribs is seen in Fig. 24. 1. Anterior common ligament. 2. Anterior costo-vertebral ligament. 3. Anterior costo-transverse ligament. 4. Interarticular ligament connecting the head of the rib to the intervertebral substance, and separating the two synovial membranes of this articulation.

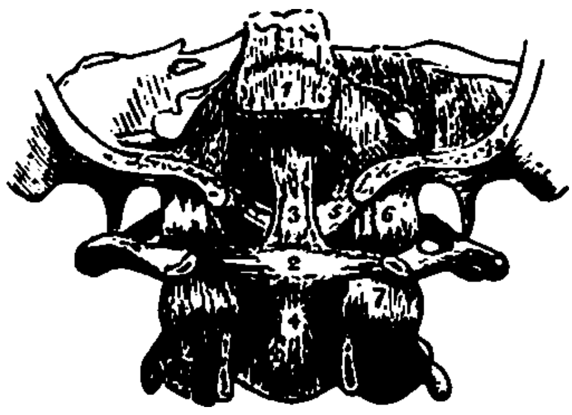
THE NECK JOINT.—There are seven ligaments connecting the atlas with the os occipitis: Two *anterior ligaments*, one of which is a *rounded* cord, attached above to the base of the occipital, and below to the anterior tubercle of the atlas; the other is a *broad* membranous layer, lying deeper, attached to the margin of the occipital foramen above, and to the whole length of the anterior arch of the atlas below; a *posterior ligament*, thin and membranous, attached above to the margin of the occipital foramen, and below to the posterior arch of the atlas; two *lateral ligaments*, strong fascicula of fibres, attached below to the base of the transverse process of the atlas, at each side and above to the transverse process of the occipital bone; two *capsular ligaments*, thin ligamentous capsules surrounding the synovial membranes of the articulation, between the condyles of the occipital bone and the superior articular processes of the atlas. The motions between the cranium and atlas are *flexion* and *extension*.

The axis is articulated with the occipital bone by three ligaments—the *occipito-axoid*, a broad band covering the odontoid process and its ligaments, and two *odontoid*, short, thick fibrous fasciculi, which pass outward from the apex of the odontoid process to the sides of the occipital foramen and condyles. These ligaments are called *check* ligaments, because they limit the rotatory movements of the head.

The atlas is articulated with the axis by five ligaments. The *anterior* consists of ligamentous fibres, passing from the anterior tubercle and arch of the atlas to the base of the odontoid process and body of the axis. The *posterior* is a thin membranous layer, which passes between the posterior arch of the atlas and the laminæ of the axis. The two *capsular* loosely surround the articular processes of the atlas and axis, and permit great freedom of movement. The *transverse* is a strong band, arching across the area of the ring of the atlas, from one articular process to the other. It retains the odontoid process of the axis in connection with the anterior arch of the atlas. Where it crosses the odontoid process, some fibres pass downward to be attached to the body of the axis, and others are sent upward to the basilar process of the occipital bone. This disposition enables the atlas, and with it the whole head, to rotate upon the axis, its extent of rotation being limited by the odontoid ligaments.

Fig. 25 is a posterior view of the ligaments connecting the atlas, axis, and occipital bone. The back part of the occipitis and the arches of the atlas and axis have been removed. 1. The superior part of the occipito-axoid ligament, which has been cut away to show the ligaments beneath. 2. Transverse ligament of the atlas. 3, 4. Ascending and descending slips of the transverse ligament, which have given to it the title of *cruciform*. 5. One of the odontoid ligaments; the other is seen on the opposite side. 6. One of the occipito-atloid capsular ligaments. 7. One of the atlo-axoid capsular ligaments.

Fig. 25.



NECK JOINT POSTERIORLY

Joints of the Lower Jaw.—These are formed by the *external lateral ligaments*, short, thick bands of fibres extending obliquely backward from the zygomas to the external surface of the necks of the lower jaw; the *capsular ligament*, consisting of a few irregular fibres passing from the edges of the glenoid cavities to the necks; the *inter-articular fibrous cartilages*, thin, oval plates, thicker at the edges than in the centre, placed horizontally between the heads of the condyles and the glenoid cavities, thus dividing each joint into an upper and a lower cavity; and the *synovial membranes*, one situated above and one below the cartilages.

The movements of the lower jaw are *depression* and *elevation*, by which the mouth is opened and shut; also a *forward*, *backward*, and *lateral* movement from side to side, constituting the *grinding* motion.

Fig. 26.

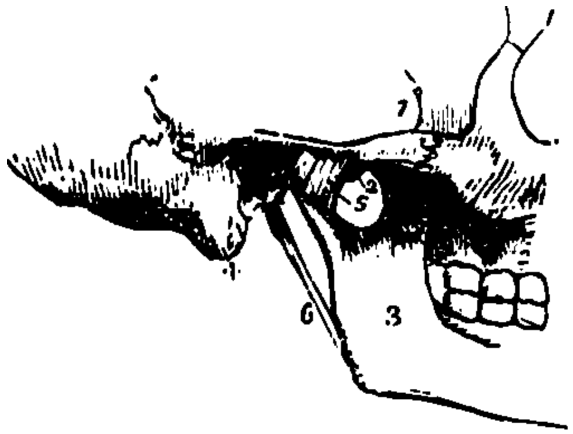


Fig. 27.

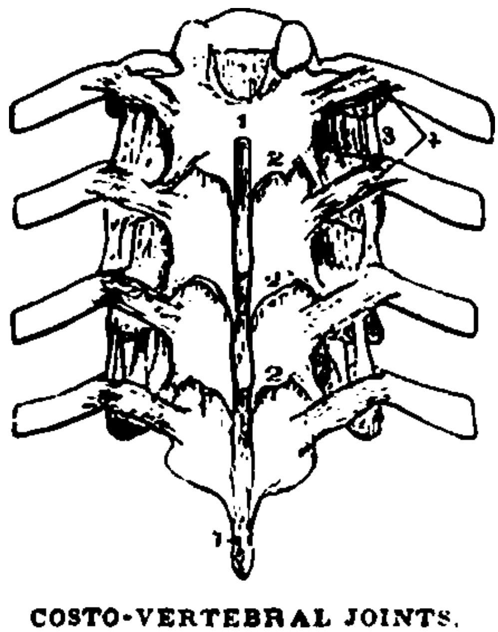
JOINTS OF THE LOWER JAW.

Fig. 26 is an external view of this articulation. 1. The zygomatic arch. 2 Tubercle of the zygoma 3. Ramus of the lower jaw. 4. Mastoid portion of the temporal bone. 5. External lateral ligament. 6. Stylo-maxillary ligament.

Fig. 27 is an internal view. 1. A section through the petrous portion of the temporal bone, and spinous process of the sphenoid. 2. An internal view of the ramus and part of the body of the lower jaw. 3. Internal portion of the capsular ligament. 4. Internal lateral ligament. 5. A small opening at its insertion, where the milo-hyoidean nerve passes. 6. Stylo-maxillary ligament.

THE COSTO-VERTEBRAL JOINTS.—The ribs have a double articular connection with the vertebra. 1. By ligaments connecting the *head of the rib* with the *bodies of the vertebra.* 2. Those connecting the *neck* and *tubercle of the rib* with the *transverse processes* of the vertebræ. This arrangement renders dislocation impossible, as the neck of the rib would break before dislocation could occur. In addition, most of these costo-vertebral articulations have a *capsular*, *interarticular*, and three *transverse ligaments*, named, from their positions, *anterior*, *middle*, and *posterior costo-transverse ligaments.*

Fig. 28.



COSTO-VERTEBRAL JOINTS.

Fig. 28 is a posterior view of a part of the thoracic portion of the vertebral column, showing the ligaments connecting the vertebræ with each other, and the ribs with the vertebræ. 1, 1. The supra-spinous ligament. 2, 2. Ligamenta subflava, connecting the laminæ. 3. Anterior costo-transverse ligament. 4. Posterior costo-transverse ligaments.

The movements of these articulations are *upward* and *downward*, and slightly *backward* and *forward*, all the movements increasing from the head to the anterior extremity of the rib.

COSTO-STERNAL JOINTS.—In front the ribs are articulated with the sternum, and some of them with each other. The ligamentous connections are the *anterior*, *posterior*, *superior*, and *inferior costo-sternal*, and the *synovial membranes*. The *sixth*, *seventh*, *eighth*, and sometimes the *fifth* and *ninth* costal cartilages have a perfect synovial membrane, and articulate with each other.

The motions of these articulations are limited to a slight sliding movement.

JOINTS OF THE STERNUM.—The pieces of this bone are connected by a thin plate of *interosseous ligament*, and *anterior* and *posterior sternal ligaments*, which contribute very much to its strength, and to the elasticity of the front of the chest.

VERTEBRO-PELVIC JOINT.—The last lumbar vertebra and the sacrum are connected by the same general ligaments as are the vertebræ with each other; in addition to which there are two proper ligaments, called *lumbo-sacral* and *lumbo-iliac.*

JOINTS OF THE PELVIS.—There are four articulations of the pelvic bones. 1. *Sacro-iliac*, the connection of which is formed by an *anterior* and *posterior sacro-iliac ligament.* The latter is also called *interosseous;* it is composed of strong fibres passing horizontally between the rough surfaces of the sacro-iliac articulations. 2. *Sacro-ischiatic*, the union of the sacrum and ischium, formed by the *anterior* and *posterior sacro-ischiatic ligaments.* The upper border of the anterior forms part of the boundary of the *great sacro-ischiatic foramen;* and its lower border a part of the *lesser sacro-ischiatic foramen.* The superior border of the posterior forms also a part of the lesser sacro-ischiatic foramen, and its lower border a part of the boundary of the perineum. The two ligaments convert the sacro-ischiatic notches into foramina.

SACRO-COCCYGEAN JOINT.—Between the sacrum and coccyx is a soft fibrous cartilage. The bones are held together also by the *anterior* and *posterior sacro-coccygean ligaments.* This articulation admits of a backward motion during parturition.

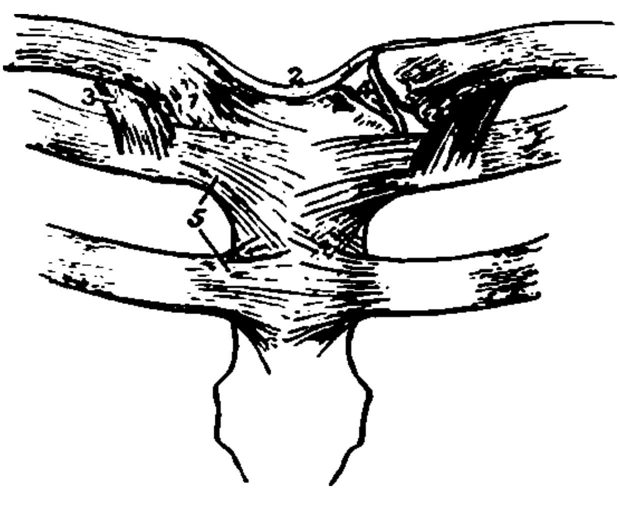
PUBIC JOINT.—The ossa pubis are connected together by an *interosseous cartilage*, the *anterior*, *posterior*, *superior*, and *sub-pubic ligaments*, which variously cross the symphisis, or place of union. The articulation becomes movable during parturition, and admits of a slight separation of the bones.

The numerous vacuities in the walls of the pelvis, and their closure by ligamentous structures, diminish materially the pressure on the soft parts during the passage of the head of the fœtus.

NOTE.—The *obturator ligament* or *membrane* is a tendo-fibrous expansion stretched across the obturator foramen. It is not concerned in articulation, but gives attachment to the obturator muscles, and leaves a space in the upper part of the foramen for the passage of the obturator vessels and nerves.

STERNO-CLAVICULAR JOINT.—The breast and collar bones are connected by the *anterior*, *posterior*, *sterno-clavicular*, *inter-clavicular*, and *costo-clavicular ligaments*, an *interarticular cartilage*, and two synovial membranes. The motions of this articulation are *gliding* and *circumduction*. This joint is the centre of the movements of the shoulder. In dislocations of the sternal end of the clavicle, the costo-clavicular ligament, called also *rhomboid*, is ruptured, occasioning a peculiar deformity.

Fig. 29.



STERNO-CLAVICULAR JOINT.

Fig. 29 shows the ligaments of the sterno-clavicular and costo-sternal articulations. 1. Anterior sterno-clavicular ligament. 2. Inter-clavicular ligament. 3. Costo-clavicular. 4. Interarticular cartilage. 5. Anterior costo-sternal ligaments of the first and second ribs.

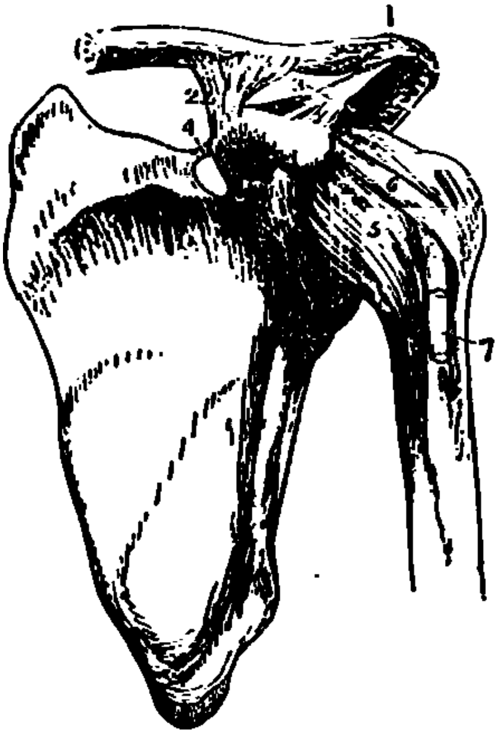
SCAPULO-CLAVICULAR JOINT—The shoulder blade and breast bone are connected by *two synovial membranes*, an *interarticular cartilage*, a *superior acromio-clavicular*, an *inferior acromio-clavicular*, and a *coraco-clavicular ligament*. This articulation admits of a *gliding* and *rotatory* movement.

NOTE.—The shoulder blade has two ligaments, *coraco-acromial* and *transverse*, which are proper to itself. The first is a thick triangular band, forming a protecting arch over the shoulder joint. The second crosses the notch in its upper border, thus converting it into a foramen.

THE SHOULDER JOINT.—The scapula and humerus form a ball-and-socket articulation; its ligaments are the *capsular*, *coraco-humeral*, and *glenoid*.

The ligaments of the scapula and shoulder joint are seen in Fig. 30. 1. Superior acromio-clavicular. 2. Coraco-clavicular. 3. Coraco-acromial. 4. Transverse. 5. Capsular. 6. Coraco-humeral. 7. The long tendon of the biceps muscle issuing from the capsular ligament, and entering the bicipital groove.

Fig. 30.



SHOULDER JOINT.

The *capsular ligament* encircles the heads of the scapula and humerus. The *coraco-humeral* is a broad band between the coracoid process of the scapula and the greater tuberosity of the humerus. The *glenoid* is a cartilaginous band around the margin of the glenoid cavity, which it deepens.

The synovial membrane of this joint is very extensive, and the articulation admits of every kind of motion.

THE ELBOW JOINT.—At this articulation the humerus, ulna, and radius are connected by four ligaments in addition to its *synovial membrane.* They are the *anterior*, composed of fibres, which pass vertically, transversely, and obliquely, forming a broad membranous layer, between the anterior surface of the humerus and the coronoid process of the ulna and orbicular ligament; the *posterior*, a broad loose layer between the posterior surface of the humerus and the olecranon; the *internal lateral*, a thick triangular layer passing between the inner condyle of the humerus to the margin of the greater sigmoid cavity of the ulna; and the *external lateral*, a strong narrow band descending from the external condyle of the humerus to the orbicular ligament and ridge of the ulna.

The motions of this articulation are *flexion* and *extension*, the former being limited by the coronoid process, and the latter by the olecranon.

Fig. 31.

ELBOW JOINT INTERNALLY.

An internal view of the ligaments is seen in Fig. 31. 1. Anterior. 2. Internal lateral. 3. Orbicular. 4. Oblique. 5. Interosseous. 6. Internal condyle of the humerus, which conceals the posterior ligament.

Fig 32.

ELBOW JOINT EXTERNALLY.

Fig. 32 is an external view of the elbow articulation. 1. Humerus. 2. Ulna. 3. Radius. 4. External lateral ligament inserted below into the orbicular (5). 6. The posterior extremity of the orbicular, spreading out at its insertion into the ulna. 7. Anterior ligament. 8. Posterior ligament.

RADIO-ULNAR JOINT.—The radius ana ulna are held together by an *interarticular cartilage*, the lower surface of which enters into the articulation of the wrist; the *orbicular ligament*, which surrounds the head of the radius, and is attached at each end to the extremities of the lesser sigmoid cavity; the *oblique ligament*, a narrow slip between the coronoid process and the inner side of the radius; the *interosseous ligament*, a broad aponeurosis between the ridges of the radius and ulna; and the *anterior inferior*, and *posterior inferior ligaments*. The orbicular ligament is necessarily ruptured in dislocations of the head of the radius.

The lower part of the interosseous ligament is perforated for the passage of the anterior interosseous artery. The posterior interosseous artery passes backward between the oblique ligament and the upper border of the interosseous ligament. This ligament affords an extensive surface for the attachment of muscles.

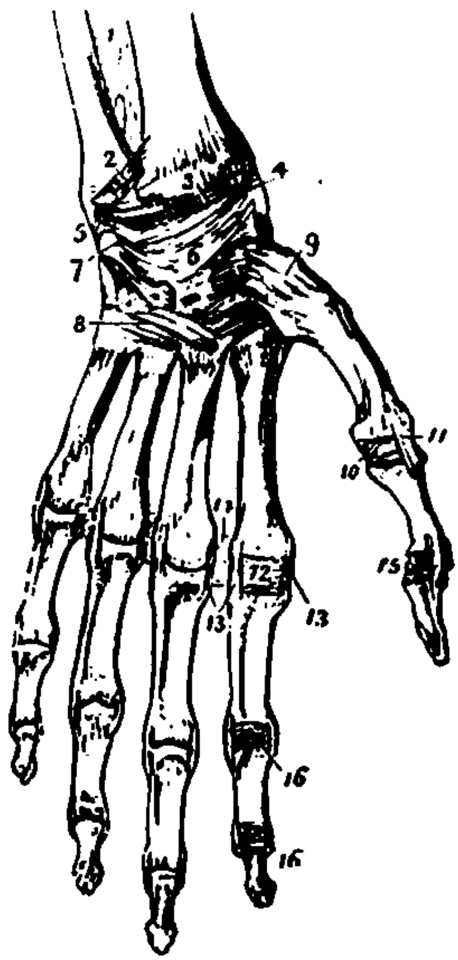
The movements of this joint are, the rotation of the radius upon the ulna; the forward rotation is called *pronation*, and the backward *supination*. The head of the radius also turns upon its own axis within the orbicular ligament and the lesser sigmoid notch of the ulna; and inferiorly a concavity in the radius moves on the rounded head of the ulna.

The anterior and posterior inferior ligaments are chiefly concerned in limiting the movements of the radius, and hence, in great muscular efforts are frequently ruptured.

THE WRIST JOINT.—This articulation is formed by the *anterior, posterior, internal lateral*, and *external lateral ligaments*, with the *synovial membrane*. Its motions are *flexion, extension, adduction, abduction*, and *circumduction*, in all of which movements the articular surfaces glide upon each other. The wrist joint is an example of the articulation called *ginglymoid*. The radial artery rests on the external lateral ligament as it passes backward to the first metacarpal space.

The ligaments of the wrist and hand are seen anteriorly in Fig. 33. 1. Interosseous membrane. 2. Anterior inferior radio-ulnar ligament. 3. Anterior ligament of the wrist. 4. Its external lateral. 5. Its internal lateral. 6. Palmar ligaments of the carpus. 7. Pisiform bone, with its ligaments. 8. Ligaments connecting second range of carpal bones with the metacarpal, and these with each other. 9. Capsular ligament of the carpo-metacarpal articulation of the thumb. 10. Anterior ligament of the metacarpo-phalangeal articulation of the thumb. 11. One of the lateral ligaments of that articulation. 12. Anterior ligament of the metacarpo-phalangeal articulation of the index finger. 13. Lateral ligaments of the same joint; the corresponding ligaments are seen in the other articulations. 14. Transverse ligament connecting the heads of the metacarpal bones of the index and middle fingers; the same ligament is seen between the other fingers. 15. Anterior and one lateral ligament of the phalangeal articulation of the thumb. 16. Anterior and lateral ligaments of the phalangeal articulations of the index finger; the anterior ligaments are removed in the other fingers.

Fig. 33.



WRIST JOINT

THE CARPAL JOINTS.—The carpal bones are connected by ligamentous bands, which pass transversely and longitudinally from bone to bone on the back, called *dorsal ligaments;* by *palmar ligaments,* which have a similar disposition in front; by *interosseous cartilages* between the bones; and by a strong ligamentous band connecting the bones of the two sides, called *anterior annular ligament.* Five distinct *synovial membranes* enter into the carpal articulations.

Between the bones of each range there is a slight movement of *flexion* and *extension.*

THE CARPO-METACARPAL JOINTS.—The second row of carpal bones articulates with the metacarpal finger bones by *dorsal* and *palmar* ligaments; and the metacarpal of the thumb is joined to the trapezium by a true *capsular ligament.* The metacarpal bones of the four finger are connected at their bases by *dorsal, palmar,* and *interosseous* ligaments. The thumb, shoulder, and hip joints are the only ones in the body having *true* capsular ligaments.

The movements of the carpo-metacarpal articulations are limited to a slight degree of *sliding* motion, except in the case of the metacarpal bone of the thumb with the trapezium, which has *flexion, extension, adduction, abduction,* and *circumduction.*

METACARPO-PHALANGEAL JOINTS.—The metacarpal and finger bones are united by *anterior* fibro-cartilaginous ligaments, strong, narrow *lateral* ligaments, and strong ligamentous bands, called *transverse* ligaments.

These articulations have the motions of *flexion*, *extension*, a limited *adduction* and *abduction*, and a slight degree of *circumduction*.

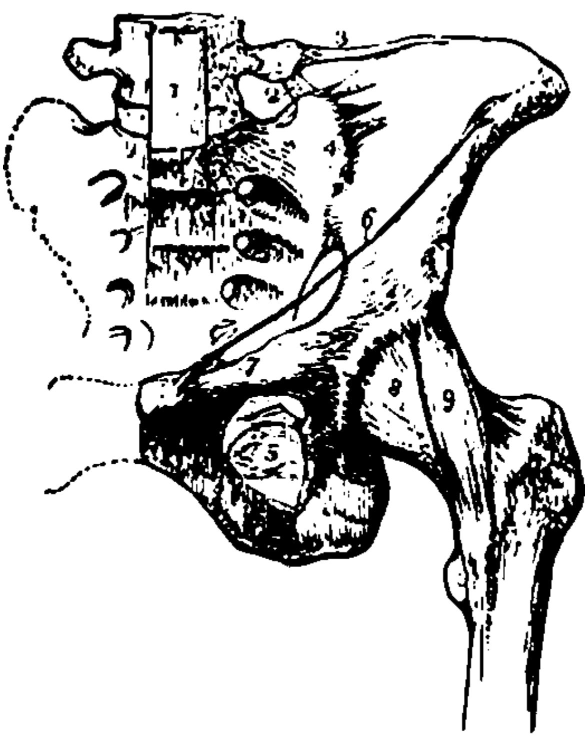
PHALANGEAL JOINTS.—The finger bones are connected by an *anterior* and two *lateral ligaments*. The extensor tendon performs the office of a posterior ligament, as with the preceding articulations.

The movements are *flexion* and *extension*.

THE HIP JOINT.—The head of the femur is received into the cup-shaped cavity of the acetabulum, forming a ball-and-socket joint. Its ligaments are the *capsular*, which embraces the acetabulum superiorly, and the neck of the femur inferiorly; the *ilio-femoral*, an accessory attachment to the anterior portion of the capsular; the *ligamentum teres*, which holds the centre of the head of the femur to the acetabulum; the *cotyloid*, a cartilaginous cord around the margin of the acetabulum, which cavity it serves to deepen; the *transverse*, extending across the notch of the acetabulum; and the *synovial membrane*, which invests the head of the femur, and spreads around the ligamentum teres.

The hip joint has an extensive range of movements—*flexion*, *extension*, *adduction*, *abduction*, *circumduction*, and *rotation*.

Fig. 34.



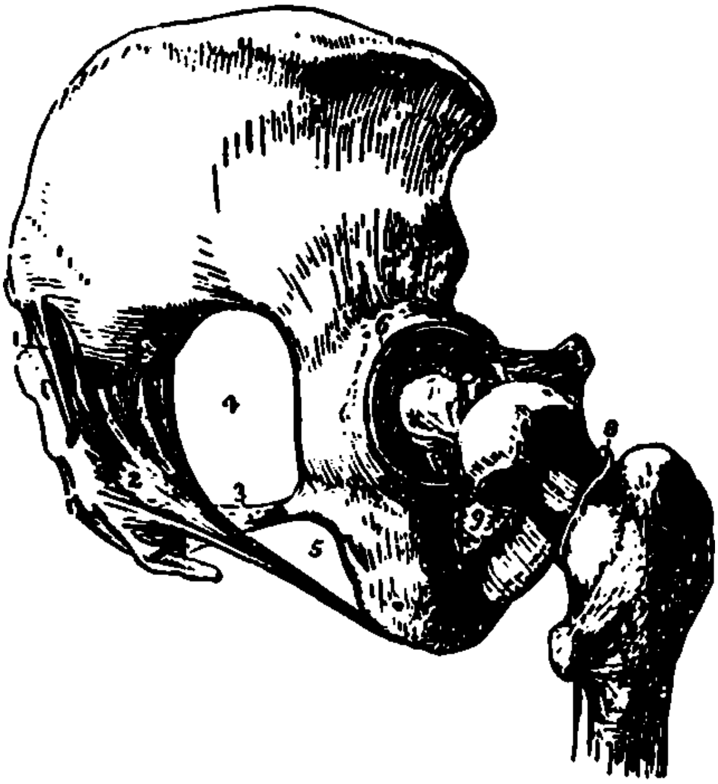
PELVIS AND HIP ANTERIORLY.

The ligaments of the pelvis and hip joint are partly shown in Fig. 34. 1. Lower part of the anterior common ligament of the vertebræ, extending downward over the front of the sacrum. 2. Lumbo-sacral. 3 Lumbo-iliac. 4. Anterior sacro-iliac. 5. Obturator membrane. 6. Poupart's ligament. 7. Gimbernat's. 8. Capsular. 9. Ilio-femoral, or accessory.

The fossa at the bottom of the acetabulum is filled by an adipose mass, covered by synovial membrane, which serves as an elastic cushion to the head of the bone during its movements.

A side view of the ligaments of the pelvis and hip joint is seen in Fig. 35. 1. Oblique sacro-iliac. 2. Posterior sacro-ischiatic. 3. Anterior sacro-ischiatic. 4. Great sacro-ischiatic foramen. 5. Lesser sacro-ischiatic foramen. 6. Cotyloid ligament of the acetabulum. 7. Ligamentum teres. 8. Edge of the capsular. 9. Obturator membrane partly exhibited.

Fig. 35.



PELVIS AND HIP LATERALLY.

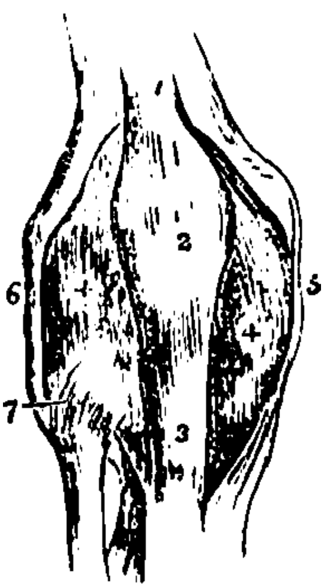
THE KNEE JOINT.—The femur, tibia and fibula, and the patella, are connected at the knee joint by thirteen ligaments; the first-named five are external, and the next five are internal to the articulation, and the remaining three are mere folds of synovial membrane.

The *anterior*, or *ligamentum patellæ*, is a prolongation of the tendon of the extensor muscles of the thigh downward to the tubercle of the tibia, enclosing the patella; the *posterior* is a broad expansion covering the whole back part of the joint; the *internal lateral* is a broad layer extending between the internal condyle of the femur and the inner tuberosity of the tibia; the *two external lateral* connect the external condyle of the femur to the outer part of the head of the tibia, and the external semilunar cartilage of the articular surfaces with the fibula. Within the joint are the *anterior* and *posterior crucial*, which connect the head of the tibia with the condyles of the femur; the *transverse*, a slip of fibres extending between the semilunar and internal cartilages; the *coronary*, short fibres connecting the borders of the semilunar cartilages to the head of the tibia and surrounding ligaments.

The *semilunar cartilages* are two falciform fibrous plates around the margin of the head of the tibia, serving to deepen the articular surface for the condyles of the femur.

The synovial membrane of this joint is the most extensive in the skeleton, investing the cartilaginous surfaces of the condyles of the femur, of the head of the tibia, and of the inner surface of the patella. Between it and the ligamentum patellæ is a mass of fatty substance which presses the membrane toward the interior of the joint, and occupies the fossæ between the condyles.

Fig. 36.

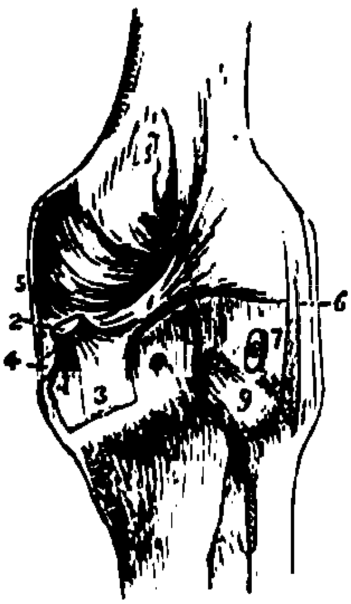


KNEE JOINT ANTERIORLY.

A slender, conical process of synovial membrane, called *ligamentum mucosum*, proceeds from the transverse ligament. Its apex is connected with the anterior part of the condyloid notch, and its base is lost in the mass of fat which projects into the joint beneath the patella. The *alar ligaments* are two fringed folds of synovial membrane, extending from the ligamentum mucosum along the edges of the mass of fat to the sides of the patella.

Fig. 36 exhibits a front view of the ligaments. 1. The tendon of the quadriceps extensor muscle of the leg. 2. Patella. 3. Anterior ligament. 4, 4. Synovial membrane. 5. Internal lateral ligament. 6. The long division of the external lateral. 7 Anterior superior tibio-fibular ligament.

Fig. 37.



KNEE JOINT POSTERIORLY.

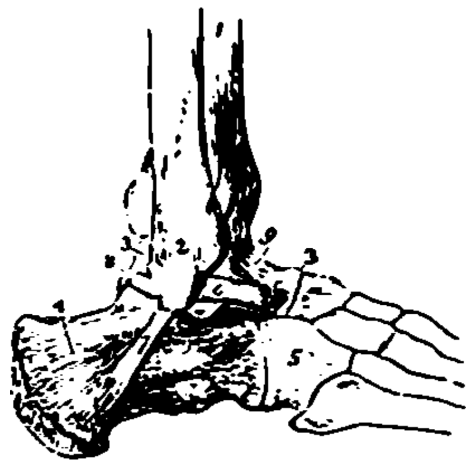
Fig. 37 gives a posterior view of the ligaments. 1. The fasciculus of the posterior ligament. 2. The tendon of the semi-membranous muscle, from which the posterior ligament is derived. 3. The process of the tendon which spreads out in the fascia of the popliteus muscle. 4. The process which is sent inward beneath the internal lateral ligament. 5. Posterior part of the internal lateral ligament. 6. The long division of the external lateral. 7. Its short division. 8. Tendon of the popliteus cut short. 9. Posterior superior tibio-fibular ligament.

The movements of this joint are *flexion* and *extension*, with a slight degree of *rotation* when the knee is semi-flexed.

Tibio-Fibular Joints.—The bones of the leg are firmly connected together at each extremity by five ligaments: the *interosseous*, *transverse*, *anterior*, and *posterior*, to which is to be added the *synovial membrane*. The movements between these bones is a very slight degree of yielding or *sliding* motion.

The Ankle Joint.—This is formed by the tibia and fibula with their malleolar processes above, and the astragalus below, connected by three ligaments: the *anterior*, a thin membranous layer; the *internal lateral*, or *deltoid*, a triangular layer of fibres attached above to the internal malleolus, and below to the astragalus, calcis, and scaphoid; and the *external lateral*, which consists of three separate bundles of fibres, proceeding from the external malleolus, the anterior of which is attached to the astragalus, the *posterior* to the back part of the same bone, and the *middle* to the outer side of the os calcis. The motions of this joint are *flexion* and *extension*.

Fig. 38.



ANKLE JOINT EXTERNALLY.

Fig. 38 is an external view of the ankle articulation. 1. Tibia. 2. External malleolus of the fibula. 3, 3. Astragalus. 4. Os calcis. 5. Cuboid. Anterior fasciculus of the external lateral ligament attached to the astragalus. 7. Its middle fasciculus attached to the calcis. 8. Its posterior fasciculus attached to the astragalus. 9. Anterior ligament.

Fig. 39.

ANKLE JOINT POSTERIORLY.

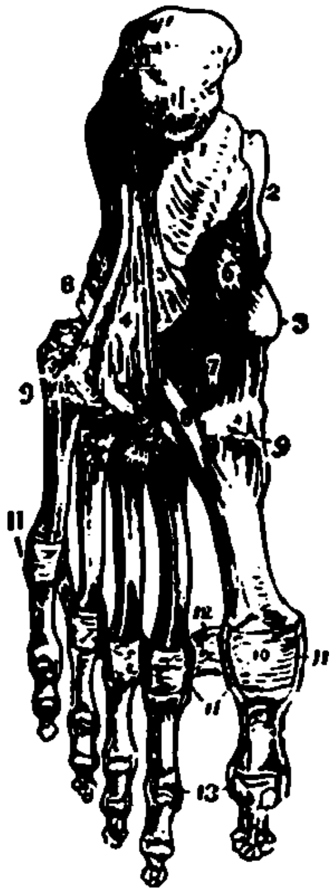
Fig. 39 is a posterior view of the ankle joint. 1. Lower part of the interosseous membrane. 2. Posterior inferior ligament connecting the tibia and fibula. 3. Transverse ligament. 4. Internal lateral. 5. Posterior fasciculus of the internal lateral. 6. Middle fasciculus of the external lateral. 7. Synovial membrane. 8. Os calcis.

THE TARSAL JOINTS.—The bones of the tarsus are connected by *dorsal* ligaments, which pass from each bone to all others contiguous: the *plantar*, which connect their under surfaces similarly, and the *interosseous*, of which there are five, situated between adjoining bones. These articulations admit of a slight degree of motion—*forward*, *backward*, and *laterally*; and between the first and second range of bones *adduction* and *abduction*, with slight *flexion* and *extension* take place.

TARSO-METATARSAL JOINTS.—The ligaments connecting the tarsal and metatarsal bones are also *dorsal*, *plantar*, and *interosseous*. The *synovial membranes* are three. The only motion is a slight *yielding* to pressure.

METATARSO-PHALANGEAL JOINTS.—The bones of the metatarsus are connected with those of the toes by ligaments, called *plantar*, *lateral*, and *transverse*, so arranged as to admit of *flexion*, *extension*, *adduction*, and *abduction*. The expansion of the extensor tendon supplies the place of a dorsal ligament.

Fig. 40.



SOLE OF THE FOOT.

THE TOE JOINTS.—The phalanges of the toes have the same ligamentous connection as those of the fingers, and the same variety and extent of motion.

The ligaments of the sole of the foot are seen in Fig. 40. 1. Os calcis. 2. Astragalus. 3. Tuberosity of the scaphoid. 4. Long calcaneo-cuboid ligament. 5. Part of the short calcaneo-cuboid. 6. Calcaneo-scaphoid. 7. Plantar tarsal. 8, 8. Tendon of the peroneus longus muscle. 9, 9. Plantar tarso-metatarsal ligaments. 10. Plantar ligament of the metatarso-phalangeal joint of the great toe; the same ligament is seen upon the other toes. 11. Lateral ligaments of the metatarso-phalangeal joint. 12. Transverse ligament. 13. Lateral ligaments of the phalanges of the great toe; the same ligaments are seen upon the other toes.

NOTE.—In amputations at the tarso-metatarsal joint, it must be understood that the metatarsal bone of the second toe is strongly wedged between the internal and external cuneiform bones, being the most firmly articulated of all the metatarsal bones.

CHAPTER III.

OF THE MUSCLES—MYOLOGY.

THE muscles are the moving organs of the body, They are composed of parallel fibres, of a deep red color, constituting *lean flesh.* These fibres are held together by a delicate web of *areolar tissue,* which becomes condensed and so modified toward the extremities of the muscles as to form glistening fibres and cords, called *tendons,* by which they are attached to the surface of the bones.

The greater portion of the bulk of the body is composed of muscular tissue. In the limbs the muscles invest and protect the bones and some of the joints. In the trunk they are spread out to enclose cavities, and form a defensive wall, capable of yielding to external pressure and again returning to its original position. The tendons of broad muscles are often spread out, forming expansions called *aponeuroses.*

The *names* of muscles are generally derived from some prominent character in shape, structure, or use, or points of attachment. The more fixed or central point of attachment is called the *origin* of a muscle, and its movable extremity its *insertion*. Some muscles, however, pull equally at both extremities.

Fig. 41.

MUSCULAR SYSTEM.

STRUCTURE OF MUSCLE.—Muscular tissue is composed of bundles of fibres, of variable size, called *fasciculi*, enclosed in a cellular sheath. Each *fasciculus* is composed of smaller bundles, and each bundle of single fibres. These *ultimate fibres*, by microscopic examination, appear to be composed of still smaller fasciculi, called *ultimate fibri's*, enclosed in a delicate sheath, called *myolemma*. Anatomists distinguish two kinds of ultimate muscular fibre: that of voluntary, or animal life, and that of involuntary, or organic life.

The *ultimate fibre of animal life* is distinguished by uniformity of calibre, by its longitudinal striæ, and by transverse markings, which occur at short regular distances. The *ultimate fibrils* are regarded as beaded filaments, consisting of a regular succession of segments and constrictions. An ultimate fibre is composed of a bundle of these fibrils, so disposed that all the segments and all the constrictions correspond, in this manner giving rise to alternate light and dark lines of the transverse striæ.

Fig. 42 represents an ultimate fibre of animal life, in which the transverse splitting into discs, in the direction of the constrictions of the ultimate fibrils, is seen.

Fig. 42.

ULTIMATE FIBRE.

The *ultimate fibre of organic life* is a simple homogeneous filament, flat, without transverse markings, and much smaller than that of animal life. The fibres are collected into fasciculi of various sizes, and held together by dark nuclear fibres. Generally a dark line, or several dark points, may be seen in the interior of the organic fibres; and sometimes the fibre is enlarged at irregular distances; these appearances are owing to the presence of unobliterated nuclei of the cells from which the fibre was originally developed.

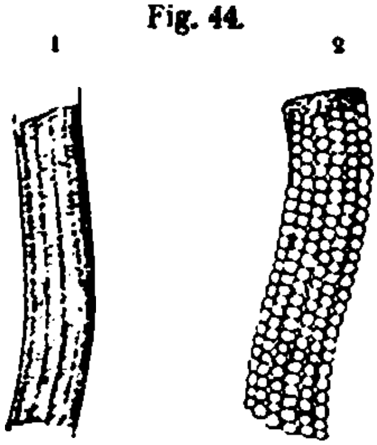
Fig. 43.

FIBRES.

In Fig. 43, 1 exhibits a muscular fibre of organic life from the bladder, magnified 600 times. Four of the nuclei are seen. 2 represents a fibre of organic life from the stomach, equally magnified.

Development of Muscular Fibre.—This is effected by the formation of nucleated cells out of an original *blastema* or fluid substance capable of becoming organized, and the conversion of the cells into the tubuli of ultimate fibres, by the process already described in relation to the development of bone, while their contents are transformed into ultimate fibrils; in this way the cell membranes constitute the myolemma, and their contents a blastema, out of which new cells are formed.

Fig. 44.



DEVELOPMENT OF MUSCLE.

In Fig. 44, 1 is a muscular fibre of animal life, enclosed in its myolemma. The transverse and longitudinal striæ are seen. 2, 2. Muscular fibres of animal life, more highly magnified than the former. The myolemma is so thin and transparent that the ultimate fibrils can be seen through it. They show the nature of the longitudinal striæ, as well as the formation of the transverse striæ.

The *voluntary system*, or that of *animal life*, is developed from the external or serous layer of the germinal membrane, and comprehends all of the muscles of the limbs and trunk. The *involuntary*, or *organic system*, is formed from the internal or mucous layer, and constitutes the thin muscular structure of the alimentary canal, bladder, and internal organs of generation. At the commencement and termination of the alimentary canal, both classes of fibres are blended in the formation of the muscular coat. The heart is developed from the middle or vascular layer of germinal membrane, and is composed of ultimate fibres having the transverse striæ of the muscles of animal life, although its action is involuntary.

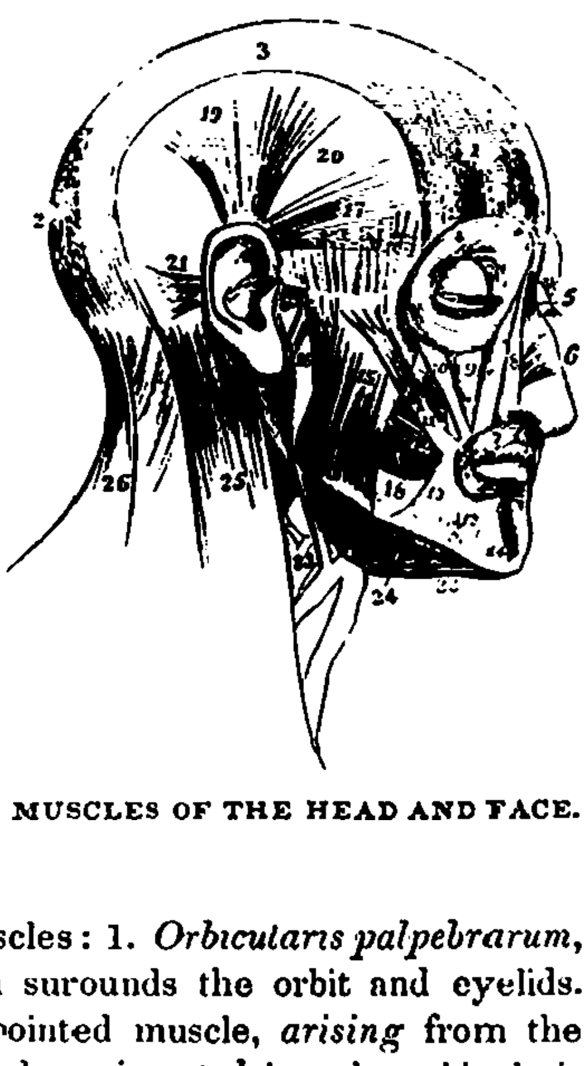
MUSCLES OF THE HEAD AND FACE.

These have been divided into eight groups—cranial, orbital, ocular, nasal, superior labal, inferior labal, maxillary, and auricular.

Cranial Group.—This has but one muscle, the *occipito-frontalis*

It is a broad expansion, covering the whole side of the vertex of the skull from the occiput to the eyebrow. It *arises* by tendinous fibres from the outer two thirds of the upper curved line of the occipital, and from the mastoid process of the temporal bone. It is *inserted* above the orbit by means of a blending of its fibres with those of the orbicularis palpebrarum, corrugator supercilii, levator labii superioris alæque nasi, and pyramidalis nasi. Its *use* is to raise the eyebrows, in doing which the integuments of the forehead are wrinkled. In some persons the whole scalp moves by the contraction of this muscle.

Fig. 45.



MUSCLES OF THE HEAD AND FACE.

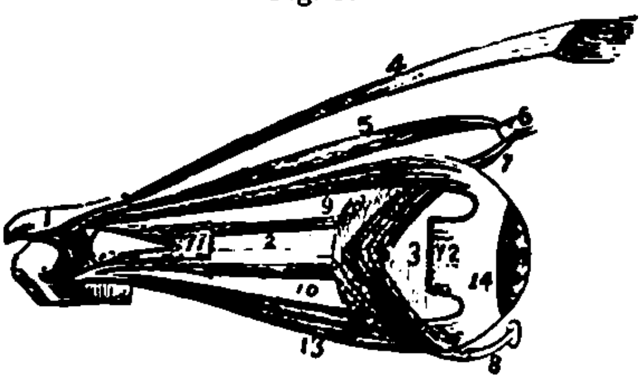
Fig. 45 shows the muscles of the head and face. 1. Frontal portion of the occipito-frontalis. 2. Its occipital portion. 3. Its aponeurosis, or expansion. 4. Orbicularis palpebrarum, which conceals the corrugator supercilii and tensor tarsi. 5. Pyramidalis nasi. 6. Compressor nasi. 7. Orbicularis oris. 8. Levator labii superioris alæque nasi. 9. Levator labii superioris proprius; the lower part of the levator anguli oris is seen between 10 and 11. 10. Zygomaticus minor. 11. Zygomaticus major. 12. Depressor labii inferioris. 13. Depressor anguli oris. 14. Levator labii inferioris. 15. Superficial portion of the masseter. 16. Its deep portion. 17. Attrahens aurem. 18. The buccinator. 19. Attollens aurem. 20. Temporal fascia covering in the temporal muscle. 21. Retrahens aurem. 22. Anterior belly of the digastricus; its tendon is seen passing through its aponeurotic pulley. 23. Stylo-hyoid, pierced by the posterior belly of the digastricus. 24. Mylo-hyoideus. 25. Upper part of the sterno-mastoid. 26. Upper part of the trapezius. The splenius is seen between 25 and 26.

The Orbital Group.—Three muscles: 1. *Orbicularis palpebrarum*, a sphincter or closing muscle, which surounds the orbit and eyelids. 2. *Corrugator supercilii*, a narrow, pointed muscle, *arising* from the inner extremity of the superciliary ridge; *inserted* into the orbicularis palpebrarum. 3. *Tensor tarsi*, a very small muscle, *arising* from the orbital surface of the lachrymal bone; *inserted* by two slips into the lachrymal canals. The *use* of this group is to close the lids, draw the eyebrows downward and inward, and extend the lachrymal canals.

The Ocular Group.—This group consists of seven: 1. *Levator palpebræ*, long, thin, and triangular, situated in the upper part of the orbit: *arises* from the upper margin of the optic foramen and sheath of the optic nerve; *inserted* into the upper border of the upper tarsal cartilage. 2. *Rectus superior, arising* with the preceding; *inserted* into the globe of the eye about three lines from the margin of the cornea. 3. *Rectus inferior; arises* from the inferior margin of the optic foramen and sheath of the optic nerve; *inserted* into the inferior surface of the globe near the margin of the cornea. 4. *Rectus internus*, a short, thick muscle; *arises* from the common tendon and the sheath of the optic nerve; *inserted* into the inner surface of the globe near the margin of the cornea. 5. *Rectus externus; arises* from the common tendon, and from the margin of the optic foramen; *inserted* into the outer surface of the globe near the cornea. 6. *Obliquus superior; arises* from the margin of the optic foramen and sheath of the optic nerve; *inserted* into the sclerotic coat near the entrance of the optic nerve. 7. *Obliquus inferior; arises* from the inner margin of the superior maxillary bone; *inserted* into the outer and posterior part of the eyeball near the entrance of the optic nerve.

Uses.—The levator raises the upper eyelids; the four recti, when acting singly, pull the eyeball upward, downward, inward, and outward; the superior oblique rolls the globe inward and forward; the inferior oblique rolls the globe outward and backward.

Fig. 46



MUSCLES OF THE EYEBALL.

Fig. 46 is a view of the ocular group, taken from the outer side of the right orbit. 1. A small fragment of the sphenoid bone around the entrance of the optic nerve into the orbit. 2. Optic nerve. 3. Globe of the eye. 4. Levator palpebræ muscle. 5. Superior oblique. 6. Its cartilaginous pulley. 7. Its reflected tendon. 8. Inferior oblique. 9. Superior rectus. 10. Internal rectus, almost concealed by the optic nerve. 11. Parts of the external rectus, showing its two heads of origin. 12. Extremity of the external rectus at its insertion. 13. Inferior rectus. 14. The tunica albuginea, which is formed by the expansion of the tendons of the four recti muscles.

The Nasal Group.—Three muscles: 1. *Pyramidalis nasi*, a slip of fibres extending from the occipito-frontalis downward upon the bridge of the nose; *inserted* into the tendinous expansion of the compressores nasi. 2. *Compressor nasi*, a thin triangular muscle; *arises* from the canine fossa of the superior maxillary bone, and, spreading out on the side of the nose into a tendinous expansion, is continuous across its ridge with its fellow of the opposite side. 3. *Dilitator naris*, a thin muscular slip expanded upon the ala of the nostril.

Uses.—The first draws down the inner angle of the eyebrow, and assists the occipito-frontalis; the second *expands* rather than compresses the nostril: the last dilates the cavity of the nostril.

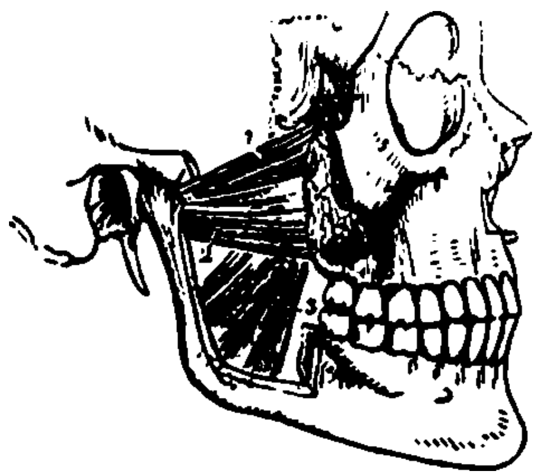
THE SUPERIOR LABIAL GROUP.—Seven muscles constitute this group: 1. *Orbicularis oris*, a sphincter completely surrounding the mouth, the use of which is to close the lips. 2. *Levator labii superioris alæque nasi;* thin, triangular, *arising* from the nasal process; *inserted*, by two distinct portions, into the ala of the nose and upper lip; its *use* is to raise the upper lip, and expand the opening of the nose. 3. *Levator labii superioris proprius;* thin, quadrilateral, *arising* from the lower border of the orbit; *inserted* into the integument of the upper lip; its *use* is to elevate the upper lip. 4. *Levator anguli oris*, *arising* from the canine fossa of the upper jaw, and, passing outwardly, is *inserted* into the angle of the mouth, which it draws inward and upward. 5. *Zygomaticus major*, and *zygomaticus minor;* two slender fasciculi of fibres, *arising* from the malar bone; *inserted* into the angle of the mouth; they pull the angle upward and outward, as in laughing. 7. *Depressor labii superioris alæque nasi*, an oval slip *arising* from the incisive fossa; *inserted* into the upper lip, and into the ala and columna of the nose; it lifts the upper lip, with the ala of the nose, and expands the opening of the nares.

THE INFERIOR LABIAL GROUP.—Comprising three muscles: 1. *Depressor labii inferioris; arises* from the side of the symphisis of the lower jaw; *inserted* into the orbicularis muscle and integuments of the lower lip; it draws the under lip directly downward and a little outward. 2. *Depressor anguli oris*, a triangular plane, *arising* from the external oblique side of the lower jaw; *inserted* into the angle of the mouth; it pulls the angle of the mouth either downward and inward, or downward and outward, by the radiation of its fibres, as in the expression of grief. 3. *Levator labii inferioris*, a conical slip, *arising* from the incisive fossa of the lower jaw; *inserted* into the integuments of the chin, which it raises and protrudes.

THE MAXILLARY GROUP.—Five muscles: 1. *Masseter*, short and thick, composed of two planes of fibres, superficial and deep; the *superficial arises* from the tuberosity of the upper jaw, the lower edge of the malar bone and zygoma, and is *inserted* into the ramus and angle of the lower jaw; the *deep layer arises* from the back part of the zygoma, and is *inserted* into the upper half of the ramus. 2. *Temporalis*, a broad radiating muscle, occupying a considerable extent of the side of the head, and fitting the temporal fossa; *arises* from the temporal ridge, temporal fascia, and temporal fossa, and converging into a strong, narrow tendon, is *inserted* into the coronoid process. 3. *Buccinator; arises* from the alveolar processes of the upper jaw, and from the external oblique line of the lower jaw; *inserted* into the angle of the mouth, where its converging fibres cross each other. 4. *External pterygoid*, a short, thick muscle, *arising* two-headed from the sphenoid bone; *inserted* into the neck of the lower jaw. 5. *Internal pterygoid*, thick, quadrangular, *arising* from the pterygoid fossa; *inserted* into the ramus and angle of the lower jaw.

Uses.—This group comprises the active agents in mastication. The buccinator circumscribes the cavity of the mouth, and shortens the cavity of the pharynx in deglutition. The masseter, temporal, and internal pterygoid close the jaws, and perform the bruising motions. The two last mentioned, with the external pterygoid, carry the lower jaw forward upon the upper, thus producing the grinding motion. All of these muscles, acting successively, produce a lateral and rotatory movement of the lower jaw.

Fig. 47.



PTERYGOID MUSCLES.

The two pterygoid muscles are seen in Fig. 47. The zygomatic arch and most of the ramus have been removed to bring them into view. 1. The sphenoid origin of the external pterygoid. 2. Its pterygoid origin. 3. Internal pterygoid muscles.

THE AURICULAR GROUP.—Three muscles: 1. *Attollens aurem*; 2. *Attrahens aurem*; 3. *Retrahens aurem*. These small muscles of the ear possess ordinarily but little contractility; they raise, extend, and retract the ear in the lower animals.

MUSCLES OF THE NECK.

The muscles of the neck are divided into eight groups, viz.:

THE SUPERFICIAL GROUP.—Two muscles: 1. *Platysma myoides; arises* from the integument over the pectoralis major and deltoid muscles; *inserted* into the side of the chin, oblique line of the lower jaw, angle of the mouth, and cellular tissue of the face. It draws the angle of the mouth, depresses the lower jaw, also produces traction on the integuments of the neck. 2. *Sterno-cleido-mastoid* is the large oblique muscle of the neck; *arises* from the sternum and clavicle; *inserted* into the mastoid process and occipital bone. *Uses.*—When both act together the head is bowed forward; either one acting singly draws the head toward the shoulder, and carries the face toward the opposite side. When the clavicular portions act more forcibly than the sternal, they give steadiness to the head, enabling it to support great weights.

The Laryngeal Group.—This group is subdivided into *depressors* and *elevators of the os hyoides and larynx.* The *depressors* are four: 1. *Sterno-hyoideus,* a ribbon-like band *arising* from the back of the upper bone of the sternum and inner extremity of the clavicle; *inserted* into the back of the os hyoides. 2. *Sterno-thyroideus,* a broader band, *arising* from the sternum with the preceding, and from the cartilage of the first rib; *inserted* into the oblique line of the great ala of the thyroid cartilage. 3. *Thyro-hyoideus, arises* from the oblique line of the thyroid cartilage; *inserted* into the lower part of the body and great cornua of the hyoid bone. 4. *Omo-hyoideus, arises* from the upper border of the scapula and transverse ligament of the suprascapular notch; *inserted* into the lower border of the body of the hyoid bone.

Uses.—All these muscles pull down the os hyoides and larynx. The first three draw them downward in the middle line; the latter inclines them to one or the other side, according to the position of the head.

The *elevators* are four muscles: 1. *Digastricus,* a two-bellied muscle, *arising* from the inner side of the mastoid process of the temporal bone; *inserted* into the lower jaw near its centre. 2. *Stylo-hyoideus,* a slender muscle, *arising* from the middle of the styloid process; *inserted* into the central part of the body of the os hyoides. 3. *Mylo-hyoideus,* a triangular plane, forming, with its fellow, the floor of the mouth; *arising* from the molar ridge of the lower jaw; *inserted* into the body of the os hyoides, and into the *raphé* of the two muscles. 4. *Genio-hyoideus, arising* on the inner side of the centre of the lower jaw; *inserted* into the upper part of the body of the os hyoides.

Uses.—All these muscles raise the os hyoides when the lower jaw is closed, and act upon the lower jaw when the os hyoides is drawn down and fixed by its depressors.

The Linguinal Group.—Five muscles: 1. *Genio-hyo-glossus;* this is the proper muscle of the tongue; *arises,* narrow and pointed, from a tubercle on the inner side of the centre of the lower jaw; *inserted* by a fan-shaped attachment into the whole length of the tongue and body of the os hyoides. 2. *Hyo-glossus,* a square plane, *arising* from the great cornua and body of the os hyoides; *inserted* into the side of the tongue. 3. *Lingualis*, consisting of a small bundle, running from the base to the apex of the tongue. 4. *Stylo-glossus*, *arising* from the styloid process and stylo-maxillary ligament; *inserted* into the substance and side of the tongue. 5. *Palato-glossus*, constituting, with its fellow, the constrictor of the isthmus of the fauces; is extended between the soft palate and base of the tongue.

Uses.—The various directions of the fibres of the linguinal muscles give the tongue every conceivable variety of motion. The palato-glossi, assisted by the uvula, close the fauces completely in the act of deglutition.

The Pharyngeal Group.—Five muscles: 1. *Constrictor inferior*, *arises* from the upper rings of the trachea, cricoid and thyroid cartilages; *inserted* into the middle of the pharynx. 2. *Constrictor medius*, *arises* from the great cornu of the os hyoides and stylo-hyoidean ligament, and its fibres, radiating from the origin, are *inserted* into the pharynx and basilar process of the occipitis. 3. *Constrictor superior*, *arises* from the molar ridge of the lower jaw, the internal pterygoid plate, and the pterygo-maxillary ligament; *inserted* with the preceding. 4. *Stylo-pharyngeus*, *arising* from the inner side of the base of the styloid process; its fibres spread out beneath the mucous membrane of the pharynx, and are *inserted* into the posterior border of the thyroid cartilage. 5. *Palato-pharyngeus*, *arises* from the soft palate; *inserted* into the inner surface of the pharynx and posterior border of the thyroid cartilage.

Uses.—The constrictors contract upon the food as soon as it passes into the pharynx, and convey it downward to the œsophagus. The stylo-pharyngei draw the pharynx upward and widen it laterally; and the palato-pharyngei draw it upward and assist in closing the opening of the fauces.

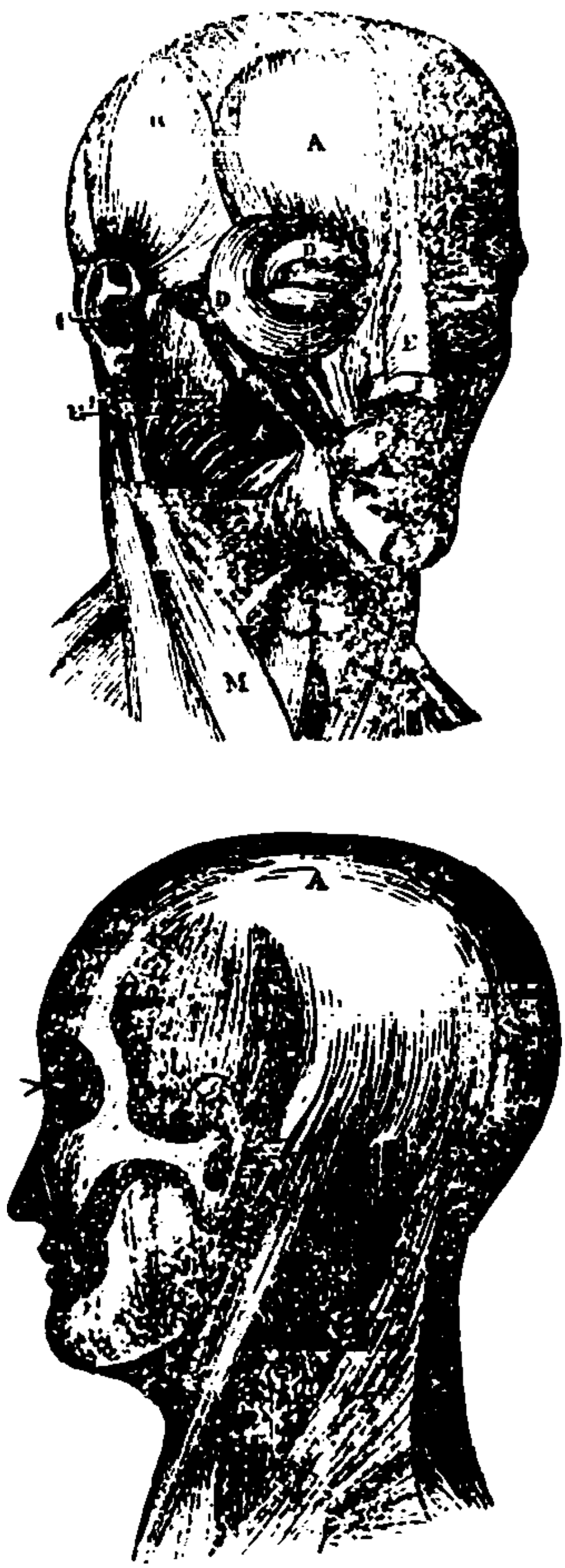
Palatal Group.—The muscles of the soft palate are three; their situation is indicated by their names. They are: 1. *Levator palati*, which *raises* the soft palate. 2. *Tensor palati*, which extends the palate laterally, so as to form a septum between the pharynx and posterior nares. 3. *Azygos uvula*, which shortens the uvula.

Prævertebral Group.—Five muscles: 1. *Rectus anticus major*, *arises* from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *inserted* into the basilar process of the occipitis. 2. *Rectus anticus minor*, *arises* from the side of the atlas; *inserted* with the preceding. 3. *Scalenus anticus*, a triangular muscle, *arising* with the rectus anticus major; *inserted* into the inner border of the first rib. 4. *Scalenus posticus; arises* from the posterior tubercles of all the cervical vertebræ, except the first; *inserted* into the first and second ribs by fleshy fibres. 5. *Longus colli*, a long flat muscle, consisting of two portions, the *upper arising* from the anterior tubercle of the atlas, and *inserted* into the transverse processes of the third, fourth, and fifth cervical vertebræ; and the *lower arising* from the bodies of the second and third, and transverse processes of the fourth and fifth, and passing down the neck, to be *inserted* into the bodies of the three lower cervical and three upper dorsal vertebræ.

Uses.—The rectus major and minor preserve the equilibrium of the head upon the atlas; and when acting with the longus colli, flex and rotate the head and vertebræ of the neck. The scaleni flex the vertebral column, and assist in elevating the ribs in inspiration.

The Laryngeal Group will be described with the anatomy of the larynx.

Fig. 48.



MUSCLES OF THE HEAD AND NECK

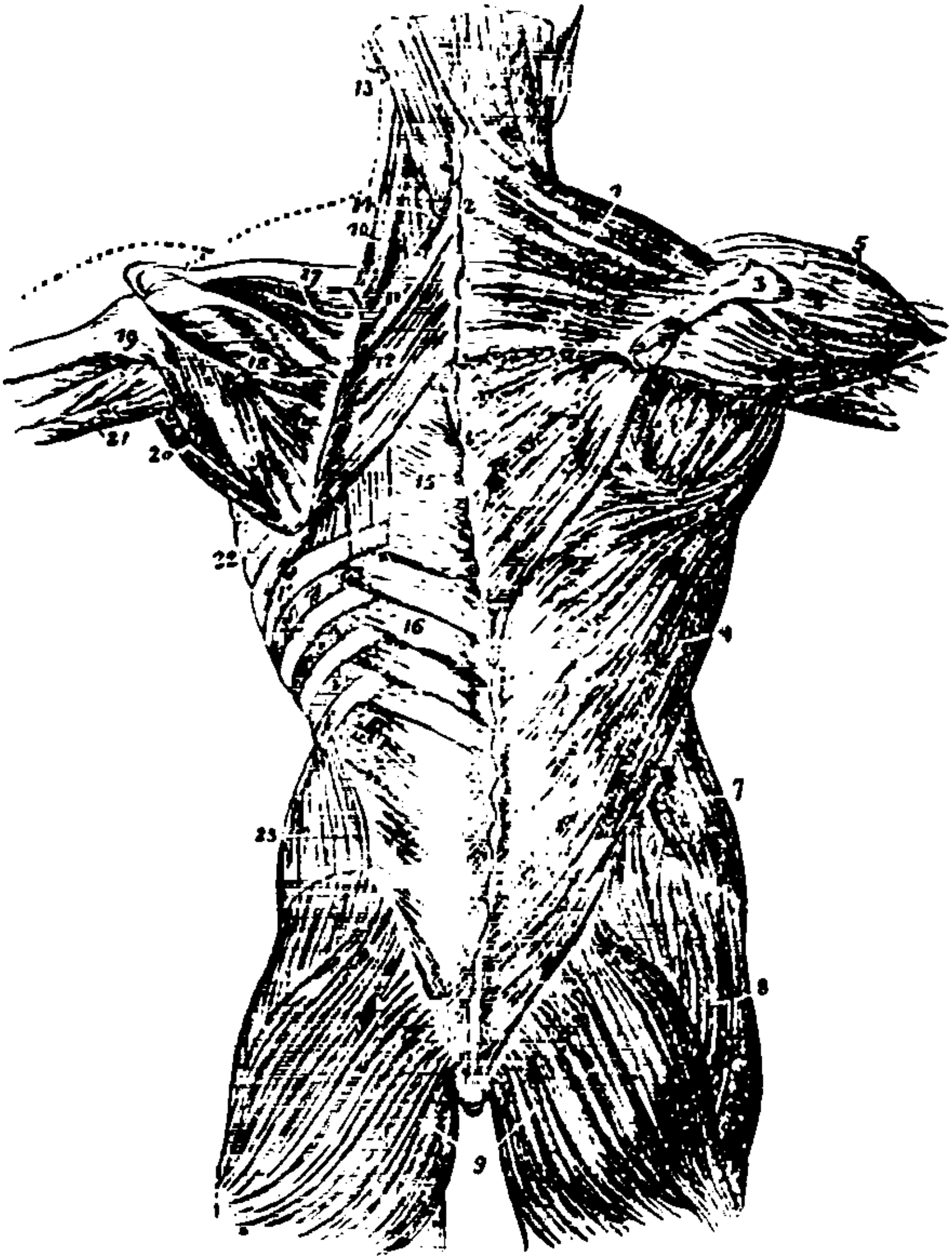
In Fig. 48 the most prominent muscles of the head and neck are seen. A. Occipito-frontalis. B. Attolleus aurem. C. The concha. D. Orbicularis palpebrarum. E. Compressor naris. F. Zygomaticus major. G. Levator labii superioris alæque nasi. H. Zygomaticus minor. I. Levator anguli oris. K. Masseter. L. Depressor anguli oris. M. Sterno-cleido mastoideus. O. Depressor labii inferioris. P. Orbicularis oris. Q. Temporalis. R. Splenius. S. Trapezius. T. Sterno-hyoideus. *a.* Helix. *b.* Anti-helix. *c.* Concha.

MUSCLES OF THE BACK.

The muscles of the back are divided into six layers.

First Layer.—Two muscles: 1. *Trapezius; arises* from the upper curved line of the occipitis, ligament of the neck, and spines of the dorsal vertebræ; *inserted* into the spine and acromion of the scapula, and scapular third of the clavicle. 2. *Latissimus dorsi*, covering the

Fig 49.



EXTERNAL MUSCLES OF THE BACK.

In Fig. 49 the first, second, and part of the third layer are seen; the first on the right, and the second on the left side. 1. Trapezius. 2. The tendinous portion which forms, with the corresponding part of the opposite muscle, the tendinous ellipse on the back of the neck. 3. Acromion process and spine of the scapula. 4. Latissimus dorsi. 5. Deltoid. 6. Infra spinatus, teres minor, and teres major, all muscles of the dorsum of the scapula. 7. External oblique. 8 Gluteus medius. 9. Glutei maximi. 10. Levator anguli scapulæ. 11. Rhomboideus minor. 12. Rhomboideus major. 13. Splenius capitis; the complexus is immediately above, and overlaid by it. 14 Splenius colli; partially seen 15. Vertebral aponeurosis. 16. Serratus posticus inferior. 17. Supra-spinatus. 18. Infra-spinatus. 19. Teres minor. 20. Teres major. 21. Long head of the triceps, passing between the teres minor and major to the upper arm. 22. Serratus magnus, proceeding forward from its origin at the base of the scapula. 23. Internal oblique.

whole lower part of the back and loins; *arises* from the spines of the seven lower dorsal and all the lumbar vertebræ, sacral spines, back part of the crest of the ilium, and three lower ribs; the fibres converge as they ascend, cross the lower angle of the scapula, curve around the lower border of the teres major, and are *inserted* into the bicipital groove of the humerus.

Uses.—The upper fibres of the trapezius draw the shoulder upward and backward, the middle directly backward, and the lower downward and backward. The latissimus dorsi draws the arm backward and downward, and rotates it inward; if the arm be fixed it will draw the spine to that side, and raise the lower rib, thus aiding inspiration; if both arms be fixed, both muscles will draw the whole trunk forward, as in climbing, walking on crutches, etc.

NOTE.—The *ligamentum nuchæ* is a thin cellulo-fibrous layer between the occipital bone and spine of the seventh cervical vertebræ.

SECOND LAYER.—Three muscles: 1. *Levator anguli scapulæ; arises* from the transverse processes of the four cervical vertebræ; *inserted* into the upper angle and posterior border of the scapula. 2. *Rhomboideus minor; arises* from the spines of the two last cervical vertebræ and ligamentum nuchæ; *inserted* into the posterior border of the scapula. 3. *Rhomboideus minor; arises* from the spines of the last cervical and four upper dorsal vertebræ; *inserted* with the preceding.

Uses.—The levator lifts the upper angle of the scapula, and with the rhomboidei carry the shoulder upward and backward.

THIRD LAYER.—These muscles all arise from the spines of the vertebral column, and pass outwardly. There are three of them: 1. *Serratus posticus superior; arises* from the spines of the lower cervical and upper dorsal vertebræ; *inserted* into the upper borders of the upper ribs. 2. *Serratus posticus inferior; arises* from the spines of the two last dorsal and three upper lumbar vertebræ; *inserted* into the lower borders of the four lower ribs. 3. The *splenius muscle, arising* from the lower part of the ligamentum nuchæ, and spines of the four lower cervical and six upper dorsal vertebræ; *inserted* by two divisions, the first, called *splenius capitis,* into the occipital bone, and the second, called *splenius colli,* into the transverse processes of the upper cervical vertebræ.

Uses.—The serrati are muscles of respiration; their actions antagonize, the posterior drawing the ribs upward to expand the chest, and the inferior drawing down the lower ribs, and diminishing the cavity of the chest, thus rendering the first an *inspiratory,* and the second an *expiratory* muscle. The splenii of one side draw the vertebral column backward and to one side, and rotate the head toward the corresponding shoulder. The splenii of both sides acting together draw the head forward; they antagonize the sterno-mastoid muscles.

Fourth Layer.—Seven muscles: 1. *Sacro-lumbalis; arises* from the back part of the crest of the ilium, posterior surface of the sacrum and lumbar vertebræ; *inserted* by separate tendons into the angles of the six lower ribs. 2. *Longissimus dorsi; arises* with the preceding; *inserted* into all the ribs between their tubercles and angles. 3. *Spinalis dorsi; arises* from the spines of the two upper lumbar and three lower dorsal vertebræ; *inserted* into the spines of all the upper dorsal vertebræ. 4. *Cervicalis ascendens; arises* from the angles of the four upper ribs; *inserted* into the transverse processes of the four lower cervical vertebræ. 5. *Transversalis colli; arises* from the transverse processes of the four upper dorsal vertebræ; *inserted* into the like processes of the five middle cervical. 6. *Trachleo-mastoid; arises* from the transverse processes of the four upper dorsal and five lower cervical vertebræ; *inserted* into the mastoid process. 7. *Complexus*, a large muscle, forming, with the splenius, the great bulk of the back of the neck; *arises* from the transverse processes of the four upper dorsal, and transverse and articular processes of the five lower cervical vertebræ; *inserted* into the occipital bone, near its spine.

Uses.—These muscles hold the vertebral column erect, and assist in steadying the head; the complexus contracts the muscles on the anterior side of the neck; when the muscles of one side act alone, they produce a rotation of the head.

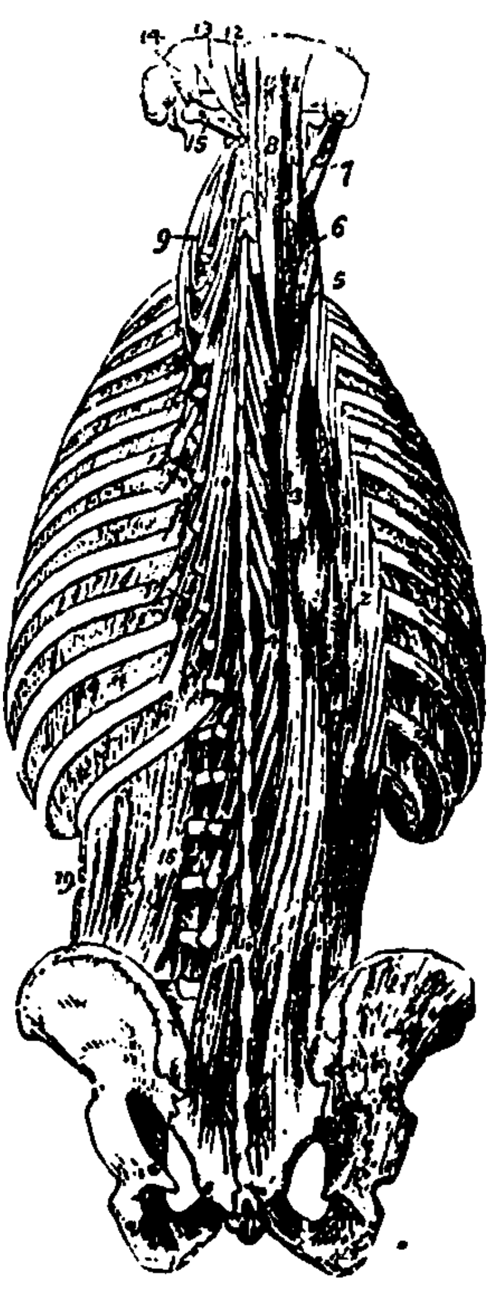
Fifth Layer.—Seven muscles: 1. *Semi-spinalis dorsi; arises* from the transverse processes of the six lower dorsal, and is *inserted* into the spines of the four upper dorsal vertebræ. 2. *Semi-spinalis colli; arises* from the transverse processes of the four upper dorsal, and is *inserted* into the spines of the five upper cervical vertebræ. 3. *Rectus posticus major; arises* from the spines of the axis; *inserted* into the lower curved line of the occipitis. 4. *Rectus posticus minor; arises* from the spinous tubercle of the atlas; *inserted* into the occipitis, below the former. 5 *Rectus lateralis; arises* from the transverse process of the atlas; *inserted* into the occipitis, external to the condyle. 6. *Obliquus inferior: arises* from the spine of the axis; *inserted* into the extremity of the transverse process of the atlas. 7. *Obliquus superior; arises* where the preceding is inserted; *inserted* into the occipitis, between the curved lines.

Uses.—The semi-spinales contribute to the support of the back in the erect position; the recti produce the antero-posterior, and the obliqui the rotatory movement of the atlas on the axis.

SIXTH LAYER.—Five muscles: 1. *Multifidus spinæ*, consisting of bundles of fibres, *arising* from the transverse processes of all the vertebræ from the sacrum to the axis; *inserted* into the spines of the first or second vertebræ above their origin. 2. *Levatores costarum*, consisting of twelve distinct fasciculi on each side, which *arise* from the transverse processes of the dorsal vertebræ, and are *inserted* into the ribs below, between the tubercles and angles. 3. *Supra-spinalis*, composed of fasciculi *arising* from the lower cervical and upper dorsal vertebræ; *inserted* into the spine of the axis. 4. *Interspinales*, small slips arranged in pairs, situated between the spines of all the vertebræ. 5. *Inter-transversales*, small quadrilateral slips between the transverse processes of all the vertebræ.

Uses.—The levators raise the posterior parts of the ribs in inspiration; the others are auxiliaries to the larger muscles in supporting the body, and holding the bones in position.

Fig. 50.



INNER MUSCLES OF THE BACK

In Fig. 50 are seen the fourth and fifth, and part of the sixth layer. 1. Origin of the sacro-lumbalis and longissimus dorsi. 2. Sacro-lumbalis. 3. Longissimus dorsi. 4. Spinalis dorsi. 5. Cervicalis ascendens. 6. Transversalis colli. 7. Trachleo-mastoideus. 8. Complexus. 9. Transversalis colli. 10. Semi-spinalis dorsi. 11. Semi-spinalis colli. 12. Rectus posticus minor. 13. Rectus posticus major. 14. Obliquus superior. 15. Obliquus inferior. 16. Multifidus spinæ. 17. Levatores costarum. 18. Intertransversales. 19. Quadratus lumborum.

MUSCLES OF THE THORAX.

The principal muscles of the thorax belong also to the upper extremity. Those proper to the thorax are three:

1. *External intercostals* 2. *Internal intercostals.* 3 *Triangularis sterni.*

The intercostals are eleven internal and eleven external planes of muscular and tendinous fibres, situated obliquely between the adjacent ribs, and filling the intercostal spaces. The fibres of the external are directed obliquely downward and inward, and those of the internal obliquely downward and backward, so that they cross each other.

The *triangularis sterni* is situated within the chest, connecting the side of the sternum and sternal extremities of the costal cartilages with the cartilages of the second, third, fourth, fifth, and sixth ribs. The lower fibres of this muscle are continuous with the diaphragm.

Uses.—The intercostals raise or depress the ribs, as they act from above or below, being thus both inspiratory and expiratory. The triangularis is a muscle of expiration, by drawing down the costal cartilages.

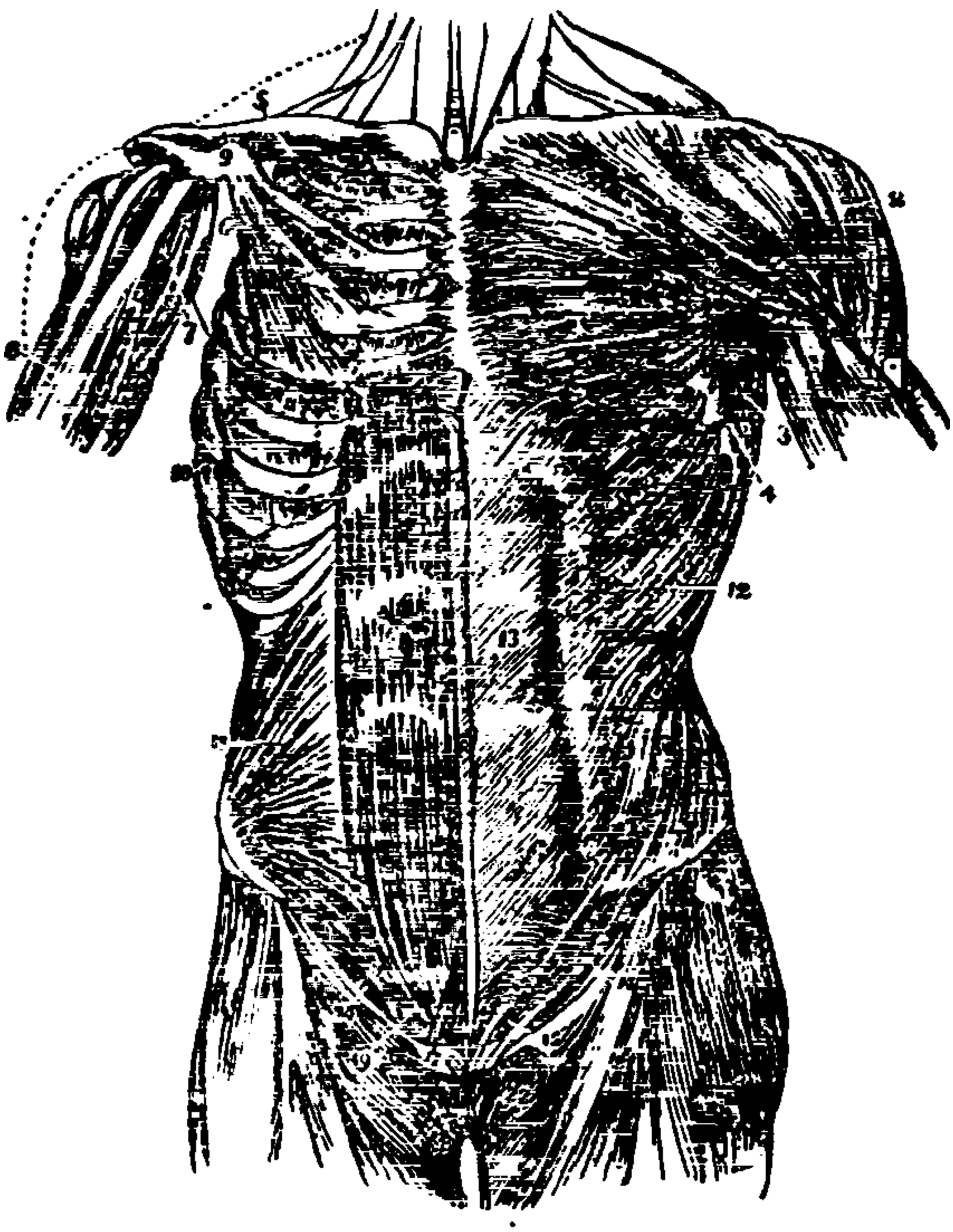
MUSCLES OF THE ABDOMEN.

The muscles of the abominal region are nine in number:

1. *Obliquus externus;* this is the external, flat, *descending* muscle; its fibres *arise* by fleshy digitations from the eight lower ribs, and spread out to a broad aponeurosis, which is *inserted* into the outer part of the crest of the ilium for one half its length, into the anterior superior spine of the ilium, spine of the pubis, pectineal line, front of the pubis, and linea alba.

NOTE.—The lower border of the aponeurosis, between the spines of the ilium and pubis, is rounded from being folded inward, and forms *Poupart's ligament.* *Gimbernat's ligament* is that part of the aponeurosis inserted into the pectineal line. The *linea alba* is a white tendinous slip extending along the middle of the abdomen from the ensiform cartilage to the os pubis. Externally, on each side of it, are two curved lines, extending from the sides of the chest to the pubis, called the *lineæ semilunares;* these lines are connected with the linea alba by several cross lines, usually three or four in number, called *lineæ transversæ.* Just above the crest of the pubis is a triangular opening, formed by the separation of the fibres of the aponeurosis, called the *external abdominal ring.* Through this ring passes the spermatic cord in the male, and the round ligament of the uterus in the female; both are invested in their passage by a thin fascia derived from the edges of the ring, called *intercolumnar,* or *spermatic fascia.* In inguinal hernia the pouch, in projecting through this opening, receives an additional covering from this spermatic fascia.

Fig. 51.



MUSCLES OF THE TRUNK.

In Fig. 51 are seen the muscles of the trunk anteriorly. The superficial layer is seen on the left side, and the deeper on the right. 1. Pectoralis major. 2. Deltoid. 3. Anterior border of the latissimus dorsi. 4. Serrations of the serratus magnus. 5. Subclavius of the right side. 6 Pectoralis minor. 7. Coracho-brachialis. 8. Upper part of the biceps, showing its two heads. 9. Coracoid process of the scapula. 10. Serratus magnus of the right side. 11. External intercostal. 12. External oblique. 13. Its aponeurosis; the median line to the right of this number is the linea alba; the flexuous line to the left is the linea semilunaris; the transverse lines above and below the number are the lineæ transversæ. 14. Poupart's ligament. 15. External abdominal ring; the margin above is called the *superior* or *internal* pillar; the margin below the *inferior* or *external* pillar; the curved intercolumnar fibres are seen proceeding upward from Poupart's ligament to strengthen the ring. The numbers 14 and 15 are situated upon the fascia lata of the thigh: the opening to the right of 15 is called *saphenous*. 16. Rectus of the right side. 17. Pyramidalis 18. Internal oblique. 19. The common tendon of the internal oblique and transversalis descending behind Poupart's ligament to the pectineal line. 20. The arch formed between the lower curved border of the internal oblique and Poupart's ligament, beneath which the spermatic cord passes, and hernia occurs.

2. *Internal oblique;* called the middle *ascending* flat muscle. It *arises* from the outer half of Poupart's ligament, from the middle two thirds of the crest of the ilium, and from the spines of the lumbar vertebræ; and is *inserted* into the pectineal line, crest of the pubis, linea alba, and five lower ribs.

3. *Cremaster;* *arises* from the middle of Poupart's ligament; it forms a series of loops upon the spermatic cord, and some of its fibres are *inserted* into the tunica vaginalis, the rest into the pectineal line of the pubis.

4. *Transversalis;* this is the internal flat muscle; it *arises* from the outer third of Poupart's ligament, internal lip of the crest of the ilium, spines and transverse processes of the lumbar vertebræ, and from the six lower ribs, indigitating with the diaphragm; *inserted* into the pectineal line, crest of the pubis, and linea alba.

5. *Rectus;* *arises* by a flat tendon from the crest of the pubis; *inserted* into the cartilages of the fifth, sixth, and seventh ribs.

6. *Pyramidalis;* *arises* from the crest of the pubis in front of the rectus; *inserted* into the linea alba midway between the umbilicus and pubis.

7. *Quadratus lumborum;* *arises* from the last rib and transverse processes of the four upper lumbar vertebræ; *inserted* into the crest of the ilium and ilio-lumbar ligament.

8. *Psoas parvus;* *arises* from the tendinous arches and intervertebral substance of the last dorsal and first lumbar vertebræ; *inserted* by an expanded tendon into the ilio-pectineal line and eminence.

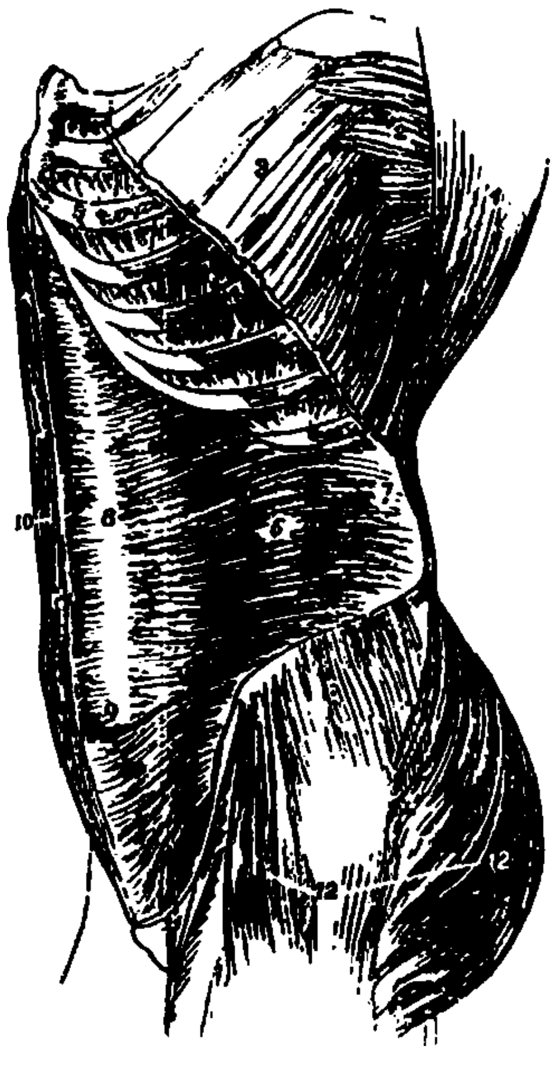
9. *Diaphragm;* this forms a muscular partition between the cavities of the chest and abdomen. In shape it is somewhat conical, and is composed of two portions, called *greater* and *lesser muscles.* The *greater muscle arises* from the ensiform cartilage, inner surfaces of the six inferior ribs, and ligamentum arcuatum externum and internum; from these points its fibres converge to the central tendon, into which they are *inserted.* The *lesser muscle arises* by two tendons from the bodies of the lumbar vertebræ; these tendons form two large fleshy bellies, called *crura,* which ascend and are *inserted* into the centra tendon.

NOTE.—The *ligamentum arcuatum externum* is the upper border of the anterior lamella of the aponeurosis of the transversalis. The *ligamentum arcuatum internum,* or *proprium,* is a tendinous arch across the psoas magnus muscle as it emerges from the chest. The *tendinous centre* of the diaphragm is called the *central tendon.* Between the sides of the ensiform cartilage and the cartilages of the adjoining ribs is a triangular space where the muscular fibres of the diaphragm are wanting; this space is closed by the peritoneum on the abdominal side, and the pleura on the side of the chest. Sometimes, from violent exertion, a portion of the alimentary canal is forced through this space, producing what is called phrenic or diaphragmatic hernia.

There are three *openings* in the diaphragm: one in the centre, for the passage of the *inferior vena cava;* an elliptic opening in its muscular portion, formed by the two crura, for the passage of the *æsophagus* and *pneumogastric nerves;* and a third, called the *aortic*, formed by a tendinous arch which passes from the tendon of one crus to that of the other; beneath this the *aorta*, *thoracic duct*, and *right vena azygos* pass. There are also small openings in the lesser muscle on each side for the great splanchnic nerves.

Uses.—The oblique muscles flex the thorax on the pelvis; either, acting singly, would twist the body to the opposite side. Either transversalis will diminish the size of the abdomen, and both constrict its general cavity. The recti and pyramidalis together pull the thorax forward; the latter alone are tensors of the linea alba. The quadratus lumborum draws the lower rib downward, and serves to bend the vertebral column to one side. The psoas parvus extends the iliac fascia, and assists in flexing the back. The diaphragm assists the abdominal muscle in expiration.

Fig. 52.



MUSCLES OF THE TRUNK LATERALLY.

Fig. 52 is a side view of the muscles of the trunk. 1. Costal region of the latissimus dorsi. 2. Serratus magnus. 3. Upper part of external oblique. 4. Two external intercostals. 5. Two internal intercostals. 6. Transversalis. 7. Its posterior aponeurosis. 8. Its anterior. 9. Lower part of the left rectus. 10. Right rectus. 11. The arched opening where the spermatic cord passes and hernia takes place. 12. The gluteus maximus, and medius, and tensor vaginæ femoris muscles invested by fascia lata.

All the abdominal muscles are respiratory, and constitute the chief forces in the act of expiration. Considering the lungs as a bellows, they constitute the handles; they are aided in this office by the muscles of the loins and back, and to some extent by the upper muscles of the trunk.

They compress the cavity of the abdomen in all directions, thus aiding the expulsion of the contents of the stomach, bowels, gall-ducts, bladder, and uterus, and also mucous and irritating substances from the bronchia, windpipe, and nose.

MUSCLES OF THE PERINEUM.

These muscles pertain to the urethra, the outlet of the bowels, and he organs of generation. There are eight of them. In the male are: 1. *Accelerator urinæ; arises* from the centre of the perineum; its fibres, dividing, are *inserted* into the ramus of the pubes and ischium, and into the fibrous substance and spongy body of the penis. 2. *Erector penis; arises* from the ramus and tuberosity of the ischium, and, curving around the root of the penis, is *inserted* into the upper surface of its corpus cavernosum. 3. *Compressor urethræ; arises* from the ramus of the ischium, and inner surface of the arch of the pubes on each side of the symphisis; *inserted* into the back part of the urethra, from the apex of the prostate gland to which they are attached, to its bulbous portion. 4. *Transversus perinei; arises* from the tuberosity of the ischium; *inserted* into the tendinous centre of the perineum. 5. *Sphincter ani*, a thin band surrounding the opening of the anus. 6. *Sphincter ani internus*, a muscular ring formed by an aggregation of the circular fibres of the rectum. 7. *Levator ani*, a thin plane of muscular fibres on each side of the pelvis, between the os pubis and spine of the ischium; *inserted* into the lower part of the coccyx, rectum, base of the bladder, and prostate gland. 8. *Coccygeus*, a triangular layer *arising* from the spine of the ischium; *inserted* into the side of the coccyx and lower part of the sacrum.

The *uses* of these muscles are expressed by their names. In the female the perineal muscles are smaller, and are modified to the difference in organization. The muscle corresponding with the accelerator urinæ in the male, is called *constrictor vaginæ;* and the analogue of the erector penis, is called *erector clitoridis.*

MUSCLES OF THE UPPER EXTREMITY.

These may be conveniently grouped according to different regions of the limb.

THORACIC REGION.—This region comprises three anterior and one lateral muscle: 1. *Pectoralis major; arises* from the sternal two thirds of the clavicle, the whole length of the sternum, the cartilages of all the true ribs except the first and last, and from the aponeurosis of the external oblique muscle; *inserted* by a broad tendon into the anterior bicipital ridge of the humerus. 2. *Pectoralis minor; arises* by three digitations from the third, fourth, and fifth ribs; *inserted* into the coracoid process of the scapula. 3. *Subclavius; arises* from the cartilage of the first rib; *inserted* into the under surface of the clavicle. 4. *Serratus magnus; arises* by fleshy serrations from the nine upper ribs, excepting the first; *inserted* into the whole length of the base of the scapula anteriorly.

Uses.—The pectoralis major draws the arm against the chest; its upper fibres assist in raising, and its lower in depressing the shoulder. When its fixed point is at the shoulder, it assists in elevating and expanding the chest. The minor pectoral muscle acts with the former, and assists in the rotatory movement of the scapula upon the chest. The subclavius draws the clavicle downward and forward in steadying the shoulder. All these muscles are called into action in forced respiration, but cannot act unless the shoulders are fixed. The serratus raises the ribs, and thereby increases the cavity of the chest in inspiration. When it acts upon the scapula, the shoulder is drawn forward, as in many cases of diseased lungs and deformed chests.

Scapular Region.—Six muscles: 1. *Subscapularis; arises* from nearly the whole of the under surface of the scapula; *inserted* by a broad, thick tendon into the lesser tuberosity of the humerus. 2. *Supra-spinatus; arises* from the whole of the supra-spinous fossa; *inserted* into the upper depression of the great tuberosity of the humerus. 3. *Infra-spinatus; arises* from the whole of the infra-spinous fossa; *inserted* into the middle depression upon the greater tuberosity of the humerus. 4. *Teres minor; arises* from the middle third of the lower border of the scapula; *inserted* into the lower depression on the greater tuberosity of the humerus. 5. *Teres major; arises* from the lower third of the inferior border of the scapula; *inserted* into the posterior bicipital ridge. 6. *Deltoid*, a large triangular muscle forming the convexity of the shoulder; *arising* from the outer third of the clavicle, the acromion process, and from the whole length of the scapula; its fibres converge to the middle of the outer side of the humerus, where they are *inserted* into a rough elevation.

Uses.—The subscapularis rotates the head of the humerus inward; when the arm is raised it draws the humerus downward. It is a powerful defence to the shoulder joint. The supra-spinatus raises the arm feebly from the side; the infra-spinatus and teres minor rotate the head of the humerus outward; the teres minor assists its rotation inward, carrying it also toward the side, and somewhat backward. The most important use of the supra-spinatus, infra-spinatus, and teres minor is to protect the joint against displacement, for which purpose their

Fig. 53.

MUSCLES OF THE UPPER ARM.

tendons, with that of the subscapularis, are in immediate contact, forming a part of its ligamentous capsule. They are, consequently, generally ruptured in luxations of the shoulder joint.

Fig. 53 exhibits the muscles of the anterior aspect of the upper arm. 1. Coracoid process of the scapula. 2. Coraco-clavicular ligament passing outward to the scapular end of the clavicle. 3. Coraco-acromial ligament, passing outward to the acromion. 4. Subscapularis. 5. Teres major; through the triangular space above the dorsalis scapulæ vessels pass. 6. Coraco-brachialis. 7. Biceps. 8. Upper end of the radius. 9. Brachialis anticus; a portion of this muscle is seen on the outer side of the tendon of the biceps. 10. Internal head of the biceps.

Humeral Region.—Four muscles: the first three are anterior, the last posterior. 1. *Coraco-brachialis*; *arises* from the coracoid process; *inserted* into a rough line on the inner side of the middle of the humerus. 2. *Biceps*; *arises* by two tendons, one, called the *short head*, from the coracoid process: the other, the *long head*, which passes through the capsular ligament of the joint, from the upper part of the glenoid cavity; *inserted* by a rounded tendon into the tubercle of the radius. 3. *Brachialis anticus*, a broad muscle covering the anterior surface of the lower part of the humerus; *arises* from fleshy serrations on both sides of the insertion of the deltoid, the anterior surface of the humerus, and from the intermuscular septa attached to the condyloid ridges; its fibres converging are *in-*

Fig. 54.

TRICEPS MUSCLE.

Fig. 54 is a posterior view of the upper arm, showing the triceps muscle. 1. Its external head. 2. Its long, or scapular head. 3. Its internal, or short head. 4. Olecranon process of the ulna 5. Radius 6. Capsular ligament.

serted into the coronoid process of the ulna. 4. *Triceps extensor cubiti*, a three-headed muscle; the *external head arises* from the humerus, below the insertion of the teres minor, and from the intermuscular septum; the *internal head arises* from the septum and the humerus, below the insertion of the teres major; the *middle*, or *scapular head*, *arises* from the upper third of the inferior border of the scapula; the three heads unite, and form a broad muscle, which is *inserted* into the olecranon of the ulna.

Brachial Region.—This group comprises twenty muscles: the first five constitute the *anterior superficial layer;* the next three the *anterior deep layer;* the seven succeeding the *posterior superficial layer;* and the five remaining the *posterior deep layer.*

1. *Pronator radii teres; arises* by two heads, one from the inner condyle of the humerus and adjoining fascia, the other from the coronoid process of the ulna; *inserted* into the middle third of the oblique ridge of the radius. 2. *Flexor carpi radialis; arises* from the inner condyle and intermuscular fascia, and its tendon, passing through a groove formed by the scaphoid and trapezium, is *inserted* into the base of the metacarpal bone of the index finger. 3. *Palmaris longus; arises* with the preceding; *inserted* into the annular ligament and palmar fascia. 4. *Flexor sublimis digitorum; arises* from the inner condyle, internal lateral ligament, coronoid process of the ulna, and oblique ridge of the radius, and divides into four tendons, which pass beneath the annular ligament into the palm of the hand; *inserted* into the base of the second phalanges of the fingers. 5. *Flexor carpi ulnaris; arises* by two heads, one from

Fig. 55.

SUPERFICIAL ANTERIOR LAYER.

In Fig. 55 is seen the superficial layer of the muscles of the fore-arm. 1. Lower part of the biceps, with its tendon. 2. Part of the brachialis anticus. 3. Part of the triceps. 4. Pronator radii teres. 5. Flexor carpi radialis. 6. Palmaris longus. 7. One of the fasciculi of the flexor sublimis digitorum. 8. Flexor carpi ulnaris. 9. Palmar fascia. 10. Palmaris brevis. 11. Abductor pollicis. 12. One portion of the flexor brevis pollicis. 13. Supinator longus. 14. Extensor ossis metacarpi, and extensor primi internodii pollicis, curving around the lower border of the fore-arm.

the inner condyle, the other from the olecranon and upper two thirds of the inner border of the ulna; its tendon is *inserted* into the pisiform bone, and base of the metacarpal bone of the little finger. 6. *Flexor profundus digitorum; arises* from the upper two thirds of the ulna and part of the interosseous membrane, and terminates in four tendons, which pass beneath the annular ligaments, to be *inserted* into the base of the last phalanges. 7. *Flexor longus pollicis; arises* from the upper two thirds of the radius and part of the interosseous membrane; its tendon passes beneath the annular ligament to be *inserted* into the last phalanx of the thumb. 8. *Pronator quadratus; arises* from the ulna; *inserted* into the lower part of the oblique line on the outer side of the radius.

Fig. 56.

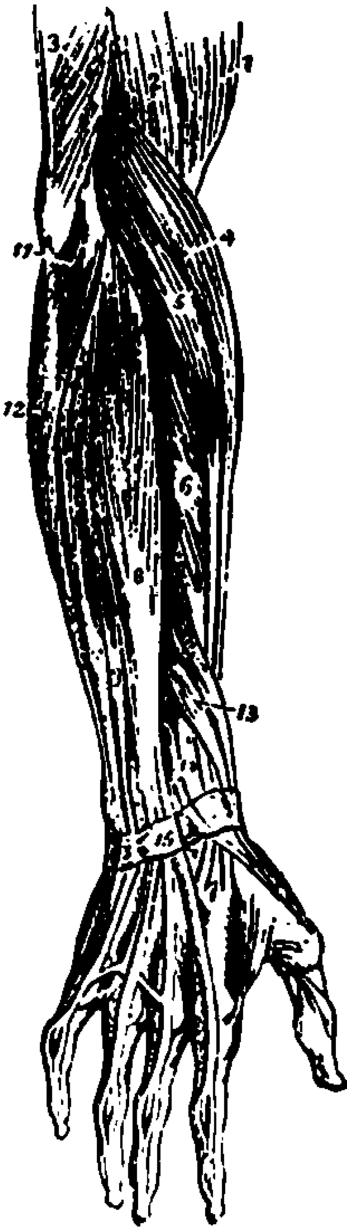
DEEP ANTERIOR LAYER

In Fig. 56 is seen the deep layer of muscles of the fore-arm. 1. Internal lateral ligament of the elbow joint. 2. Anterior ligament. 3. Orbicular ligament of the head of the radius. 4. Flexor profundus digitorum. 5. Flexor longus pollicis. 6. Pronator quadratus. 7. Adductor pollicis. 8. *Dorsal interosseous muscle of the middle finger*, and palmar interosseous of the ring finger. 9. Dorsal interosseous muscle of the ring finger, and palmar interosseous of the little finger.

9. *Supinator longus; arises* from the external condyloid region of the humerus, and, passing along the radial border of the fore-arm, is *inserted* into the styloid process of the ulna. 10. *Extensor carpi radialis longus; arises* from the humerus below the preceding; *inserted* into the base of the metacarpal bone of the index finger. 11. *Extensor carpi radialis brevis; arises* adjoining the preceding; *inserted* into the base of the metacarpal bone of the middle finger. 12. *Extensor communis digitorum; arises* with the preceding, and divides into four tendons, which are *inserted* into the second and third phalanges of the fingers. 13. *Extensor minimi digiti*, is an offset from the extensor communis; *inserted* into the last two phalanges. 14. *Extensor carpi ulnaris; arises* from the external condyle and upper two thirds of the border of the ulna; *inserted* into the metacarpal bone of the little finger. 15. *Anconeus*, a small triangular muscle, *arising* from the outer condyle; *inserted* in the olecranon and upper end of the ulna.

In Fig. 57 is seen the superficial layer of the muscles of the posterior aspect of the fore-arm. 1. Lower part of the biceps. 2. Part of the brachialis anticus. 3. Lower part of the triceps inserted into the olecranon. 4. Supinator longus. 5. Extensor carpi radialis longior. 6. Extensor carpi radialis brevior. 7. Tendons of insertion of these muscles. 8. Extensor digitorum communis. 9. Extensor minimi digiti. 10. Extensor carpi ulnaris. 11. Anconeus. 12. Part of the flexor carpi ulnaris. 13. Extensor ossis metacarpi and extensor primi internodii, lying together. 14. Extensor secundi internodii; its tendon is seen crossing the two tendons of the extensor carpi radialis longior and brevior. 15. Posterior annular ligament. The tendons of the common extensor are seen upon the back of the hand, and their mode of distribution on the dorsum of the fingers.

Fig. 57.

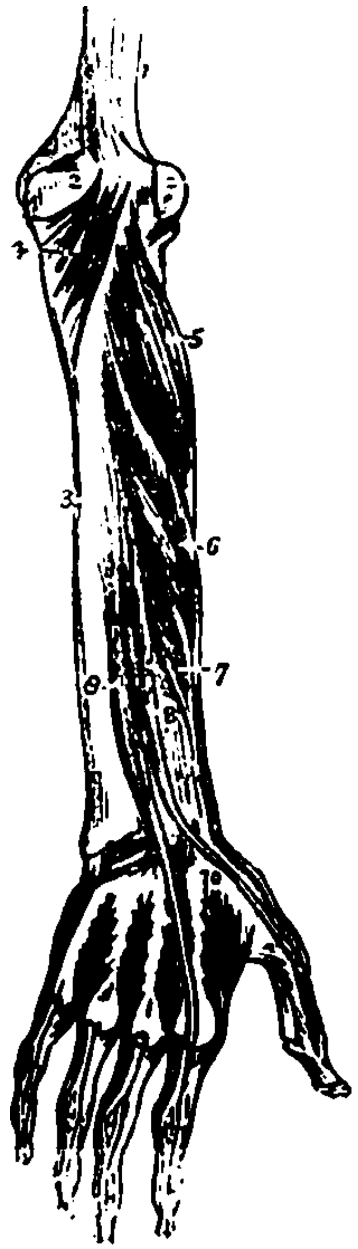


SUPERFICIAL LAYER POSTERIORLY.

16. *Supinator brevis; arises* from the external condyle, lateral and orbicular ligament, and the ulna, and winds around the upper part of the radius, to be *inserted* into th, upper third of its oblique line. 17. *Extensor ossis metacarpi pollicis; arises* from the ulna, radius, and interosseous membrane, and is *inserted* into the base of the metacarpal bone of the thumb. 18. *Extensor primi internodii pollicis; arises* from the interosseous membrane and ulna, and is *inserted* into the base of the first phalanx of the thumb. 19. *Extensor secundi internodii pollicis; arises* with the preceding, and is *inserted* into the base of the last phalanx of the thumb. 20. *Extensor indicis; arises* with and a little above the two preceding; *inserted* into the aponeurosis formed by the common extensor tendon of the index finger.

Note.—The tendons of the flexor and extensor muscles of the fore-arm are provided with synovial bursæ, as they pass beneath the annular ligament; those of the back of the wrist have distinct sheaths formed by the posterior annular ligament. These bursæ are small membranous sacs filled with a mucous fluid, and they serve as soft cushions for the tendons to play upon, in a situation exposed to a great degree and rapidity of motion. The advantages and even necessity of an additional covering, or distinct sheath, for the tendons on the back of the wrist, is obvious, from their exposed situation and feeble protection by flesh and integument.

Fig. 58.



DEEP LAYER POSTERIORLY.

Fig. 58 exhibits the deep layer of muscles on the posterior aspect of the fore-arm. 1. Lower part of the humerus. 2. Olecranon. 3. Ulna. 4. Anconeus. 5. Supinator brevis. 6. Extensor ossis metacarpi pollicis. 7. Extensor primi internodii pollicis. 8. Extensor secundi internodii pollicis. 9. Extensor indicis. 10. First dorsal interosseous ligament. The other three dorsal interossii are seen between the metacarpal bones of their respective fingers.

Uses.—The pronator radii teres and pronator quadratus rotate the radius upon the ulna, producing pronation of the hand. The flexor carpi radialis and ulnaris bend the wrist; the flexor sublimis and profundus bend the second and last joints of the fingers; the flexor longus pollicis bends the last joint of the thumb. The palmaris longus draws the palmar fascia tense, and assists in the flexion of the wrist and fore-arm. The anconeus assists the triceps in extending the fore-arm upon the arm; the supinatus longus and brevis produce supination of the fore-arm, and antagonize the pronators; the extensor carpi radialis longior and brevior, and ulnaris, extend the wrist, antagonizing the two flexors of the carpus. The extensor communis digitorum extends the fingers, antagonizing the flexors, sublimis, and profundus. The extensor ossi metacarpi, primi internodii, and secundi internodii pollicis, are the special extensors of the thumb, and counterbalance the actions of the flexor ossis metacarpi, flexor brevis, and flexor longus pollicis. The extensor indicis extends the first finger, and is hence called "indicator;" the extensor minimi digiti is the special extensor of the little finger, enabling it to be extended distinctly from the other fingers.

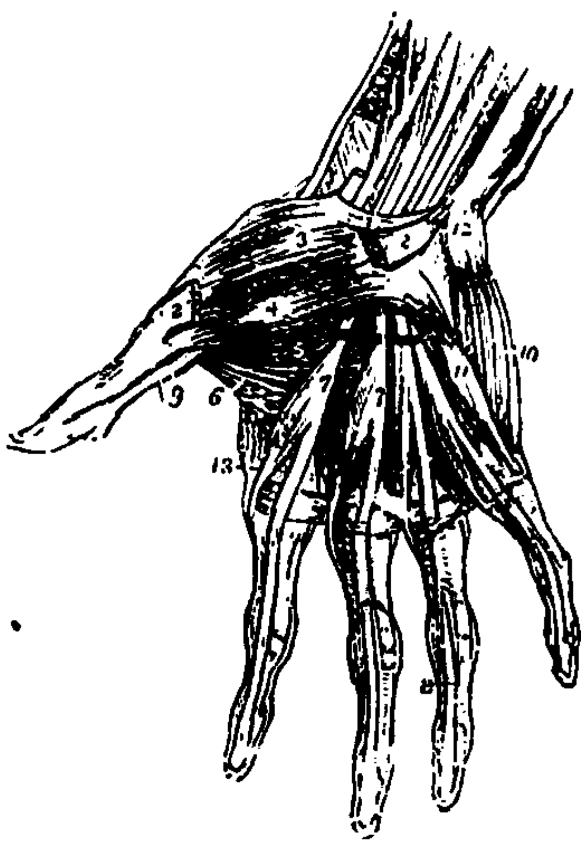
MUSCLES OF THE HAND.

RADIAL REGION.—Four muscles: 1. *Abductor pollicis; arises* from the scaphoid and annular ligament; *inserted* into the base of the first phalanx of the thumb. 2. *Flexor ossis metacarpi; arises* from the trapezium and annular ligament; *inserted* into the whole length of the metacarpal bone. 3. *Flexor brevis pollicis:* its *external* portion *arises* with the preceding; its *internal* from the trapezoides and os magnum; both are *inserted* into the base of the first phalanx of the thumb, having each a sesamoid bone in the tendon to protect the joint. 4. *Adductor pollicis; arises* from the whole length of the metacarpal bone of the middle finger, and its converging fibres are *inserted* into the base of the first phalanx.

Uses.—These muscles, as their names import, produce in the thumb the movements of abduction, adduction, and flexion.

The muscles of the hand are seen in Fig. 59. 1. Annular ligament. 2, 2. Origin and insertion of the abductor pollicis, the middle portion being removed. 3. Flexor ossis metacarpi. 4. One portion of the flexor brevis pollicis. 5. Its deep portion. 6. Adductor pollicis. 7, 7. Lumbricales, arising from the deep flexor tendons, on which the numbers are placed, the tendons of the flexor sublimis having been removed from the palm. 8. One of the tendons of the deep flexor, passing between the two terminal slips of the tendon of the flexor sublimis, to reach the last phalanx. 9. Tendon of the flexor longus pollicis, passing between the two portions of the flexor brevis to the last phalanx. 10. Abductor minimi digiti. 11. Flexor brevis minimi digiti; the edge of the flexor ossis metacarpi is seen projecting beyond the inner border of the flexor brevis. 12. Prominence of the pisiform bone. 13. First dorsal interosseous muscle.

Fig. 59.



MUSCLES OF THE HAND.

Ulnar Region.—Four muscles: 1. *Palmaris brevis;* a thin plane, *arising* from the annular ligament and palmar fascia, and passing transversely inward, is *inserted* into the integuments on the inner border of the hand. 2. *Abductor minimi digiti;* a small tapering slip, *arising* from the pisiform bone; *inserted* into the base of the first phalanx of the little finger. 3. *Flexor brevis minimi digiti;* a small muscle, *arising* from the unciform bone and annular ligament; *inserted* into the base of the first phalanx. 4. *Flexor ossis metacarpi; arises* with the preceding; *inserted* into the whole length of the metacarpal bone of the little finger.

Uses.—These muscles are subservient to the motions of the little finger.

Palmar Region.—Three sets of muscles: . *Lumbricales;* four in number, *arising* from the tendons of the deep flexor, and *inserted* into the aponeurotic expansion of the extensor tendons on the radial side of the fingers. 2. *Palmar interossei;* three in number, each *arising* from the base of the metacarpal bone of one finger, and are *inserted* into the base of the first phalanx and aponeurotic expansion of the extensor tendon of the same finger, the middle one being excepted. 3. *Dorsal interossei;* these are situated in the four spaces between the metacarpal bones; they *arise* by two heads from the adjoining sides of the base of the metacarpal bones; *inserted* into the base of the first phalanges, and aponeurosis of the extensor tendons.

Uses.—The lumbricales are auxiliary to the deep flexors; the palmar interossei are adductors, and the dorsal interossei abductors; hence each finger is furnished with its proper adductor and abductor, two flexors, and, with the exception of the middle and ring fingers, which have but one, two extensors. The thumb has a flexor and extensor of the metacarpal bone; and the little finger a metacarpal flexor.

MUSCLES OF THE LOWER EXTREMITY.

These have usually been arranged into groups corresponding with the regions of the hip, thigh, leg, and foot.

MUSCLES OF THE HIP.—There are nine muscles of the hip, which together constitute the GLUTEAL REGION: 1. *Gluteus maximus;* this is the thick quadrangular mass of flesh forming the convexity of the nates, or buttocks. It *arises* from the back part of the crest of the ilium, the posterior surface of the sacrum and coccyx, and the great sacro-ischiatic ligament; passing obliquely outward and downward, it is *inserted* into the rough line between the trochanter major to the linea aspera; by means of its tendon it is continuous with the fascia lata covering the outer side of the thigh. Between its broad tendon and the femur a large bursa is situated. 2. *Gluteus medius; arises* from the outer lip of the crest of the ilium for four fifths of its length, and from the dorsum ilii and surrounding fascia; its fibres converge to the outer part of the trochanter major, into which its tendon is *inserted.* 3. *Gluteus minimus; arises* from the surface of the dorsum ilii; its fibres converge to the anterior border of the trochanter major, where they are *inserted* by a rounded tendon. 4. *Pyriformis;* a pear-shaped muscle, *arising* from the anterior surface of the sacrum and ilium adjoining; it passes out of the pelvis through the great sacro-ischiatic foramen; *inserted,* by a rounded tendon, into the trochanteric fossa of the femur. 5. *Gemellus superior;* a small slip *arising* from the spine of the ischium, and *inserted* into the tendon of the obturator internus, and into the trochanteric fossa. 6. *Obturator internus: arises* from the inner surface of the anterior wall of the pelvis; passes out of the pelvis through the lesser sacro-ischiatic foramen, and is *inserted* into the trochanteric fossa.

Fig. 60.

DEEP GLUTEAL MUSCLES.

Fig. 60 shows the deep muscles of the gluteal region. 1. External surface of the ilium. 2. Posterior surface of the sacrum. 3. Posterior sacro-iliac ligaments. 4. Tuberosity of the ischium. 5. Great or posterior sacro-ischiatic ligament. 6. Anterior or lesser sacro-ischiatic ligament. 7. Trochanter major. 8. Gluteus minimus. 9. Pyriformis. 10. Gemellus superior. 11. Obturator internus, passing out of the lesser sacro-ischiatic foramen. 12. Gemellus inferior. 13. Quadratus femoris. 14. Adductor magnus, its upper part. 15. Vastus externus. 16. Biceps. 17. Gracilis. 18. Semitendinosus.

7. *Gemellus inferior; arises* from the anterior point of the tuberosity of the ischium; *inserted* into the trochanteric fossa and tendon of the obturator internus. 8. *Obturator externus; arises* from the obturator membrane and surrounding bone; its tendon passes behind the neck of the femur, to be *inserted* into the trochanteric fossa. 9. *Quadratus femoris*, a square muscle *arising* from the external border of the tuberosity of the ischium; *inserted* into a rough line, called *linea quadrati*, on the posterior border of the trochanter major.

Uses.—The glutei are abductors of the thigh, when acting from the pelvis; when the thigh is their fixed point, they steady the pelvis on the head of the thigh bone, as in standing; they also assist in carrying the leg forward in walking; the minimus rotates the limb slightly inward; the medius and maximus rotate it outward. The other muscles of this group are called *external rotators*, their office being to rotate the limb outwardly, everting the knee and foot.

MUSCLES OF THE THIGH.

These are divided into three regions—*anterior, internal*, and *posterior.*

ANTERIOR FEMORAL REGION.—Six muscles: 1. *Tensor vaginæ femoris*, a short flat muscle on the outer side of the hip, *arising* from the crest of the ilium, near its anterior superior spine; *inserted* between two layers of the fascia lata at one fourth down the thigh. 2. *Sartorius* (tailor's muscle); a long ribbon-like muscle, *arising* from the anterior superior spinous process of the ilium, and the notch below, and crossing the upper part of the thigh obliquely, descends behind the inner condyle of the femur, and is *inserted* into the inner tuberosity of the tibia by an aponeurotic expansion. 3. *Rectus;* a straight muscle, *arising* by two tendons, one from the anterior inferior spinous process of the ilium, the other from the upper lip of the acetabulum; *inserted* by a broad, strong tendon into the upper border of the patella. 4. *Vastus externus; arises* from the inner border of the patella; *inserted* into the femur and outer side of the linea aspera, as high as the base of the trochanter. 5. *Vastus internus; arises* from the inner border of the patella; *inserted* into the femur and inner side of the linea aspera as high up as the anterior intertrochanteric line. 6. *Crureus; arises* from the upper border of the patella; *inserted* into the front aspect of the femur, as high as the anterior intertrochanteric line.

Fig. 61.

ANTERIOR FEMORAL MUSCLES.

NOTE.—The two vasti and crureus together constitute the *triceps extensor cruris.*

Fig. 61 shows the muscles of the anterior femoral region. 1. Crest of the ilium. 2. Its anterior superior spinous process. 3. Gluteus medius. 4. Tensor vaginæ femoris; its insertion into the fascia lata is seen inferiorly. 5. Sartorius. 6. Rectus. 7. Vastus externus. 8. Vastus internus. 9. Patella. 10. Iliacus internus. 11. Psoas magnus. 12. Pectineus. 13. Adductor longus. 14. Part of the adductor magnus. 15. Gracilis.

Uses.—The tensor vaginæ femoris stretches the fascia lata, rendering it tense, and slightly inverting the limb; the sartorius bends the leg upon the thigh, and the thigh upon the pelvis, carrying the leg across that of the opposite side—the tailor's sitting position; when fixed below it assists the extensors of the leg in supporting the trunk. The four remaining muscles extend the leg upon the thigh. By their attachment to the patella, which acts as a fulcrum, they are advantageously disposed for great power. When their fixed point is from the tibia they steady the thigh upon the leg; and the rectus, by its attachment to the pelvis, serves to balance the trunk upon the lower extremity.

INTERNAL FEMORAL REGION.—Seven muscles: 1. *Iliacus internus;* a flat radiated muscle, *arising* from the inner concave surface of the ilium, and, joining with the tendon of the psoas, is *inserted* into the trochanter minor of the femur. 2. *Psoas magnus; arises* from the intervertebral substances, part of the bodies and bases of the transverse processes of the lumbar vertebræ, and from tendinous arches thrown across the constricted portion of the last dorsal and four upper lumbar vertebræ, and, passing along the margin of the brim of the pelvis and beneath Poupart's ligament, its tendon, united with that of the iliacus internus, is *inserted* into the posterior part of the trochanter minor, a bursa being interposed. 3. *Pectineus;* a flat quadrangular muscle, *arising* from the pectineal line of the pubis and surface of bone in front; *inserted* into the femur, between the anterior intertrochanteric line and the linea aspera. 4. *Adductor longus; arises* by a round tendon from the front surface of the pubis below the angle; *inserted* into the middle third of the linea aspera. 5. *Adductor brevis; arises* from the body and ramus of the pubis; *inserted* into the upper third of the linea aspera. 6. *Adductor magnus;* a broad triangular muscle; *arises* from the ramus of the pubes and ischium, and tuber ischii, and, radiating outward, is *inserted* into the whole length of the linea aspera and inner condyle of the femur. 7. *Gracilis;* a slender muscle, *arising* from the body of the os pubis, and ramus of the pubis and ischium; *inserted* into the inner tuberosity of the tibia.

Uses.—The iliacus, psoas, pectineus, and adductor longus bend the thigh upon the pelvis, and rotate the entire limb outward; the pectineus and adductors move the limb outward powerfully. The gracilis assists in adduction, and contributes also to the flexion of the leg.

POSTERIOR FEMORAL REGION.—Three muscles: 1. *Biceps femoris;* double-headed, one head *arising* in common with the semi-tendinosus, the other from the lower two thirds of the linea aspera; *inserted* by a strong tendon into the head of the fibula; a portion of its tendon is continued into the fascia of the leg, and another is attached to the outer tuberosity of the tibia. 2. *Semi-tendinosus;* remarkable for its long tendon; *arises* from the tuberosity of the ischium with the long head of the biceps; *inserted* into the inner tuberosity of the tibia. 3. *Semi-membranosus;* named from its tendinous expansion; *arises* from the tuberosity of the ischium in front of the preceding; *inserted* into the back part of the inner tuberosity of the tibia.

NOTE.—The biceps forms the *outer hamstring;* the tendons of the semi-tendinosus, semi-membranosus, gracilis, and sartorius form the *inner hamstring.*

Uses.—These muscles are the direct flexors of the leg upon the thigh; those fibres which originate from below also balance the pelvis on the lower extremities. The biceps everts the leg when partially flexed, and the semi-tendinosus turns it inward when partially flexed.

Fig. 62.

POSTERIAL FEMORAL MUSCLE.

Fig. 62 exhibits the muscles of the posterior femoral and gluteal region. 1. Gluteus medius. 2. Gluteus maximus. 3. Vastus externus covered in by fascia lata. 4. Long head of the biceps. 5. Its short head. 6. Semi-tendinosus. 7. Semi-membranosus. 8. Gracilis. 9. Part of the inner border of the adductor magnus. 10. Edge of the sartorius. 11. The popliteal space. 12. Gastrocnemius; its two heads.

MUSCLES OF THE LEG.

They are divided into three regions: anterior tibial, fibular, and posterior tibial.

ANTERIOR TIBIAL REGION.—Four muscles: 1. *Tibialis anticus; arises* from the upper two thirds of the tibia, the interosseous membrane, and the deep fascia; its tendon passes through a distinct sheath in the annular ligament, and is *inserted* into the inner side of the internal cuneiform bone, and base of the metatarsal bone of the great toe. 2. *Extensor longus digitorum; arises* from the head of the tibia, upper three fourths of the fibula, interosseous membrane, and from the deep fascia; below it divides into four tendons, which pass beneath the annular ligament, and are *inserted* into the second and third phalanges of the four lesser toes. 3. *Peroneus tertius; arises* from the lower fourth of the tibia; *inserted* into the base of the metatarsal bone of the little toe. 4. *Extensor proprius pollicis; arises* from the lower two thirds of the fibula and interosseous membrane; *inserted* into the base of the last phalanx of the great toe.

Uses.—The first two are direct flexors, bending the foot upon the leg; acting with the tibialis posticus, they direct the foot inward, and with the peroneus longus and brevis, outward. They help to maintain the flatness of the foot during progression. The extensor longus digitorum and extensor proprius pollicis are direct extensors of the toes; they also assist the flexion of the entire foot upon the leg. When acting from below they increase the firmness of the ankle joint.

Posterior Tibial Region.—Seven muscles; the first three make the *superficial group;* the last four the deep layer: 1. *Gastrocnemius; arises* by two heads from the two condyles of the femur, which, uniting to form the bellied part of the leg, are *inserted*, by means of the tendo Achillis, into the lower part of the tuberosity of the os calcis, a synovial bursa being interposed between the tendon and bone. 2. *Plantaris*, a very small muscle, *arising* from the outer condyle of the femur, and *inserted*, by a long, slender tendon, into the os calcis, by the side of the tendo Achillis. 3. *Soleus*, a broad muscle, *arising* from the head and upper third of the fibula, and oblique line and middle third of the tibia; its fibres converge to the tendo Achillis, by which it is *inserted* into the os calcis.

Uses.—These three muscles of the calf draw powerfully on the os calcis, lift the heel, and continuing their action, raise the entire body. They are the principal muscles in walking, leaping, and dancing. When they are fixed below they steady the leg upon the foot.

Fig. 63.

SUPERFICIAL TIBIAL MUSCLES

The superficial muscles of the posterior aspect of the leg are shown in Fig. 63. 1. Biceps, forming the outer hamstring. 2. The tendons forming the inner hamstring. 3. Popliteal space. 4. Gastrocnemius. 5, 5. Soleus. 6. Tendo Achillis. 7. Posterior tuberosity of the os calcis. 8. Tendons of the peroneus longus and brevis, passing behind the outer ankle. 9. Tendons of the tibialis posticus and flexor longus digitorum, passing into the foot behind the ankle.

4. *Popliteus; arises* by a rounded tendon from a deep groove on the outer side of the external condyle of the femur, beneath the external lateral ligament, and spreading obliquely over the head of the tibia, is *inserted* into the bone above its oblique line. 5. *Flexor longus pollicis; arises* from the lower two thirds of the fibula, and passing through a groove in the astragalus and os calcis, is *inserted* into the bone of the last phalanx of the great toe. 6. *Flexor longus digitorum; arises* from the surface of the tibia, below the popliteal line; its tendon passes through a sheath with the tibialis posticus behind the inner malleolus, and then through a second sheath connected with a groove in the astragalus and os calcis, into the sole of the foot, where it divides into four tendons, which are *inserted* into the base of the last phalanx of the four lesser toes, perforating the tendons of the flexor brevis digitorum. 7. *Tibialis*

posticus; arises by two heads from the adjacent sides of the tibia and fibula their whole length, and from the interosseous membrane; its tendon runs into the sheath with the flexor longus digitorum, passes through its proper sheath over the deltoid ligament, and is *inserted* into the tuberosity of the scaphoid and internal cuneiform bone.

Uses.—The popliteus flexes the leg upon the thigh, at the same time carrying it inward, so as to invert the leg. The flexors are connected in the foot by a tendinous band, so that they act together in bending the toes. The tibialis posticus extends the tarsus upon the leg, antagonizing the tibialis anticus. These last two combine in adducting the foot.

Fibular Region.—Two muscles: 1. *Peroneus longus; arises* from the head and upper third of the outer side of the fibula, and terminates in a long tendon which passes behind the external malleolus, and obliquely across the sole of the foot; *inserted* into the base of the metatarsal bone of the great toe. 2. *Peroneus brevis,* lies beneath the former, *arising* from the lower half of the fibula, and terminates in a tendon which passes behind the external malleolus, and through a groove in the os calcis, to be *inserted* into the base of the metatarsal bone of the little toe.

Uses.—The peronei are extensors of the foot, conjointly with the tibialis posticus, and antagonize the tibialis anticus and peroneus tertius. All of these acting together maintain the foot in a flat position, as in walking.

MUSCLES OF THE FOOT.

These may be arranged, according to their situation above or below, into those of the *dorsal* and those of the *plantar* regions.

Dorsal Region.—Two muscles: 1. *Extensor brevis digitorum; arises* from the outer side of the os calcis, crosses the foot obliquely, and terminates in four tendons, one of which is *inserted* into the first phalanx of the great toe, and the others into the sides of the long extensor tendons of the second, third, and fourth toes. 2. *Dorsal interossei;* these are placed between the metatarsal bones.

Plantar Region.—The muscles of this region are subdivided into four *layers.*

First Layer.—Three muscles: 1. *Abductor pollicis,* lies along the inner border of the foot, one head *arising* from the inner tuberosity of the os calcis, the other from the internal annular ligament and plantar fascia; *inserted* into the first phalanx of the great toe, and internal sesamoid bone. 2. *Abductor minimi digiti*, lies along the outer border of the foot, *arising* from the outer tuberosity of the os calcis, and plantar fascia; *inserted* into the base of the first phalanx of the little toe. 3. *Flexor brevis digitorum*, situated between the two preceding; *arises* from the under surface of the os calcis, from the plantar fascia and intermuscular septa; *inserted*, by four tendons, into the base of the second phalanx of the four lesser toes.

Fig. 64.

FIRST LAYER PLANTAR MUSCLES.

The first layer of muscles in the sole of the foot is shown in Fig. 64. 1. Os calcis. 2. Posterior part of the plantar fascia divided transversely. 3. Abductor pollicis. 4. Abductor minimi digiti. 5. Flexor brevis digitorum. 6. Tendon of the flexor longus pollicis. 7, 7. Lumbricales.

Second Layer.—Two muscles: 1. *Musculus accessorius; arises* by two slips from either side of the under surface of the os calcis; *inserted* into the outer side of the tendon of the flexor longus digitorum. 2. *Lumbricales*, four muscular slips, *arising* from the tibial side of the tendon of the flexor longus digitorum; *inserted* into the expansion of the extensor tendons, and base of the first phalanx of the four lesser toes.

Fig. 65.

PLANTAR MUSCLES.

The third and part of the second layer of muscles of the sole of the foot are seen in Fig. 65. 1. Divided edge of the plantar fascia. 2. Musculus accessorius. 3. Tendon of the flexor longus digitorum. 4. Tendon of the flexor longus pollicis. 5. Flexor brevis pollicis. 6. Adductor pollicis. 7. Flexor brevis minimi digiti. 8. Transversus pedis. 9. Dorsal and plantar interossei. 10. Convex ridge formed by the tendon of the peroneus longus in its oblique course across the foot.

Third Layer.—Four muscles: 1. *Flexor brevis pollicis; arises* from the side of the cuboid, and from the external cuneiform bone; *inserted* by two heads into the base of the first phalanx of the great toe. Two sesamoid bones are found in these tendons. 2. *Adductor pollicis; arises* from the cuboid bone and sheath of the tendon of the peroneus longus, and from the base of the third and fourth metatarsal bones; *inserted* into the base of the first phalanx of the great toe. 3. *Flexor brevis minimi digiti; arises* from the base

Fig. 66.

DEEP PLANTAR MUSCLES.

of the metacarpal bone of the little toe, and sheath of the peroneal tendon; *inserted* into the base of the first phalanx of the little toe. 4. *Transversus pedis; arises* by fleshy slips from the heads of the metatarsal bones of the four lesser toes; *inserted* into the base of the first phalanx of the great toe, its tendon being blended with that of the adductor pollicis

Fig. 66 shows the deep-seated muscles in the sole of the foot. 1. Tendon of the flexor longus pollicis. 2. Tendon of the flexor communis digitorum pedis. 3. Flexor accessorius. 4, 4. Lumbricales. 5. Flexor brevis digitorum. 6. Flexor brevis pollicis pedis. 7. Flexor brevis minimi digiti pedis.

Fourth Layer.—One set of muscles: *Interossei plantares;* three in number, placed upon the metatarsal bones; *arising* by the base of the metatarsal bones of the three outer toes; *inserted* into the inner side of the extensor tendon and base of the first phalanx of the same toes.

Fig. 67.

PLANTAR INTEROSSEI.

The interossei plantares are seen in Fig. 67. 1. Abductor tertii. 2. Abductor quarti. 3. Interossei minimi digiti.

Uses.—All the muscles of the foot act upon the toes, the action and nature and situation of each muscle being expressed by its name. The movements of the toes are flexion, extension, adduction, and abduction. The great toe, like the thumb, is provided with special muscles for independent action. The lumbricales are assistants to the long flexor; and the transversus pedis is placed across the foot for the purpose of drawing the toes together.

The firm articulations of all the metacarpal bones, and the great strength and number of the ligaments and tendons of the leg, feet, and toes, are admirably adapted for combining power of endurance with facility of motion; the toes generally have four flexors, two extensors, four adductors, and four abductors; while the great toe, in addition, has two distinct flexors, two extensors, one adductor, and one abductor.

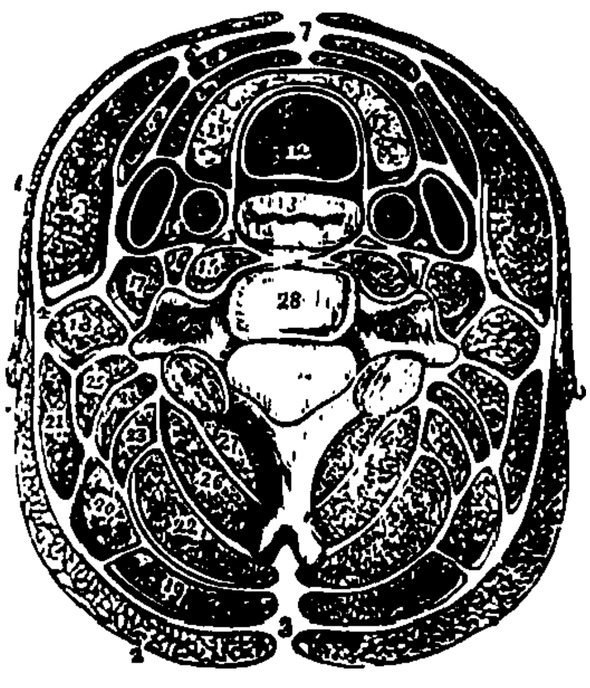
CHAPTER IV.

OF THE FASCIÆ—APONEUROLOGY.

The soft structures and delicate organs of the body are every where invested with protecting coats, or bandages, called fasciæ. They are composed of laminæ of various thickness, and are divided into cellulo-fibrous and aponeurotic.

The *cellulo-fibrous fascia* invests the whole body between the skin and the deeper parts, and affords a medium of connection between them. It is composed of fibrous tissue, arranged in a cellular form, the cells containing adipose substance, thus affording a yielding and elastic structure, through which the minute vessels and nerves pass to the papillary layer of the skin, without obstruction or injury from pressure. By dissection it may be separated into two layers, between which the subcutaneous vessels and nerves are found. In some situations this fascia is condensed into strong inelastic membrane, as in the deep fascia of the neck and thorax, and the sheaths of vessels.

Fig. 68.



DISTRIBUTION OF THE FASCIA.

Fig. 68 is a transverse section of the neck, showing the deep cervical fascia and its numerous prolongations, forming sheaths for the different muscles. 1. Platysma myoides. 2. Trapezius. 3. Ligamentum nuchæ, from which the fascia may be traced forward beneath the trapezius, inclosing the other muscles of the neck. 4. Division of the fascia to form a sheath for the sterno-mastoid muscle (5). 6. Point of reunion. 7. Union of the deep fascia of opposite sides of the neck. 8. Section of the sterno-hyoid. 9. Omo-hyoid. 10. Sterno-thyroid. 11. Lateral lobe of the thyroid gland. 12. Trachea. 13. Æsophagus. 14. Sheath containing the common carotid artery, internal jugular vein, and pneumogastric nerve. 15. Longus colli; the sympathetic nerve is in front. 16. Rectus anticus major. 17. Scalenus anticus. 18. Scalenus posticus. 19 Splenius capitis. 20. Splenius colli. 21. Levator anguli scapulæ. 22. Complexus. 23. Trachleo-mastoid. 24. Transversalis colli. 25. Cervicalis ascendens. 26. Semi-spinalis colli. 27. Multifidus spinæ. 28. A cervical vertebra; the transverse processes are seen to be traversed by the vertebral artery and vein.

The *aponeurotic fascia* is strong and inelastic, composed of parallel tendinous fibres, connected by others passing in different directions.

In the limbs it forms distinct sheaths, inclosing all the muscles and tendons, constituting the deep fascia. It is firmly connected to the bones, and to the prominent points of the clavicle. scapula, elbow, wrist, pelvis, knee, ankle, etc. Its pressure assists the muscular action and the circulation of fluids. In the palm of the hand and sole of the foot it is a powerful protection to the structures.

PRINCIPAL FASCIÆ.

Temporal Fascia.—The fascia of the temple is a strong aponeurotic membrane covering the temporal muscle on each side of the head.

Cervical Fasciæ.—The fasciæ of the neck are divided into the *superficial*, which is a part of the common superficial fascia of the entire body, and the *deep*, a strong cellulo-fibrous layer which invests the muscles of the neck, and retains and supports the vessels and nerves.

Thoracic Fascia.—The thoracic fascia is a dense layer of cellulo-fibrous membrane stretched horizontally across the superior opening of the thorax, and forming the upper boundary of the chest, as the diaphragm does the lower. It supports the heart in its situation, and also the large blood-vessels, windpipe, and æsophagus, which pass through it.

Abdominal Fasciæ.—The lower part of the walls of the abdomen, and the cavity of the pelvis, are supported on their internal surface with a layer of fascia; at the bottom of the pelvis it is reflected inward to the sides of the bladder. In different situations its parts are called *fascia transversalis*, *iliac*, and *pelvic fascia*. The transverse and iliac fasciæ meet at the crest of the ilium and Poupart's ligament; the pelvic is confined to the cavity of the true pelvis. These fasciæ are important in their relations to

INGUINAL HERNIA.

There are two kinds of inguinal hernia, oblique and direct. In the *oblique*, the intestine escapes from the abdominal cavity into the spermatic canal, through the *internal abdominal ring;* this ring is situated in the fascia transversalis, about midway between the spine of the pubis and superior anterior spine of the ilium, half an inch above Poupart's ligament. The bowel pushes along a pouch of peritoneum which forms the *hernial sac*, and distends a process of the transverse fascia. After emerging from the internal ring, it passes beneath the lower borders of the transversalis and internal oblique muscles, and finally through the external abdominal ring in the aponeurosis of the external oblique muscle. While passing the internal oblique, it receives the cremaster muscle as an additional investment, and upon protruding from the external ring, still another from the intercolumnar fascia.

Hence the coverings of an inguinal hernia from the surface to the bowel are: 1. The integument. 2. Superficial fascia. 3. Intercolumnar fascia. 4. The cremaster muscle. 5. Transversalis fascia. 6. Peritoneal sac.

The *spermatic canal* is about an inch and a half in length, and in the normal condition gives passage to the spermatic cord in the male, and the round ligament of the uterus, with its vessels, in the female. It is bounded at its inner termination by the internal, and at its outer extremity by the external, abdominal ring. It is also bounded in front by the aponeurosis of the external oblique; behind by the transversalis fascia and the conjoined tendon of the internal oblique and transversalis; above by the arched borders of the same muscles; below by the grooved border of Poupart's ligament.

Of oblique inguinal hernia there are three kinds: 1. *Common oblique;* already described. 2. *Congenital;* this has no proper sac, but is contained within the tunica vaginalis; the other coverings are the same as in the first variety. It results from the pouch of the peritoneum, which is carried downward into the scrotum by the descent of the testicle in the fœtus, not closing, so that the intestine is forced into the open canal. 3. *Encysted;* a protrusion of the intestine in which the pouch of the peritoneum forming the tunica vaginalis, being only partially closed, and remaining open externally to the abdomen, admits of its passing into the scrotum behind the tunica vaginalis. The surgeon, in operating, divides three layers of serous membrane, the first and second being those of the tunica vaginalis, and the third the peritoneal layer, or true hernial sac.

Direct inguinal hernia is so called when the bowel passes directly through the external ring, forcing before it the opposing parietes. Its coverings are the same as in the oblique hernia, except that the conjoined tendon of the internal oblique and transversalis muscles form its fourth investment, instead of the cremaster muscle.

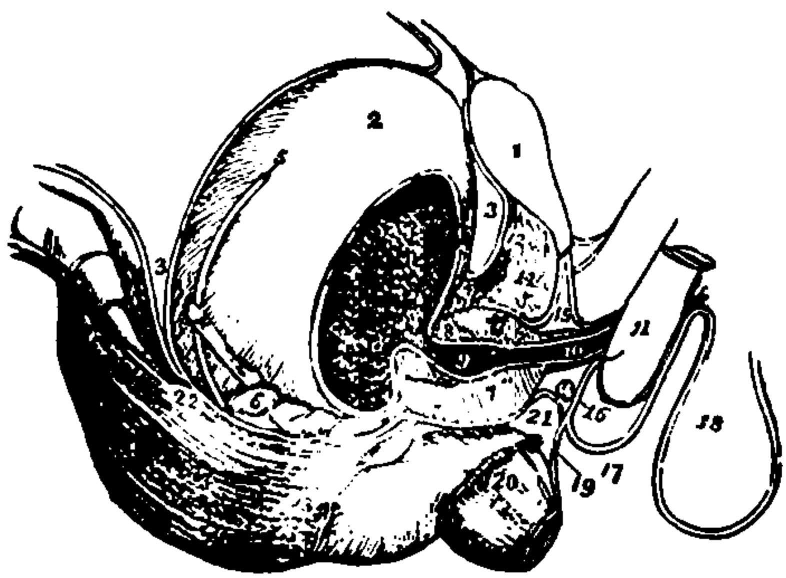
Direct inguinal hernia never attains as great bulk as the oblique form; all these varieties may descend into the cavity of the scrotum, and are then called *scrotal hernia.*

ILIAC FASCIA.—The iliac fascia invests the psoas and iliacus muscles; beneath the femoral arch it forms a part of the sheath of the femoral vessels.

Pelvic Fascia.—This is attached to the inner surface of the os pubis, and along the margin of the pelvis, from which it descends into the pelvic cavity, where it divides into two layers, the *pelvic* and *obturator.* The *pelvic layer* is reflected inward from near the symphisis pubis to the neck of the bladder, forming the *anterior vesical ligaments;* an ascending reflected portion encloses the sides of the bladder and vesical plexus of veins, and forms the lateral ligament of the bladder. Other reflexions constitute layers for investing the lower portion of the alimentary canal. The *obturator layer* passes downward, covering the obturator internus muscle, and encloses the internal pudic vessels and nerves.

Perineal Fasciæ.—The *superficial perineal fascia* is a thin aponeurotic layer covering the muscles of the genital portion of the perineum. The *deep perineal fascia*, called also *Camper's*, and *triangular ligament*, is stretched across the pelvis, so as to constitute a defence to its outlet.

Fig. 69.



PELVIC FASCIA.

In the side view of the viscera of the pelvis, Fig. 69, is shown the distribution of the perineal and pelvic fasciæ. 1. Symphisis pubis. 2. Bladder. 3. The recto-vesical fold of peritoneum, passing from the anterior surface of the rectum to the back part of the bladder. 4. The ureter. 5. The vas deferens. 6. Right vesicula seminalis. 7. Prostate gland divided by a longitudinal section. 8, 8. Section of a ring of elastic tissue encircling the prostatic portion of the urethra at its commencement. 9. Prostatic urethra. 10. Membranous portion. 11. The commencement of the corpus spongiosum penis, the bulb. 12. Anterior ligaments of the bladder. 13. Edge of the pelvic fascia reflected upon the rectum. 14. Location of a plexus of veins, between the pelvic and deep perineal fascia. 15. The deep perineal fascia; its two layers. 16 Cowper's gland of the right side. 17. Superficial perineal fascia, ascending in front of the root of the penis to become continuous with the dartos of the scrotum (18). 19. Layer of the deep fascia prolonged to the rectum. 20. Lower part of the levator ani. 21. The inferior segment of the funnel-shaped process given off from the posterior layer of the deep perineal fascia, which is continuous with the recto-vesical fascia; the attachment of this fascia to the recto-vesical fold of peritoneum is seen at 22.

Fascia of the Upper Extremity.—The *superficial* contains between its layers the superficial nerves, veins, and lymphatics. The *deep* is thick upon the dorsum of the scapula, but thin in the axillary space In the fore-arm it is very strong at the elbow and wrist joints, uniting with the ligamentous structures. In the latter joint it forms the *posterior annular ligament.* The *palmar fascia* occupies the middle and side of the hand, its central portion spreads over the heads of the metacarpal bones, where it divides into slips which are attached to the phalanges.

Fasciæ of the Lower Extremity.—As in the upper extremity, the *superficial fascia* of the lower contains between its layers the superficial vessels and nerves. At the groin these layers are separated by the lymphatic glands. The *deep fasciæ* of the thigh is called, from its great extent, *fascia lata*. It is strongly connected with the prominent points of bone around the hip, knee, and ankle joints. The sheath of the femoral vessels is a continuation of the abdominal fascia down the thigh. In this sheath is an interval between the vein and its inner wall, the upper opening of which is called the *femoral ring*. This ring is bounded in front by Poupart's ligament, behind by the os pubis, internally by Gimbernat's ligament, and externally by the femoral vein, and is closed only by a thin layer of areolar tissue, called *septum crurale*, which retains the lymphatic gland in position, and the peritoneum.

FEMORAL HERNIA.

When violent or long-continued pressure is made on the abdominal viscera, a portion of intestine may be forced through the femoral ring into the interval or space in the sheath of the femoral vessels, constituting *femoral hernia*. The protruding intestine pushes along the peritoneum and septum crurale. If the causes continue, the intestine will be forced forward through an opening, called *saphenous*, in the fascia lata, carrying along two additional coverings, the sheath of the femoral vessels, or fascia proper, and another investment, called the *cribriform fascia*; next curving upward over Poupart's ligament, the hernia becomes fixed beneath the superficial fascia and skin. Its direction being therefore *downward*, then *forward*, and then *upward*, the efforts to reduce it must be directed in the reverse order.

The *fascia of the leg* is thickened toward the ankle joint into narrow bands, which form the *annular ligaments*.

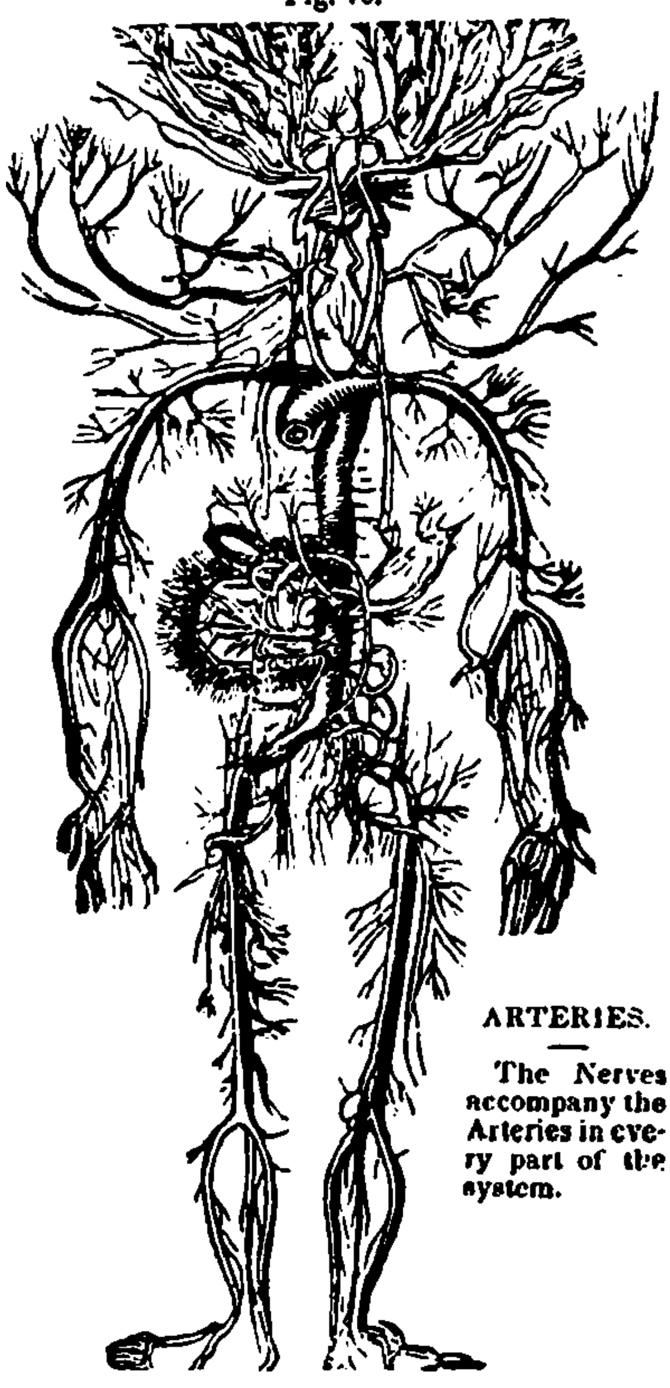
The *plantar fascia* forms strong layers, which invest the tendons and joints of the foot and toes.

CHAPTER V.

OF THE ARTERIES—ANGEIOLOGY.

The arteries constitute that part of the circulating system which carries the blood *from* the heart to all parts of the body. They are dense, cylindrical tubes, which form they retain when emptied of blood, and even after death, from which circumstance the ancients regarded them as air-vessels.*

Fig. 70.



ARTERIES.

The Nerves accompany the Arteries in every part of the system.

ARTERIAL SYSTEM.

The *aorta*, which proceeds from the left ventricle of the heart, and branches, contain the pure or arterial blood, and, with the veins which return this blood again to the heart, constitute the *greater* or *systemic circulation*. The *pulmonary* artery, which conveys the venous or impure blood to the lungs, with its corresponding veins, is called the *lesser* or *pulmonary* circulation.

Structure of Arteries.—Arteries are composed of three coats: the *external* is cellular, or areolo-fibrous; the *middle* is muscular, or, rather, a mixed tissue of elastic and contractile fibres; and the *internal* is nervous, or a serous membrane, throughout whose substance are ramified the nerves of organic life. The outer coat is firm and strong: the middle is thick and soft; and the internal thin and polished.

Distribution of Arteries.—All the arteries of the general system are branches of the aorta, which divide and subdivide to their final ramifications in the capillary system. From the aorta most of the branches pass off at right angles, which moderates the impetus of the blood; but in the extremities the branches leave the main artery at an acute angle, which favors the most rapid circulation. When an artery divides, the area of its branches is always greater than that of the sin-

* The term angeiology has been applied to the vascular system; it includes the blood-vessels, arteries, and veins, and the lymphatics.

gle trunk; and the combined area of the ultimate ramifications of all the arteries is vastly greater than that of the aortic trunk. This arrangement allows a more quiet motion of the vital current in the extreme vessels, where decomposition and recomposition of structures are effected. All the arteries are invested with a fibro-cellular sheath, which also contains their accompanying veins, and sometimes a nerve.

INTERCOMMUNICATION OF ARTERIES.—In all parts of the body the arterial tubes communicate with each other by branches passing between, called *inosculations*, or *anastomoses*. Those connections increase in frequency as the vessels diminish in size, so that their final distribution is a complete circle of inosculations. The advantage of this provision against obstructions which are most liable to occur in the smaller branches is obvious. When an artery is divided, or its cavity obliterated, the anastomosing branches above enlarge and make up the loss of blood by a collateral circulation. The arteries do not terminate directly in veins, but in an intermediate system, called the *capillary*, an extremely minute network of vessels and nerves, from which the veins arise.

THE SYSTEMIC ARTERIES.

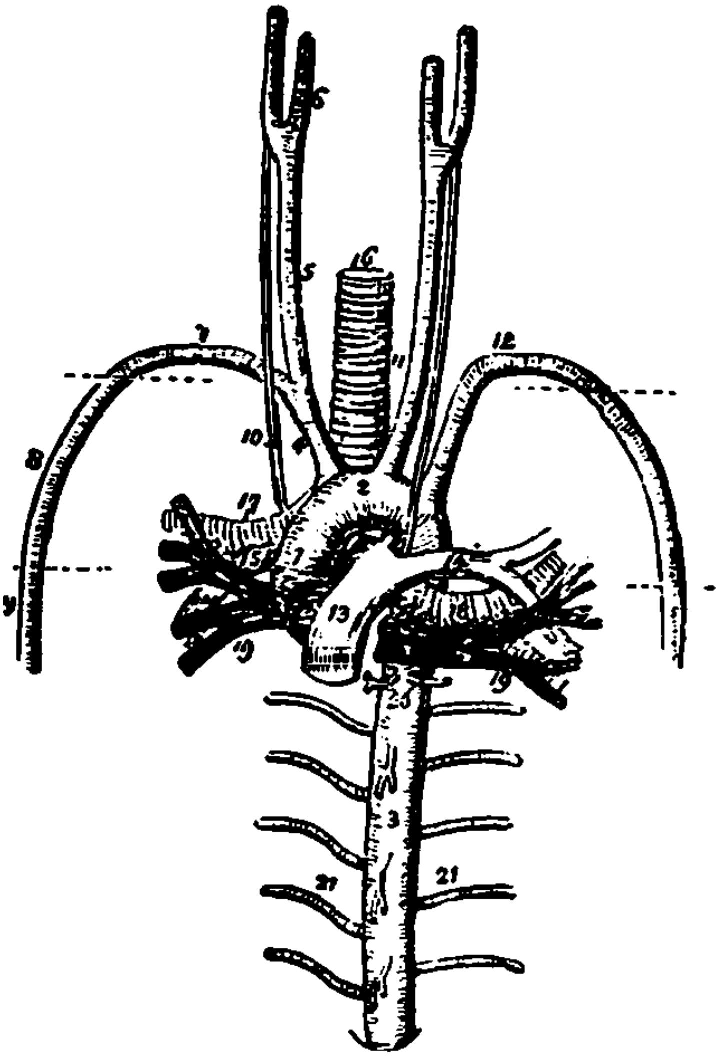
AORTA.—The *aorta* arises from the left ventricle of the heart, opposite the articulation of the fourth costal cartilage with the sternum, and *arches* backward and to the left, and then descends on the left side of the spine to the fourth lumbar vertebra. It is hence divided into *ascending*, *arch*, and *descending*, the descending portion being subdivided into *thoracic* and *abdominal*. At its commencement there are three dilatations, called its *sinus*, corresponding with the three *semilunar valves*.

The *coronary* arteries are the only branches given off by the ascending aorta; they arise just behind the semilunar valves, pass through the grooves between the auricles and ventricles, and are distributed to the substance of the heart.

ARTERIA INNOMINATA.—The *arteria innominata* arises from the arch of the aorta, is an inch and a half in length, and ascends obliquely toward the right side in front of the trachea; behind the right sterno-clavicular joint it divides into the right carotid and right subclavian.

COMMON CAROTID ARTERIES.—The *right* common carotid arises from the bifurcation of the innominata, and ascends the neck perpendicularly to the upper border of the thyroid cartilage, where it divides into the external and internal carotids. The *left* arises from the arch of the aorta, ascends the neck, and divides like the right.

Fig. 71.

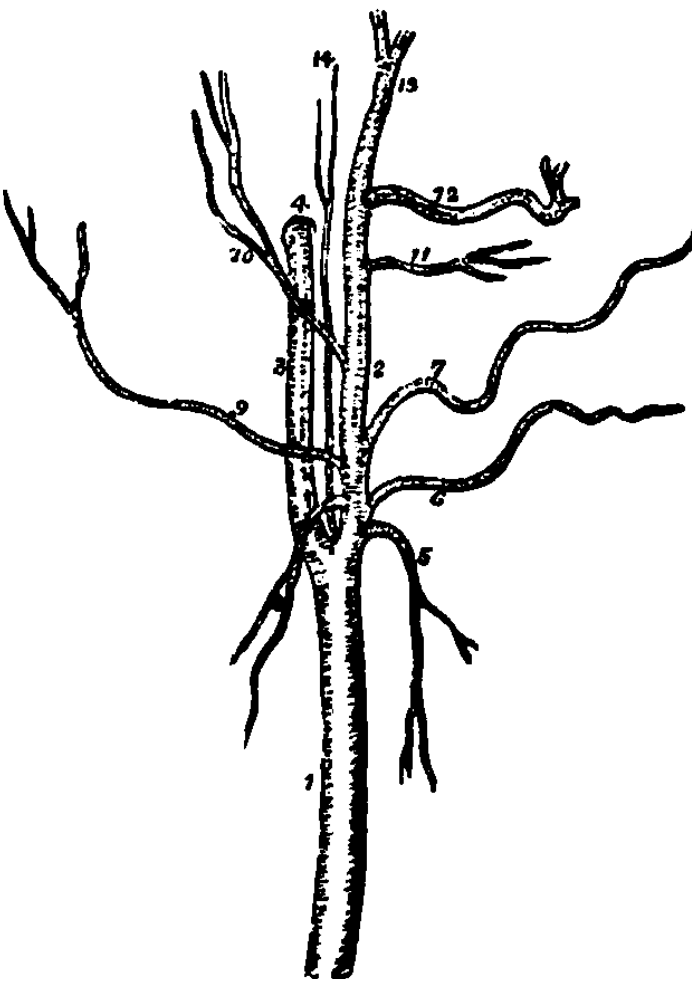


LARGE CARDIAC VESSELS.

Fig. 71 shows the relations of the large vessels proceeding from the root of the heart, that viscis being removed. 1. Ascending aorta. 2. Arch. 3. Thoracic aorta. 4. Innominata; this divides, at 5, into right carotid, which, at 6, subdivides into external and internal carotid; and 7, the right subclavian. 8. Axillary. 9. Brachial. 10. Right pneumogastric nerve. 11. Left carotid. 12. Left subclavian. 13. Pulmonary. 14. Left pulmonary. 15. Right pulmonary. 16. Trachea. 17. Right bronchus. 18. Left bronchus. 19, 19. Pulmonary veins. 20. Bronchial arteries. 21 Intercostal.

EXTERNAL CAROTIDS.—Each external carotid, passing through the deep portion of the parotid gland, ascends nearly perpendicularly to the space between the neck of the lower jaw and the meatus auditorius, where it divides into the temporal and internal maxillary. It gives off nine branches; the first three *anteriorly*, the next three *superiorly*, and the last three *posteriorly*. 1. *Superior thyroid;* curves downward to the thyroid gland, where it is distributed. It sends a *hyoid* branch to the muscles of the hyoid bone, and *superior* and *inferior laryngeal*, and *muscular* branches to the larynx. 2. *Linguinal;* ascends obliquely to the under surface of the tongue, running forward in a serpentine direction to its tip, where it is called the *ranine artery;* it gives off the *hyoid*, *dorsalis linguæ*, and *sublingual* branches. A branch of this latter branch is often divided in cutting the frænum linguæ in tongue-tied children. 3. *Facial;* this arises above the os hyoides, and descends obliquely to the submaxillary gland, where it is embedded; it then curves around the body of the lower jaw, ascends to the angle of the mouth, and thence to the angle of the eye, giving off, below the jaw, *inferior palatine*, *submaxillary*, *submental*, and *pterygoid* branches, and on the face the *masseteric*, *inferior labial*, *inferior coronary superior coronary*, and *lateralis nasi* branches. 4. *Mastoid;* turns downward to be distributed to the sterno-mastoid muscle and lymphatic glands of the neck. 5. *Occipital* passes backward a little below the facial, forms a loop with the hypo-glossal nerve, and is distributed upon the occiput, anastomosing freely with the opposite occipital, the temporal, and auricular arteries. It gives off the *inferior meningeal* to the dura mater, and the *princeps cervicis*, a large branch which descends the neck between the complexus and semi-spinalis colli, and inosculates with the deep cervical branch of the subclavian. This branch establishes an important collateral circulation between the branches of the carotid and subclavian, after the ligature of the common carotid. 6. *Posterior auricular; arises* above the level of the digastric and stylo-hyoid muscles, and ascends below the parotid gland, to be distributed, by two branches, to the external ear and side of the head, anastomosing with the occipital and temporal. It sends off the *stylo-mastoid* branch to the tympanum and aquæductus Fallopii. The anterior arteries of the ear are branches of the temporal. 7. *Ascending pharyngeal; arises* near the external carotid bifurcation, and ascends to the base of the skull, where it divides into two branches—*meningeal,* which, passing through the foramen lacerum posterius, is distributed to the dura mater, and *pharyngeal,* which supplies the pharynx, tonsils. and Eustachian tube. 8. *Parotideans;* four or five branches distributed to the parotid gland and adjacent integuments. 9. *Transversalis facei; arises* from the trunk within the parotid gland, crosses the masseter muscle, and is distributed to the temporo-maxillary articulation, and muscles and integuments of the side of the face, inosculating with the facial and infra-orbital.

Fig. 72.



CAROTIDS AND BRANCHES

Fig. 72 is a plan of the common carotids, with the branches of the external. 1. Common carotid. 2. External carotid. 3. Internal carotid. 4. Carotid foramen in the petrous portion of the tempora bone. 5. Superior thyroid. 6 Lingual. 7. Facial. 8. Mastoid 9. Occipital. 10. Posterior auricular. 11. Transverse facial. 12. Internal maxillary. 13. Temporal 14. Ascending pharyngeal

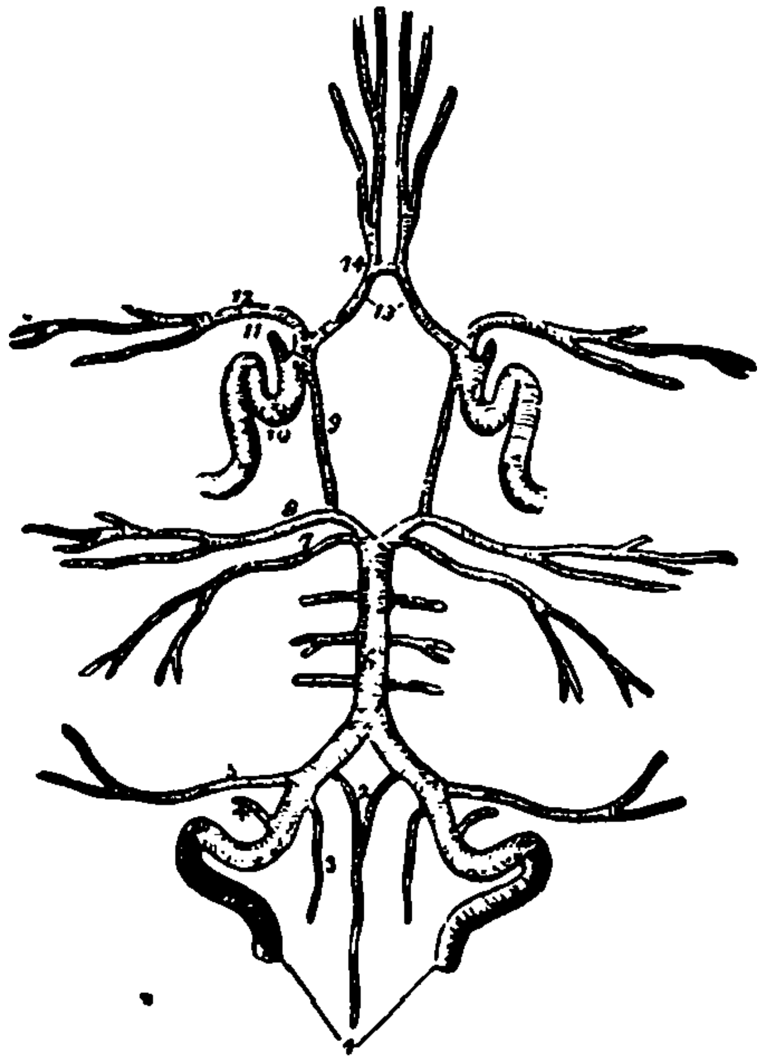
THE TEMPORAL ARTERY.—This terminal branch of the external carotid ascends over the root of the zygoma, where it divides into two branches: 1. *Anterior temporal;* distributed over the front of the temple and arch of the skull, anastomosing with its fellow, the frontal and supra-orbital. 2. *Posterior temporal;* curves upward and backward, inosculating with its fellow, the occipital and posterior auricular. It sends off three branches—the *orbitar* to the palpebral arteries, the *middle temporal* to the temporal muscle, and the *anterior auricular* to the ear.

THE INTERNAL MAXILLARY ARTERY.—The other terminal branch of the external carotid passes inward behind the neck of the lower jaw to the deep structures of the face. Its branches are: 1. *Tympanitic,* distributed to and around the drum of the ear, passing through the glenoid fissure. 2. *Inferior dental;* descends to the dental foramen, and enters the canal of the lower jaw with the dental nerve. It supplies the teeth of the lower jaw, sending small branches along the canals in their roots. A branch also emerges at the mental foramen and anastomoses with the facial arteries. 3. *Meningea media;* passes through the foramen spinosum of the sphenoid bone, and becomes the middle artery of the dura mater, its branches ramifying through a part of that membrane and the bones of the skull. 4. *Meningea parva;* enters the cranium through the foramen ovale, and is distributed to the dura mater, giving off a twig to the nasal fossæ and soft palate. 5. *Muscular branches;* distributed to the muscles of the maxillary region. 6. *Superior dental;* descending, winds around the tuberosity of the upper jaw, and gives branches to the back teeth, gums, and the antrum 7. *Infra-orbital;* enters the orbit of the eye, and passes along the infra-orbital canal, sending branches to the orbit, antrum, teeth of the upper jaw, and integuments. 8. *Pterygo-palatine;* a small branch sent to the upper part of the pharynx and Eustachian tube. 9. *Spheno-palatine,* or *nasal;* enters the upper meatus of the nose, and supplies the mucous membrane of its septum and walls, and sphenoid and ethmoid cells. 10. *Posterior palatine;* descends along the posterior palatine canal, and is distributed to the palate. A branch called *Vidian,* passes backward to the sheath of the Vidian nerve and Eustachian tube.

INTERNAL CAROTID ARTERIES.—From the bifurcation of the common carotid, each internal carotid curves slightly *outward,* then ascends nearly perpendicularly through the maxillo-pharyngeal space, to the carotid foramen in the os petrosum. It next passes *inward* along the carotid canal, *forward* by the sella turcica and then *upward,* piercing the dura mater, and dividing into three terminal branches. These remarkable angular curves greatly diminish the force of blood thrown into the substance of the brain. The cerebral portion of the artery gives off the following branches: 1. *Ophthalmic;* it enters the orbit through the optic foramen, passes to the inner angle of the eye, and divides into two groups of branches, the first being distributed to the orbit and surrounding parts, and the second supplying the muscles and globe of the eye. These branches are named from their distribution: *Lachrymal, supra-orbital, posterior ethmoidal, anterior ethmoidal, palpebral, frontal, nasal, muscular, anterior ciliary, short ciliary, long ciliary,* and *centralis retinæ.* 2. *Tympanitic;* this enters the tympanum through a small foramen in the carotid canal. 3. *Anterior meningeal;* distributed to the dura mater and Casserian ganglion. 4. *Anterior cerebral;* passes forward along the longitudinal fissure between the two hemispheres of the brain, and gives branches to the optic and olfactory nerves, anterior lobes, third ventricle, corpus callosum, and inner surface of the hemispheres. The two anterior cerebral arteries are connected soon after their origin; the anastomosing trunk is called the *anterior communicating artery.* 4. *Middle cerebral;* passes outward along the fissure of Sylvius, and divides into three branches, which supply the anterior and middle lobes of the brain, and the corpus striatum. 5. *Posterior communicating;* passes backward, and inosculates with the posterior cerebral. 6. *Choroidean;* a small branch sent off to the choroid plexus, and walls off the middle cornua.

The Subclavian Arteries.—The *right* arises from the innominata, and the *left* from the arch of the aorta. Each emerges from the chest by passing over the first rib between the anterior and middle scaleni muscles. Its primary branches are five, most of which are given off before it arrives at the upper rib. The first three *ascend;* the remaining two *descend.* 1. *Vertebral;* this is its largest branch; it passes through the foramina in the transverse processes of all the cervical vertebræ, except the lower, and enters the skull through the foramen magnum of the occipitis. At the lower border of the pons Varolii the two arteries unite to form the *basilir.* The vertebral and basilir arteries send off the following secondary branches: *Lateral spinal,* to the spinal cord and membranes; *posterior meningeal,* to the dura mater, cerebellar fossæ, and falx cerebelli; *anterior spinal,* to the spinal cord; *posterior spinal,* to the spinal cord; *inferior cerebellar,* to the lower surface of the cerebellum; *transverse,* to the pons Varolii and adjacent parts of the orain; *superior cerebellar,* to the upper surface of the cerebellum; and *posterior cerebral,* to the posterior lobes of the cerebrum. A remarkable connection of arteries at the base of the brain, formed by the interior communicating branch, anterior cerebrals, and internal carotids in front, and by the posterior communicating, posterior cerebrals, and basilir behind, is called the circle of Willis.

Fig. 73.



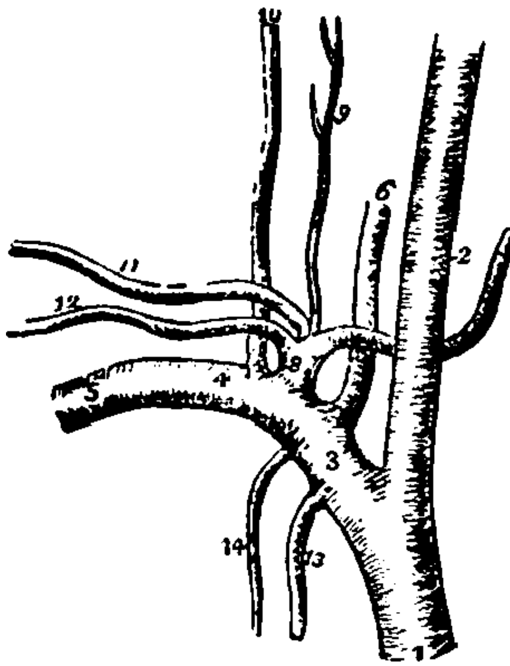
CIRCLE OF WILLIS.

Fig. 73 exhibits the communication of the arteries constituting the circle of Willis. 1. Vertebral arteries. 2. The two anterior spinal branches united to form a single vessel. 3. One of the posterior spinal arteries. 4. Posterior meningeal. 5. Inferior cerebellar. 6. Basilir, giving off transverse branches to either side. 7. Superior cerebellar. 8. Posterior cerebral. 9. Posterior communicating branch of the internal carotid. 10. Internal carotid, showing its curvature within the skull. 11. Ophthalmic, divided across. 12. Middle cerebral. 13. Anterior cerebral, connected by, 14. The anterior communicating artery.

2. *Thyroid axis;* this is a short trunk, dividing soon after its origin into four branches: *Inferior thyroid*, distributed to the thyroid gland, and sending twigs to the trachea, larynx, and œsophagus; *supra-scapular*, distributed to the muscles on the upper surface of the shoulder blade, sending a twig to the trapezius; *posterior scapular*, passing across the neck, supplying the muscles behind the scapula, and giving branches to those of the neck; with the branches of the external carotid, subclavian, and axillary, it establishes an important anastomotic communication; *superficial cervical*, distributed to the deep muscles and glands of the neck, and sending twigs through the intervertebral foramina to the spinal cord and membranes. 3. *Profunda cervicis;* passes backward below the lower cervical vertebra, and then ascends the back of the neck, inosculating with branches of the occipital and scapular. 4. *Superior intercostal;* descends behind the pleura upon the necks of the first two ribs, supplying their spaces, and inosculating with the first aortic intercostal.

Fig. 74 shows the branches of the right subclavian. 1. Innominata. 2. Right carotid. 3. First portion of the subclavian. 4. Its second portion. 5. Its third portion. 6. Vertebral artery. 7. Inferior thyroid. 8. Thyroid axis. 9. Superficialis cervicis. 10. Profunda cervicis. 11. Posterior scapular. 12. Supra-scapular. 13. Internal mammary. 14. Superior intercostal.

Fig. 74.



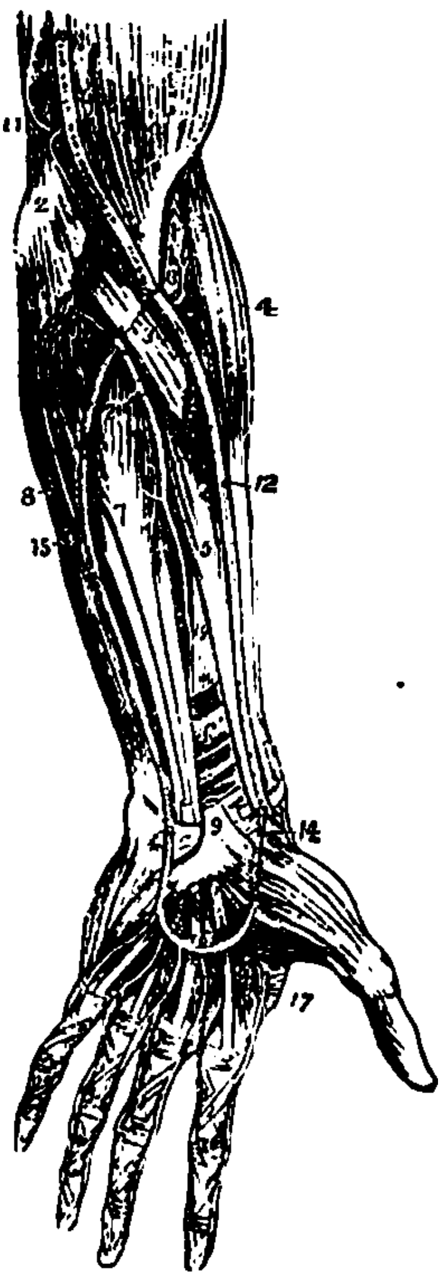
SUBCLAVIAN BRANCHES.

5. *Internal mammary;* descends by the side of the sternum to the diaphragm, where it enters the sheath of the rectus, and inosculates with the epigastric; it sends off the following branches: *Anterior intercostal*, to the front intercostal muscles; *mammary*, to the breasts; *comes nervi phrenica*, which accompanies the phrenic nerve; *mediastinal* and *pericardiac*, to the mediastinum, pericardium, and thymus gland; and *musculo-phrenic*, to the diaphragm and intercostal spaces.

The Axillary Arteries.—The axillaries curve gently through the middle of the armpit, where they become the brachial. Each axillary gives off seven branches: 1. *Thoracica acromialis;* distributed to the pectoral muscles and mammary gland, and inosculating with the suprascapular. 2. *Superior thoracic;* distributed with the preceding, inosculating with the intercostal and mammary. 3. *Inferior thoracic;* distributed to the pectoralis minor, serratus magnus, and subscapularis muscles, and axillary and mammary glands, inosculating with the superior thoracic, intercostal, and mammary. 4. *Thoracica axillaris;* distributed to the plexus of nerves and glands in the armpit. 5. *Subscapular;* the largest branch; supplies the muscles on the under surface and lower border of the shoulder blade, and the side of the chest. A branch, called *dorsalis scapulæ*, is sent to the upper side of the scapula. 6. *Circumflex;* these wind around the neck of the humerus, and supply the shoulder joint. 7. *Posterior circumflex;* a larger branch distributed to the joint and deltoid muscle.

Brachial Arteries.—Each brachial artery extends down the arm, from the lower border of the latissimus dorsi to the elbow, where it divides into the radial and ulnar. Along the arm it gives off four branches: 1. *Superior profunda;* winds around the humerus between the triceps and bone and inosculates with the radial recurrent; it sends the *posterior articular* to the elbow joint. 2. *Inferior profunda;* arises from the middle of the brachial, descends to the elbow with the ulnar nerve, and inosculates with the posterior ulnar recurrent. 3. *Anastomotica magna;* arises two inches above the elbow, and inosculates with both ulnar recurrents and the inferior profunda. 4. *Muscular branches;* distributed to the muscles along its course, viz., coraco-brachialis, biceps, deltoid, brachialis anticus, and triceps.

Fig. 75.



ARTERIES OF FORE-ARM.

The Radial Artery.—The radial division of the brachial runs along the radial side of the fore-arm from the elbow to the wrist, where it turns around the base of the thumb beneath its extensor tendons, and passes into the palm of the hand. It then crosses the metacarpal bones to the ulnar side, forming the *deep palmar arch*, and terminates by inosculating with the superficial palmar arch. This is the artery which, from its superficial position above the wrist and base of the thumb, is selected for "examining the pulse." Its branches are: 1. To the fore-arm; the *recurrent radial* and *muscular*. 2. To the wrist; *superficialis volæ*, *carpalis anterior*, *carpalis posterior*, *metacarpalis*, and *dorsales pollicis*. 3. To the hand; *princeps pollicis*, *radialis indicis*, *interosseæ*, and *perforantes*, distributed as their names import.

The arteries of the fore-arm are shown in Fig. 75. 1. Biceps muscle. 2. Inner condyle of the humerus. 3. Pronator radii teres. 4. Supinator longus. 5. Flexor longus pollicis. 6. Pronator quadratus. 7. Flexor profundus digitorum. 8. Flexor carpi ulnaris. 9. Annular ligament. 10. Brachial artery. 11. Anastomotica magna. 12. Radial. 13. Radial recurrent. 14. Superficialis volæ. 15. Ulnar. 16. Its superficial palmar arch. 17. Magna pollicis and radialis. 18. Posterior ulnar recurrent. 19. Anterior interosseous. 20. Posterior interosseous.

The Ulnar Artery.—The ulnar division of the brachial crosses the arm obliquely, then runs down the ulnar side to the wrist, crossing the annular ligament, forming the superficial palmar arch, and terminating by inosculating with the superficial volæ Its branches are: 1.

To the fore-arm; *anterior* and *posterior recurrent*, *anterior* and *posterior interosseous*, and *muscular*. 2. To the wrist; *carpialis anterior* and *posterior*. 3. To the hand; *digitales*, distributed as their names import.

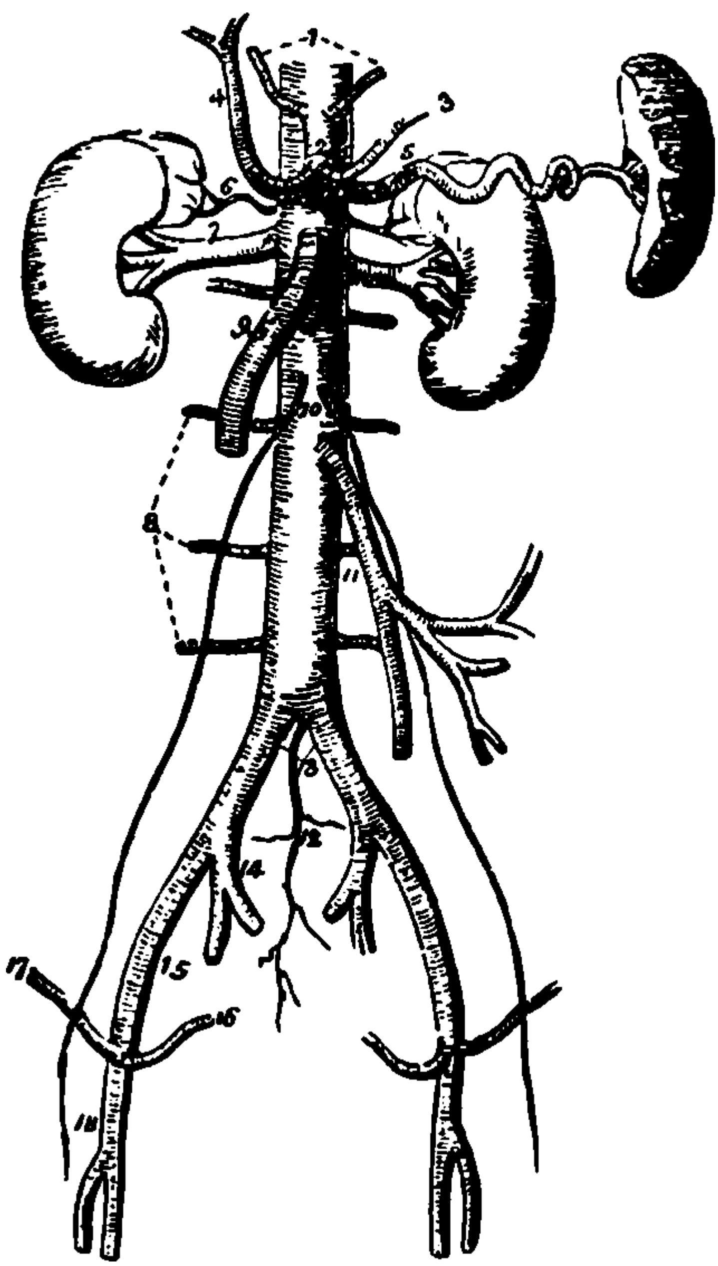
THE THORACIC AORTA.—In the cavity of the chest the aorta gives off three groups of branches: 1. *Bronchial;* four in number, distributed to the bronchial glands and tubes; they also send branches to the œsophagus, pericardium, and left auricle. They are the nutritive vessels of the lungs. 2. *Œsophageal;* numerous small branches distributed to the œsophagus, and making a chain of anastomoses along its course. 3. *Intercostal;* nine on each side, arising from the posterior part of the aorta, and sent to the nine lower intercostal spaces, where each branch gives off a *dorsal branch;* thus dividing into *spinal* and *muscular* branches, which supply the spina cord, and muscles and integuments of the back.

THE ABDOMINAL AORTA.—In the abdominal cavity the aorta gives off nine primary branches: 1. *Phrenic;* these are given off immediately below the diaphragm, and soon divide into an *internal* branch, which inosculates with its fellow in front of the œsophageal opening, and an *external*, which is distributed to the circumference of the diaphragm, and sends branches to the supra-renal capsules. The phrenic arteries inosculate with branches of the internal mammary, inferior intercostal, epigastric, œsophageal, gastric, hepatic, and supra-renal. 2. *The Cœliac axis;* this is a single trunk, arising just above the first lumbar vertebræ, about half an inch in length; it divides into three large branches, the gastric, hepatic, and splenic.

The *Gastric artery* is the smallest branch; it ascends between the two layers of the lesser omentum to the cardiac orifice of the stomach, to be distributed to the lower part of the œsophagus and lesser curve of the stomach. It inosculates with branches of the hepatic and splenic.

The *Hepatic* branch ascends along the right border of the lesser omentum to the liver, where it divides into right and left branches; these are distributed along the portal canals to the right and left lobes. It sends a *pyloric* branch to the lesser curve of the stomach and duodenum; the *gastro-duodenalis*, dividing into the *gastro-epiploica dextra* and *pancreatico-duodenalis*, which are distributed to the greater curve of the stomach, pancreas, and duodenum; and the *cystic*, which is distributed to the gall-bladder. The gastric, pyloric, and splenic branches inosculate with each other, and with branches of the pancreas, duodenum, jejunum, and mesentery.

Fig. 76.



ABDOMINAL BRANCHES.

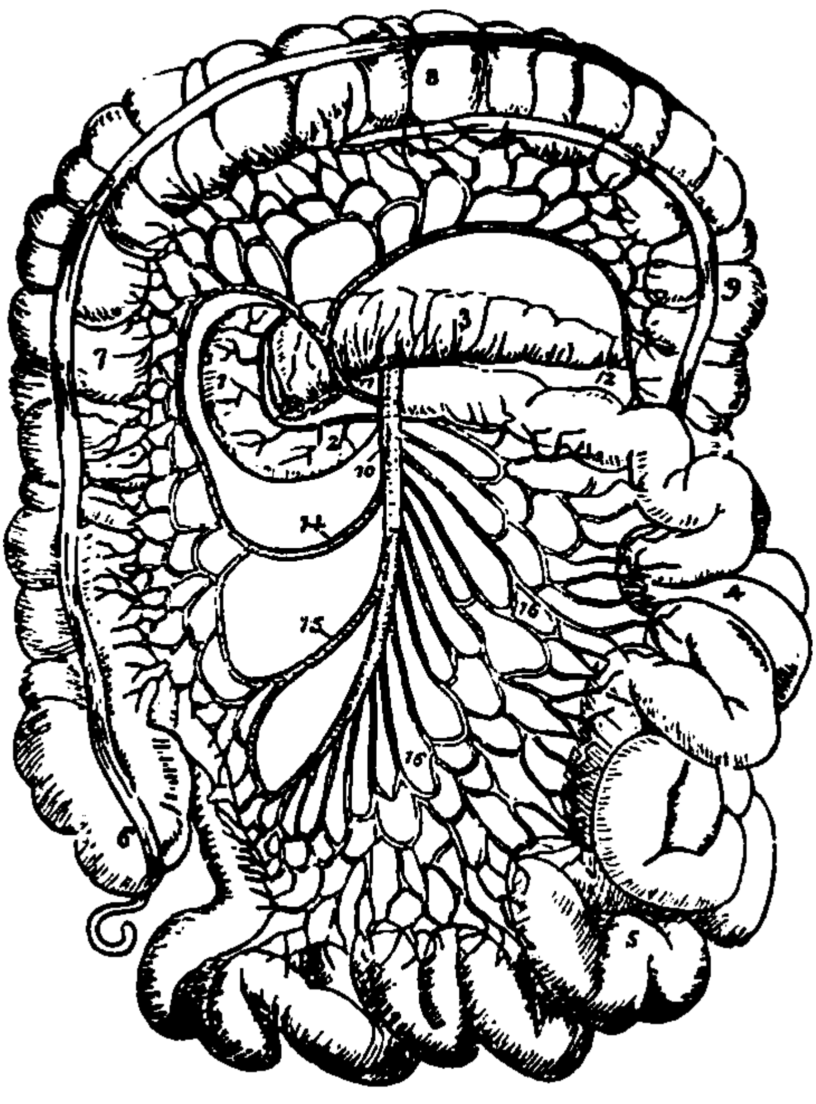
The abdominal aorta is shown in Fig. 76, with its branches. 1. Phrenic arteries. 2. Cœliac axis. 3. Gastric artery. 4. Hepatic. 5. Splenic. 6. Right supra-renal. 7. Right renal. 8. Lumbar. 9. Superior mesenteric. 10. The two spermatic. 11. Inferior mesenteric. 12. Sacra media. 13. Common iliaca. 14. Right internal iliac. 15. External iliac. 16. Epigastric. 17 Circumflexa ilii. 18. Femoral.

The *Splenic* artery is the largest branch of the cœliac axis; it passes horizontally to the left along the upper border of the pancreas, and enters the spleen by five or six divisions, which are distributed to its structure. In its course it is tortuous and serpentine, frequently making a complete turn upon itself. It is accompanied by the splenic vein, and splenic plexus of nerves. It sends off numerous small branches, *pancreaticæ parvæ*, to the pancreas; the largest follows the pancreatic duct, and is called *pancreatica magna;* several branches, *vasa brevia*, to the great end of the stomach, to which they are distributed, inosculating with branches of the gastric; and the *gastro-epiploica sinistra*, which appears to be the continuation of the splenic artery; it passes from left to right along the great curve of the stomach, and inosculates with the gastro-epiploica dextra; its distribution is to the curve of the stomach and great omentum.

3. *Superior mesenteric;* arises behind the pancreas, and descends within the layers of the mesentery to the right iliac fossa. Its branches are: *Vasa intestini tenuis;* fifteen or twenty branches, distributed to the small intestines. Between the layers of the mesentery the larger

branches inosculate so as to form series of arches; from these secondary arches are similarly formed, and from the latter a third series, from which branches are distributed to the intestinal coats. Sometimes a fourth or even fifth series of arches is produced. *Ileo-colic;* descends to the right iliac fossa, where it divides into branches, which form arches, and are finally distributed to the ilium, cæcum, and colon. *Colica dextra;* forms arches, from which branches are distributed to the ascending colon. *Colica media;* distributed, like the preceding, to the transverse part of the colon. All the branches of the superior mesenteric inosculate freely with each other.

Fig. 77.



MESENTERIC DISTRIBUTION.

Fig. 77 shows the course and distribution of the superior mesenteric artery. 1. Duodenum. 2. Its transverse portion. 3. Pancreas. 4. Jejunum. 5. Ileum. 6. Cæcum, with its vermiform appendix. 7. Ascending colon. 8. Its transverse portion. 9. Commencement of the descending colon. 10. Superior mesenteric artery. 11. Colica media. 12. The branch inosculating with the colica sinistra 13. Branch of the superior mesenteric inosculating with the pancreatico-duodenalis. 14. Colica dextra. 15. Ileo-colica. 16, 16. Branches from the convexity of the superior mesenteric to the small intestines.

4. *Spermatic;* the spermatic arteries are two small vessels arising from the aorta below the mesenteric, and, passing obliquely outward, accompany the ureters along the front of the psoas muscle to the border of the pelvis. Each spermatic artery is then directed outward to the internal abdominal ring, following the spermatic cord, with its corresponding veins and plexus of nerves, through the scrotum to the testicle, to which it is distributed. In the female they descend into the pelvis, and pass between two layers of the broad ligaments of

the uterus, to be distributed to the ovaries, Fallopian tubes, and round ligaments, inosculating with the uterine arteries. 5. *Inferior mesenteric;* arises two inches below the superior mesenteric, and descends to the left iliac fossa, when it divides into the *colica sinistra*, which is distributed to the descending colon; the *sigmoideæ*, several branches sent to the sigmoid flexure of the colon; and the *superior hæmorrhoidal*, which descends to the rectum, and is there distributed. 6. *Supra-renal;* two small vessels sent to the supra-renal capsules. 7. *Renal;* two large trunks given off immediately below the superior mesenteric; they divide into several large branches, which are minutely ramified in the substance of the kidneys. 8. *Lumbar;* four or five branches curving around the lumbar vertebræ, then, dividing into branches, distributed to the vertebræ, spinal cord, dorsal and abdominal muscles. 9. *Sacra media;* arises at the bifurcation of the aorta, and, descending, inosculates with the lateral sacral arteries, sending branches to the rectum and anterior sacral nerves.

THE COMMON ILIAC ARTERIES.—The abdominal aorta divides into the two common iliacs opposite the fourth lumbar vertebra. They are about two and a half inches long, and opposite the sacro-iliac symphasis divide into the internal and external iliac.

THE INTERNAL ILIAC ARTERY.—This is a short trunk, from one to two inches in length, dividing opposite the great sacro-ischiatic foramen into an anterior and posterior trunk. The branches of the *anterior trunk* are: 1. *Umbilical;* this is the commencement of the fibrous cord into which the umbilical artery of the fœtus is converted after birth. In after life the cord remains pervious a short distance, constituting the umbilical artery of the adult; it gives off the *superior* and *middle vesical*, and *middle hæmorrhoidal* arteries to the bladder, vesiculæ seminales, prostate gland, and rectum. 2. *Ischiatic;* presses downward to the lower border of the great ischiatic notch, where it emerges from the pelvis, then passes down between the trochanter major and tuberosity of the ischium, in company with the ischiatic nerves, where it divides into the *hæmorrhoidal*, distributed to the rectum; *inferior vesical*, to the base and neck of the bladder, vesiculæ seminales, and prostate gland; *coccygeal*, to the integuments and muscles around the anus and coccyx; *inferior gluteal*, to the gluteus maximus; *comes nervi ischiatici*, to the lower part of the thigh; and *muscular* branches, which supply the posterior part of the hip and thigh. 2. *Internal pudic;* passes down in front of the ischiatic, emerges from the pelvis through the great sacro-ischiatic foramen, crosses the spine of the ischium, and re-enters the pelvis through the lesser sacro-ischiatic foramen; it then crosses the internal obturator muscle to the ramus of the ischium, ascends the ramus, and at the symphysis enters the deep perineal fascia, finally reaching the dorsum of the penis, along which it runs, much diminished in size, supplying that organ under the name of *dorsalis penis*. Within the pelvis it sends branches to the bladder, vesiculæ seminales, prostate gland, and rectum. Externally to the pelvis it gives off the *external hæmorrhoidal* to the muscles and integuments of the anus and perineum; *superficialis perinei*, to the scrotum and perineum; *bulbosa*, to the corpus spongiosum of the penis; *corposis cavernosi*, to the corpus cavernosum; and *dorsal*, distributed to the body of the penis.

In the female the internal pudic is smaller; its distribution is the same in principle to the corresponding organs. The *uterine* and *vaginal* arteries are derived from the internal iliac, umbilical, internal pudic, and ischiatic arteries.

The branches of the posterior trunk are: 1. *Ileo-lumbar;* distributed to the abdominal muscles. 2. *Obturator;* this passes from the pelvis through the obturator foramen, and divides into *internal* and *external* branches, which are distributed to the muscles around the hip joint. 3. *Lateral sacral;* two in number; the *superior* passes through the posterior sacral foramen, and is distributed to the spinal canal and sacral integuments; the *inferior* supplies the sacral nerves. 4. *Gluteal;* this is the continuation of the main trunk; it passes through the great sacro-ischiatic foramen, and divides into a *superficial* branch, which ramifies in the gluteus maximus and adjacent integuments; a *deep superior* branch, which inosculates with the circumflex arteries; and *deep inferior* branches, which are sent to the gluteus minimus and capsule of the hip joint.

THE EXTERNAL ILIAC.—The external iliac of each side passes obliquely downward along the inner border of the psoas muscle, from opposite the sacro-iliac symphysis to the femoral arch, where it becomes the femoral artery. It is surrounded by lymphatic vessels and glands throughout its whole course. Its branches are: 1. *Epigastric;* arises near Poupart's ligament, passes forward between the peritoneum and transversalis fascia, ascends obliquely to the sheath of the rectus, which it enters and passes upward behind that muscle. It is distributed to the rectus, inosculating in its substance with the internal mammary. It sends a *cremasteric* branch to the muscle of that name, and inosculating branches to the obturator artery. The epigastric artery forms the prominence of the peritoneum, which divides the iliac fossa into internal and external portions, from the former of which direct inguinal hernia issues, and from the latter oblique inguinal hernia. 2. *Circumflexa ilii;* arises nearly opposite the epigastric. It is distributed to the abdominal muscles, inosculating with the inferior intercostal and lumbar.

THE FEMORAL ARTERY.—After emerging from Poupart's ligament the external iliac enters the thigh, and takes the name of *femoral.* It passes down the inner side of the thigh midway between the anterior superior spine of the ilium and the symphysis pubis, to the opening in the adductor magnus, which is about two thirds the distance to the knee, where it takes the name of popliteal. Its branches are: 1 *Superficial circumflexa ilii;* to the integuments of the groin and inguinal glands. 2. *Superficial epigastric;* distributes branches to the groin, and ascends toward the umbilicus, to inosculate with branches of the epigastric and internal mammary. 3. *Superficial external pudic;* to the penis and scrotum in the male, and the labia in the female. 4. *Deep external pudic;* to the scrotal integuments and perineum. 5. *Profunda;* to the flexor muscle on the back of the leg. This artery which arises two inches below Poupart's ligament, divides into the *external circumflex*, which supplies the muscles on the front and outer side of the thigh, and inosculates with the gluteal and ischiatic; the *internal circumflex*, which winds around the inner side of the neck of the femur, supplying the muscles on the upper and inner side of the thigh, anastomosing with the adjacent vessels; and the *perforating arteries;* three branches, distributed to the posterior, anterior, and flexor muscles of the thigh, and inosculating freely with the surrounding branches of other arteries. These anastomoses maintain the collateral circulation of the limb after ligature of the femoral artery. 6. *Muscular;* given off to all the surrounding muscles. 7. *Anastomotica magna;* this runs along the tendon of the adductor magnus to the inner condyle, and inosculates with the arteries around the knee joint; some of the branches are distributed to the vastus internus.

THE POPLITEAL ARTERY.—This continuation of the femoral passes obliquely outward to the lower border of the popliteal muscle, where it divides into the anterior and posterior tibial. Its branches are: 1 *Superior articular;* two branches, *external* and *internal*, which wind around the femur, supplying the knee joint and lower part of the femur, anastomosing with each other and the adjacent arteries. 2. *Azygos articular;* one or more sent to the interior of the synovial membrane. 3. *Inferior articular;* two branches, *external* and *internal,* which wind around the head of the tibia, supply the knee joint, heads of the tibia and fibula, and anastomose with each other and the adjacent arteries. 4. *Crural;* two large muscular branches, distributed to the two heads of the gastrocnemius.

THE ANTERIOR TIBIAL ARTERY.—This runs down the front aspect of the leg to the ankle joint, where it becomes the dorsalis pedis. Its branches are: 1. *Recurrent;* distributed to the knee joint, and anastomosing with the articular. 2. *Muscular;* numerous branches distributed to the anterior tibial region. 3. *Malleolar;* two branches, *external* and *internal*, distributed to the ankle joint, and anastomosing extensively with adjacent arteries.

THE DORSALIS PEDIS.—This continuation of the anterior tibial runs forward along the tibial side of the upper surface of the foot, from the ankle to the base of the metatarsal bone of the great toe, where, after sending off the *tarsea* branches to the tarsal articulations, and the *metatarsea*, which form an arch across the base of the foot and bones, and also giving off the *interosseæ*, which are distributed to the dorsal interossei muscles and toes, it divides into the *dorsalis pollicis*, distributed to the great and second toes, and the *communicating*, which passes to the sole of the foot, inosculating with the external plantar.

THE POSTERIOR TIBIAL ARTERY.—This division of the popliteal passes obliquely down the tibial side of the leg to the concavity of the os calcis, where it divides into the internal and external plantar. Its branches are: 1. *Peroneal;* a large branch given off two inches below the lower border of the popliteal muscle; it runs downward along the inner border of the fibula to its lower third, where it divides into an *anterior* branch, distributed around the outer malleolus, and a *posterior*, to the tarsus. 2. *Nutritious;* to the nutritive canal of the tibia. 3. *Muscular;* numerous branches sent to the deep muscles of the leg. A *recurrent* branch passes up and anastomoses with the articular arteries. 4. *Internal calcanean;* several branches sent to the os calcis and integuments, and anastomosing with the neighboring arteries.

THE PLANTAR ARTERIES.—The *internal* proceeds from the bifurcation of the posterior tibial, along the inner border of the foot, supplying that part and the great toe. The *external*, the largest division, passes outward to the fifth metatarsal space, then turns horizontally inward between the layers of muscles to the first metatarsal space, where it inosculates with the communicating branch of the dorsalis pedis. It sends off branches, named after their manner of distribution, *muscular*, *articular*, *digital*, *anterior* and *posterior perforating*, which supply the various structures and parts of the foot, and form numerous inosculating connections with each other

THE PULMONARY ARTERY.

The pulmonary artery arises from the left side of the right ventricle in front of the origin of the aorta; it ascends obliquely to the under surface of the aorta, where it divides into the right and left pulmonary. In its course upward and backward it crosses the commencement of the aorta, to which it is connected by a thick, impervious cord, the remains of the ductus arteriosus.

The RIGHT PULMONARY passes beneath the arch and behind the ascending aorta to the root of the lungs, where it divides into three branches, which are distributed to the three lobes of the right lung.

The LEFT PULMONARY, the largest division, passes in front of the descending aorta to the root of the left lung, to which it is distributed.

These arteries divide and subdivide in the substance of the lungs, and finally terminate in a network of capillary vessels around the air cells and intercellular passages.

CHAPTER VI.

OF THE VEINS—ANGEIOLOGY.

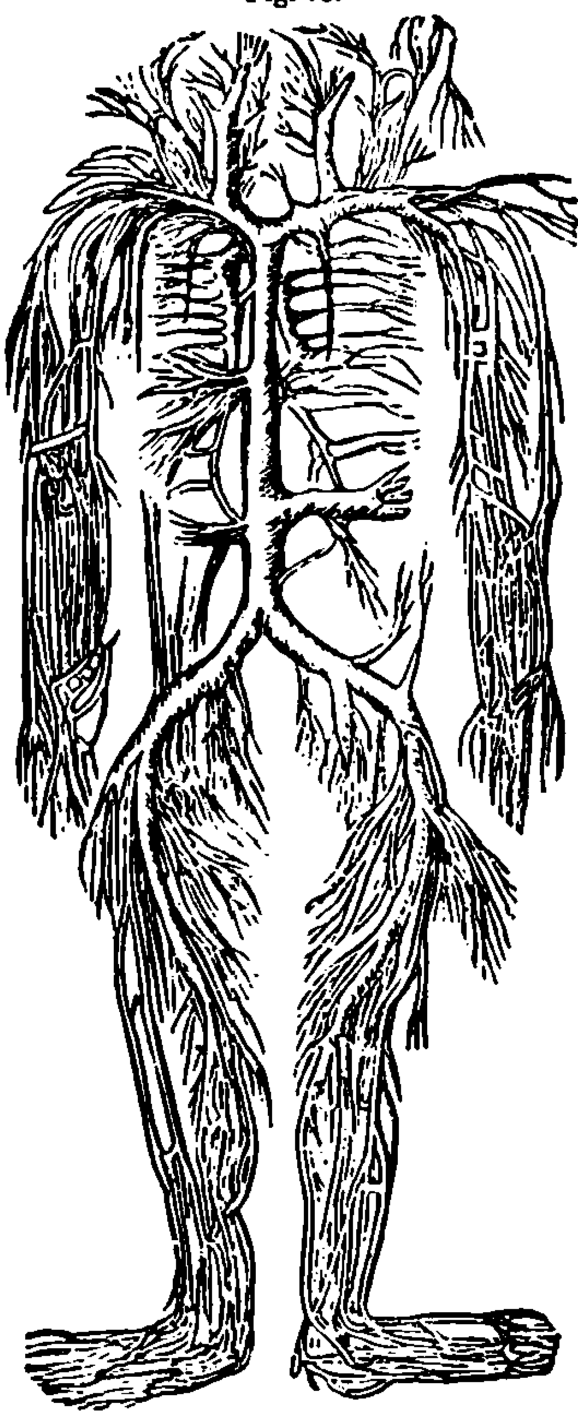
THE veins are the vessels which return the blood to the heart, after it has been circulated through the various structures of the body by the arteries. They are thinner than the arteries, and collapse and flatten on becoming empty.

In the systemic circulation the veins convey the dark-colored blood from the capillaries to the right auricle of the heart. The veins of the pulmonary circulation correspond to the arteries of the systemic circulation, as they convey the pure red blood from the capillaries of the lungs to the left auricle.

Veins originate by minute radicles in all the textures of the body, and converge to larger trunks, the sum of the radicles being larger than that of the main trunk; hence the blood, in returning to the heart, passes from a larger to a smaller channel, which increases its rapidity of motion.

STRUCTURE OF VEINS.—Like the arteries, the veins have three coats. The *external* is cellular, or areolar; the *middle* is fibrous, or muscular; and the *internal* is nervo-serous. The *middle* coat consists of an outer layer of circular fibres, and an inner layer of longitudinal organic muscular fibres. The inner coat is probably a continuation of the inner coats of arteries. The differences between the structures of arteries and veins is the thinness and inelasticity of the veins, and the existence of valves in them. These valves are generally semilunar fibrous flaps, arranged in pairs, one on each side of the vessel; sometimes, however, there is a single spiral flap, and occasionally three. The free border of the valvular flaps is concave, and directed forward, allowing a free current toward the heart, but preventing a retrograde motion. The valves are most numerous in the veins of the extremities; they are generally absent in very small veins, in the portal and cerebral veins, and those of the viscera; they are also absent in the large trunks, as the cavæ, azygos, innominata, and iliac.

Fig. 78.



THE VENOUS SYSTEM.

Veins are divided into *superficial*, *deep*, and *sinuses*. The *sinuses* are excavations in the structure of an organ, and lined by the internal coat of the veins. The principal are those of the dura mater, the diploe, the canalous structure of bones, and the uterus.

VEINS OF THE HEAD.—The venous blood from the face and exterior of the head is principally collected by veins which accompany the arteries, and have the same names. The principal trunks are: 1 *Facial;* descends along the middle of the forehead, passes downward by the side of the root of the nose, and continues beneath the zygomatic muscles, receiving the *supra-orbital*, *nasal*, *ophthalmic*, *alveolar*, and *palpebral* branches, and finally terminating in the internal jugular. 2. *Internal maxillary*; receives the branches from the zygomatic and pterygoid fossæ, and joins with the temporal behind the neck of the lower jaw, constituting the temporo-maxillary. 2. *Temporo-maxillary*; passes down through the parotid gland, at the lower border of which it becomes the external jugular, receiving in its course the *anterior auricular*, *masseteric*, *transverse facial*, and *parotid*. 3. *Temporal*; descends between the meatus auditorius externus and the condyle of the lower jaw, and unites with the internal maxillary. 4. *Occipital*; follows the occipital artery, and terminates in the internal jugular.

Veins of the Diploe.—The venous blood of the bones of the head is received from the cellular capillaries, which terminate externally in the veins of the pericranium, and internally in the veins and sinuses of the dura mater.

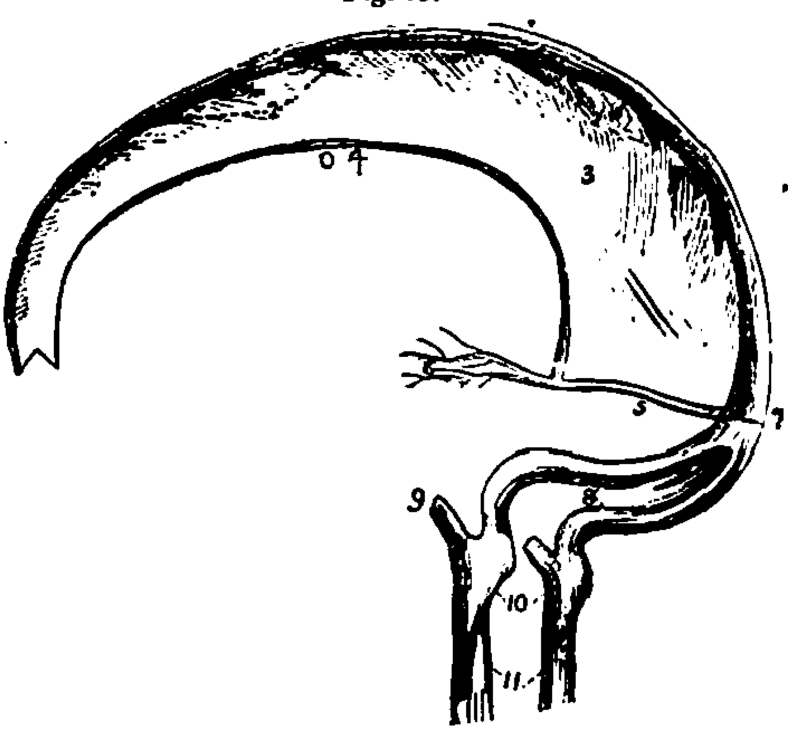
Veins of the Cerebrum and Cerebellum.—The *superficial cerebral* are situated on the surface of the hemispheres, lying in grooves formed by the convexities of their convolutions. The *superior* terminate in the superior longitudinal sinus. The *deep* commence within the lateral ventricles, and unite to form the *venæ galeni*, which, escaping through an opening, called the *fissure of Bichat*, terminates in the straight sinus.

The *cerebellar* are disposed like the cerebral, and terminate in the lateral and petrosal sinuses.

Sinuses of the Dura Mater.—These are irregular channels, formed by a splitting of the layers of the membrane, which are lined by a continuation of the inner coat of the veins. The principal are: 1. *Superior longitudinal*; attached to the falx cerebri; it extends along the middle line of the arch of the skull to the occipital bone, where it divides into the lateral sinuses. Its termination forms a dilatation, called *torcular Herophili*, which is the point of communication of the six sinuses, the superior longitudinal, two lateral, two occipital, and the straight. 2. *Inferior longitudinal*; situated in the lower free margin of the falx cerebri, terminating in the straight sinus. 3. *Straight*; extends across the tentorium, from the inferior longitudinal to the torcular Herophili. 4. *Occipital*; two canals commencing around the foramen magnum, and terminating in the torcular Herophili. 5. *Lateral*; these commence at the torcular Herophili, and terminate in the internal jugulars.

Fig. 79 represents a part of the sinuses of the dura mater. 1. Superior longitudinal sinus. 2, 2. Entrance of veins of the pia mater. 3. Falx cerebri. 4. Inferior longitudinal sinus. 5. Straight or fourth sinus. 6. Venæ Galeni. 7. Torcular Herophili. 8. Lateral sinuses. 9. Inferior petrosal sinus. 10, 11. Internal jugular veins.

Fig. 79.



SINUSES OF THE BRAIN.

SINUSES OF THE BASE OF THE SKULL.—These are five in number: 1. *Cavernous;* situated on each side of the sella turcica, receiving the ophthalmic veins, and terminating in the inferior petrosal. 2. *Inferior petrosal;* terminates in the internal jugular with the lateral. 3. *Circular;* surrounds the pituitary gland in the sella turcica, communicating on each side with the cavernous. 4. *Superior petrosal;* this establishes a communication between the cavernous and lateral on each side. 5. *Transverse;* passes across the basilir process of the occipital, forming a communication with the two inferior petrosal.

VEINS OF THE NECK.—The veins which return the blood from the head are: 1. *External jugular;* descends the neck from the parotid gland, in a line drawn from the angle of the lower jaw to the middle of the clavicle, crosses the sterno-mastoid muscle, and terminates in the subclavian. 2. *Anterior jugular;* this collects the blood from the superficial structures of the neck, and opens into the subclavian, near the preceding. 3. *Internal jugular;* commences at the foramen lacerum posterius on each side of the base of the skull, and descends near the carotids to the root of the neck, where it unites with the subclavian to form the vena innominata. It receives *facial*, *lingual*, *pharyngeal*, *occipital*, and *thyroid* branches. 4. *Vertebral;* descends by the side of the vertebral artery in the canal of the transverse cervical processes, and terminates at the commencement of the vena innominata.

VEINS OF THE UPPER EXTREMITIES.—These are divided into the *deep*, which accompany the arteries, and are called *venæ comites*, and the *superficial*, the principal branches of which are: 1. *Anterior ulnar;*

running up the inside of the fore-arm to the elbow, where it becomes the basilic. 2. *Posterior ulnar;* ascends the back of the hand and fore-arm, and terminates in the anterior ulnar at the inner condyle. 3. *Basilic;* ascends from the common ulnar formed by the two preceding, along the inner side of the arm to the axilla, where it becomes the axillary vein. 4. *Radial;* commences in the large vein of the thumb, ascends the outer border of the fore-arm to the elbow, becoming there the cephalic. 5. *Cephalic;* ascends the outer side of the arm, and terminates in the subclavian beneath the clavicle. 6. *Median;* passes up between the anterior ulnar and radial; at the elbow it receives a branch from the deep veins, and divides into the median cephalic and median basilic. 7. *Median cephalic;* passes outward in the groove between the biceps and supinator longus to join the cephalic. 8. *Median basilic;* passes inward, and terminates in the basilic. The median cephalic and median basilic branches are commonly selected for the operation of *venesection*, or *bleeding*, by which that "minute instrument of mighty mischief"—the lancet of the surgeon—has shed more blood in the civilized world than has the sword of the warrior; in both cases unfortunately for science and humanity.

The Axillary Vein.—The venæ comites of the brachial artery and the basilic vein unite to form the axillary vein, which becomes the subclavian at the lower border of the first rib. It lies in front of the axillary artery.

The Subclavian Vein.—This crosses over the first rib beneath the clavicle, and unites with the internal jugular to form the vena innominata. It lies in front of the subclavian artery.

Veins of the Lower Extremities.—The *deep* veins accompany the arteries in pairs. Near the knee joint the *anterior* and *posterior tibial* and *peroneal* veins unite to form the popliteal, which, as it ascends, becomes the femoral, and then the external iliac.

The Popliteal Vein.—Ascending through the popliteal region it receives several *muscular* and *articular* branches, and the *external saphenous.*

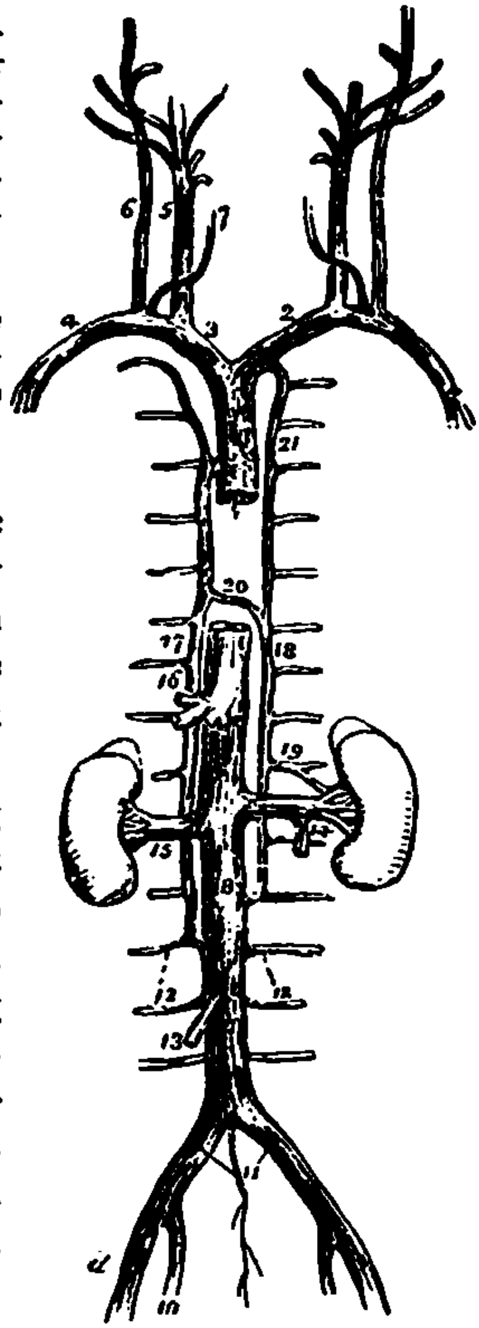
The Femoral Vein.—This vein ascends the thigh in the sheath with the artery, and on entering the pelvis becomes the external iliac. It receives *muscular* veins—the *profunda*, and *internal saphenous.*

The *saphenous veins* collect the blood from the foot and leg.

Veins of the Trunk.—Of these there are seven divisions: 1. *Superior vena cava and its formative branches.* The *superior cava* is a short trunk, about three inches in length, formed by the junction of the venæ innominatæ. It descends on the right side of the mediastinum, and entering the pericardium, terminates in the upper part of the right auricle. Its branches are: the *venæ innominatæ*, two large trunks formed by the union of the internal jugular and subclavian at each side of the root of the neck; the *right vena innominata* lies externally to the arteria innominata, and receives the right lymphatic duct, *right vertebral, right internal mammary*, and *right inferior thyroid veins*; the *left vena innominata*, much the longest, extends across the roots of the three great arteries arising from the arch of the aorta, where it unites with the right to constitute the superior cava.

Fig. 80 is a representation of the principal veins of the trunk and neck. 1. Superior cava. 2. Left innominata. 3. Right innominata. 4. Right subclavian. 5. Internal jugular. 6. External jugular. 7. Anterior jugular. 8. Inferior cava. 9. External iliac. 10. Internal iliac. 11. Common iliac; the small vein between is the sacra media. 12, 12. Lumbar veins. 13. Right spermatic. 14. Left spermatic. 15. Right renal. 16. Trunk of the hepatic veins. 17. Greater azygos 18. Lesser azygos. 19. A branch communicating with the left renal. 20. Termination of the lesser in the greater azygos. 21. Superior intercostal, communicating below with the lesser azygos, and above in the left innominata.

Fig. 80.



VEINS OF THE TRUNK AND NECK

2. *Inferior vena cava, and its formative branches.* The inferior cava is formed by the union of the common iliac veins between the fourth and fifth lumbar vertebræ, ascends along the front of the spine, on the right of the aorta, passes through the fissure in the back side of the liver, and the opening in the middle of the diaphragm, to the right auricle. It receives as branches: 1. The *iliac veins, external* and *internal*, which commence in the pelvic cavity, and passing upward along its brim, terminate opposite the sacro-iliac symphisis, by uniting together to form the common iliac vein. 2. The *common iliac* receives the *epigastric* and *circumflexa ilii* immediately above Poupart's ligament; the *lumbar* veins from the loins; the *right spermatic* from the venous plexus in the spermatic cord—in the female the

ovarian, from the ovaries, round ligaments, and Fallopian tubes; the *renal*, or *emulgent*, from the kidneys—the *left spermatic vein* is received by the left renal—and the *supra-renal*, *phrenic*, and *hepatic* from the ramifications of the renal and phrenic arteries and the liver. 3. *Azygos veins;* these comprise the *vena azygos major*, *vena azygos minor*, and *superior intercostal vein*, which form a communicating system between the superior and inferior cava, and return the blood from that part of the trunk in which these vessels are deficient on account of their connection with the heart. The *azygos major* commences in the lumbar region, passes up through the aortic opening in the diaphragm, and, receiving all the right intercostal veins, terminates in the superior cava. The *azygos minor* commences on the left side of the lumbar region, passes beneath the border of the diaphragm, and receiving the six or seven lower left intercostal veins, terminates in the azygos major. The *superior intercostal* is the trunk formed by the union of the five or six upper intercostal veins of the left side. 4. *Vertebral and spinal veins.* The plexuses of the veins of the vertebral column and spinal cord are numerous, and may be grouped into the *dorsi-spinal*, which receive the returning blood from the dorsal muscles and surrounding structures; the *meningeo-rachidian*, which form two longitudinal trunks extending the whole length of the vertebral column, pouring their blood into the sacral, lumbar, vertebral, and intercostal veins; and the *medulli-spinal*. which receive the blood from the membranes of the spinal marrow. 5. *Cardiac veins.* The veins returning the blood from the substance of the heart are named, according to their situation and size, the *grea cardiac*, or *coronary*, *anterior* and *posterior cardiac*, and *venæ Thebesii*

The Portal System.—The veins which return the blood from the chylopoietic viscera constitute the portal system. There are four of them: 1. *Inferior mesenteric;* this receives the blood from the rectum by means of the hemorrhoidal veins, from the sigmoid flexure and descending colon, and terminates in the splenic. 2. *Superior mesenteric;* formed by branches, which collect the blood from the ramifications of the superior mesenteric artery; it unites with the splenic in the formation of the portal vein. 3. *Splenic;* arises from the spleen in several large trunks, passes horizontally behind the pancreas, and unites with the superior mesenteric, receiving in its course the gastric, pancreatic, and inferior mesenteric veins. 4. *Gastric;* the gastric veins correspond with the gastric, gastro-epiploic, and vasa brevia arteries, and terminate in the splenic vein.

The Vena Portæ.—The portal vein is formed by the union of the splenic and superior mesenteric veins behind the pancreas, ascends to the transverse fissure of the liver, where it divides into two branches, one of which is sent to each lateral lobe of that viscus; each primary branch then divides into numerous secondary branches. Within the liver the portal vein receives the venous blood from the capillaries of the hepatic artery.

Fig. 81.

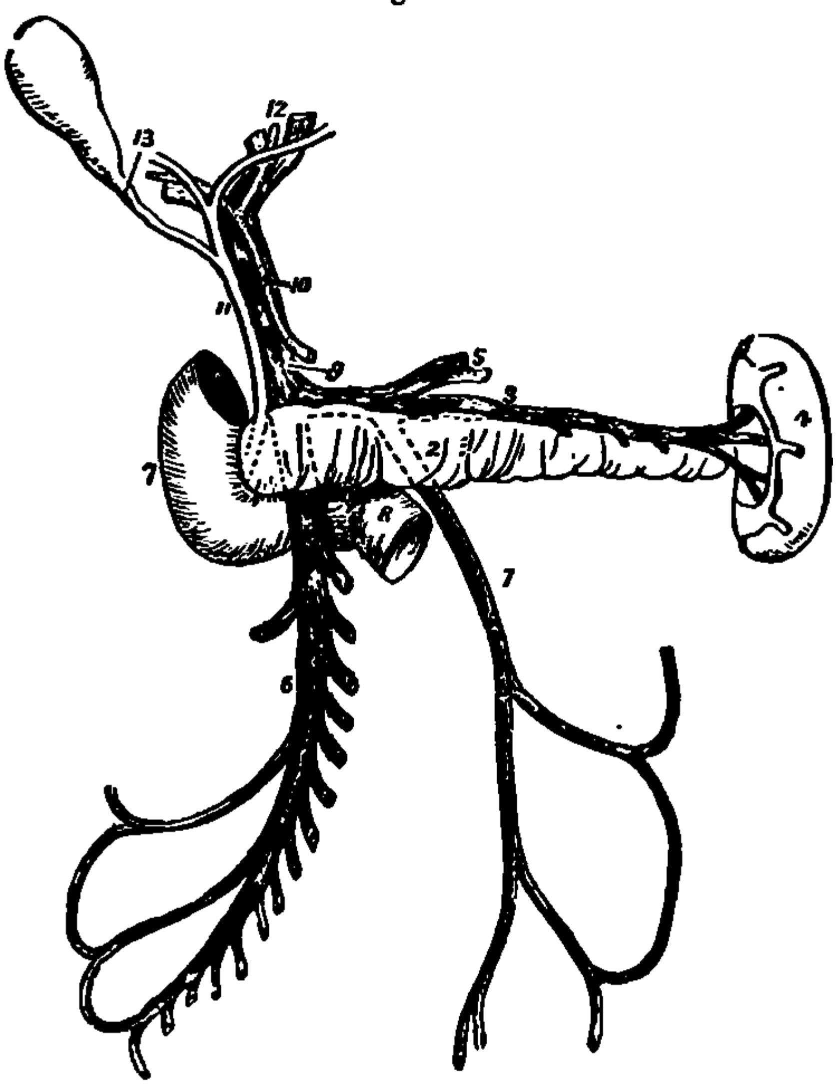


Fig. 81 shows the relations of the vena portæ. 1. Inferior mesenteric vein; the dotted lines trace its course behind the pancreas (2), to terminate in the splenic vein (3). 4. The spleen. 5. Gastric veins opening into the splenic. 6. Superior mesenteric. 7. Descending portion of the duodenum. 8 Its transverse portion. 9. Portal vein. 10. Hepatic artery. 11. The ductus communis choledochus. 12. The division of the duct and vessels at the transverse fissure of the liver. 13. The cystic duct leading to the gall bladder.

THE PORTAL VEIN.

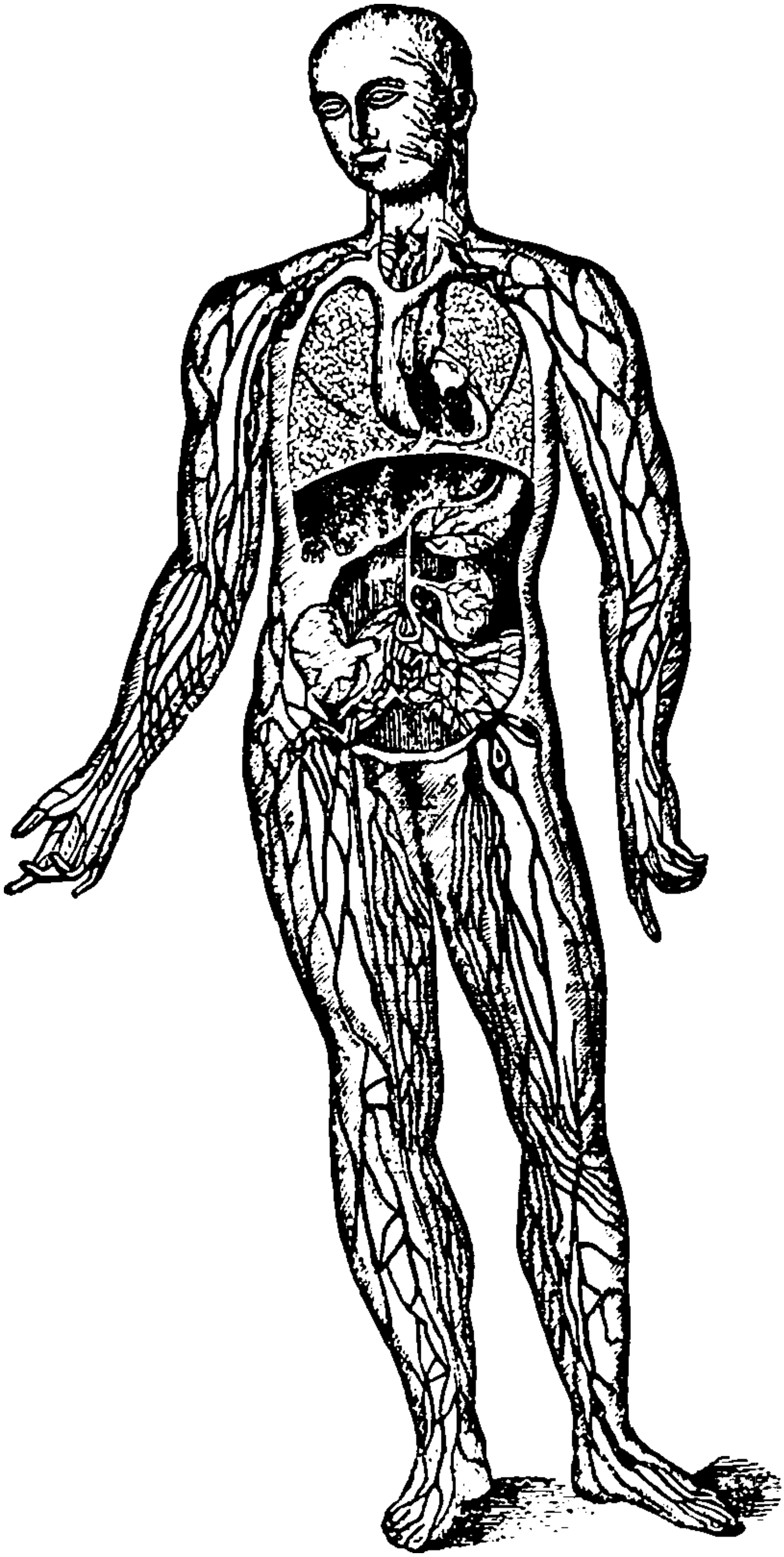
Pulmonary Veins.—The veins which return the arterial blood from the lungs to the left auricle of the heart are four in number. They differ from veins in general, in being but little larger than their corresponding arteries, and in accompanying singly each branch of the pulmonary artery. The right pulmonary veins pass behind the superior cava, and the left behind the pulmonary artery, to the left auricle.

CHAPTER VII.

OF THE LYMPHATICS—ANGEIOLOGY.

The lymphatic vessels constitute what is called the *absorbent* system. They are named from the lymph, or water-like fluid, which they convey. They are minute transparent vessels, uniform in size, having numerous valves, which give them a knotted appearance, and before entering a gland divide into several branches. Their office is to collect the nutritive products of digestion from the alimentary canal, and the effete, disorganized matter from all parts of the body, and convey them into the venous blood near the heart.

Fig. 82.



LYMPHATIC SYSTEM.

Lymphatic vessels originate in a delicate network distributed throughout the skin, the various surfaces and internal structures of organs, and proceed in nearly straight lines toward the root of the neck. They are intercepted in their course by numerous oblong, flattened bodies, called *lymphatic glands*, The vessels entering these glands are called *vasa inferentia*, and those which leave them *vasa efferentia*. These divisions of the lymphatics subdivide just before entering and just after leaving the glands.

Though lymphatic vessels are generally distributed throughout the tissues—probably all the tissues—yet they have never been detected in the brain, spinal cord, eye, bones, cartilages, tendons, membranes of the ovum, umbilical cord, and placenta.

Like arteries and veins, they are composed of three coats. Anastomoses between them occur, though less frequently than with arteries and veins. They are smallest in the neck, larger in the upper, and still larger in the lower extremities.

The *valves* of lymphatic vessels give them a knotty or constricted appearance similar to that of the veins; near the glands the valves are most numerous. The presence of valves is marked by two small dilatations, or pouches, analogous to the valvular sinuses of the veins. These sinuses are always on the side of the valves toward the heart.

Lymphatic glands are composed of a minute plexus of lymphatic vessels, intimately connected with a plexus of blood-vessels, and enclosed in a thin capsule of cellular tissue. In their internal substance numerous convolutions are formed by the lymphatic vessels. In form they are small, oval, somewhat flattened or rounded bodies, termed conglobate, or absorbent, presenting a lobulated appearance on the surface, while the face of a section appears cellular, from the division of the numberless convolutions which are formed by the lymphatic vessels within its substance. These glands are larger in young persons than in the adult, and smallest in old age.

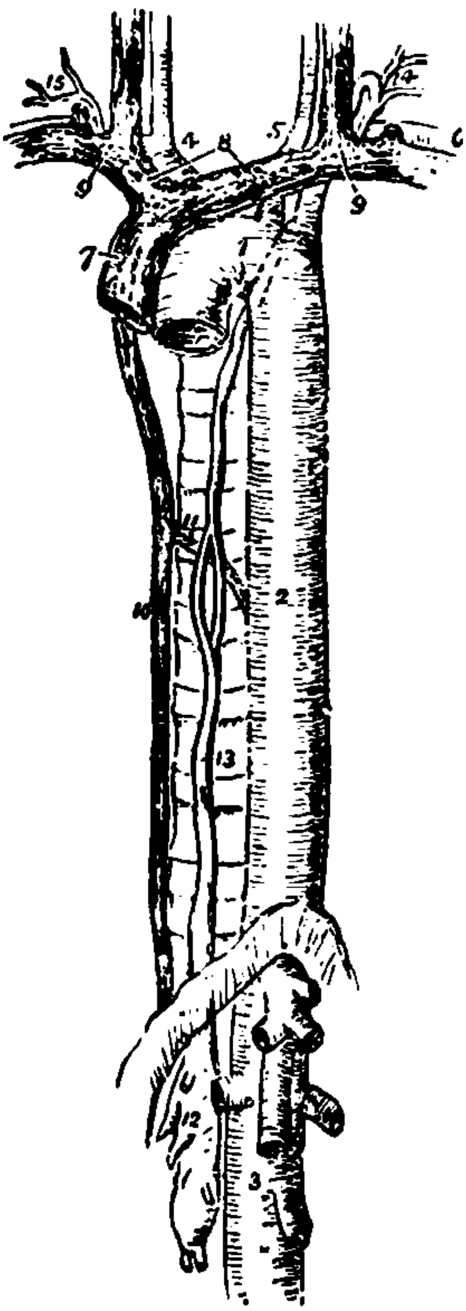
The *lacteals* are the lymphatic vessels of the small intestines, which convey the milk-like fluid, called *chyle*, to the thoracic duct. These are the *nutritive* absorbents, and in their course pass through the numerous glands of the mesentery.

The *superficial lymphatic vessels* follow the course of the veins, passing through the deep fascia in convenient situations to join the deep lymphatics.

The *superficial lymphatic glands* are placed in the most protected situations of the superficial fascia, as in the hollow of the ham and groin, and on the inner side of the arm.

The *deep lymphatics* accompany the deep veins; those from the lower part of the body converging to the glands around the inferior vena cava, and terminating in the thoracic duct. From the upper part of the trunk of the body on the left side, and from the left side of the head and neck, they also proceed to the thoracic duct. But those on the right side of the head and neck, right arm, and right side of the thorax, form a distinct duct, which terminates at the junction of the right subclavian and internal jugular veins.

Fig. 83.



LYMPHATIC CENTRE.

Fig. 83 exhibits the course and termination of the thoracic duct. 1. Arch of the aorta. 2. Thoracic aorta. 3. Abdominal aorta and its branches. 4. Arteria innominata, dividing into right carotid and right subclavian. 5. Left carotid. 6. Left subclavian. 7. Superior cava, formed by the union of 8, the venæ innominatæ, and then by the junction (9) of the internal jugular and subclavian at each side. 10. Greater azygos vein. 11. Termination of the lesser azygos in the greater. 12. Receptaculum chyli; several lymphatic trunks are seen opening into it. 13. Thoracic duct, divided opposite the middle of the dorsal vertebræ into two branches, which soon reunite; the course of the duct behind the arch of the aorta and left subclavian artery is shown by a dotted line. 14. The duct, making its turn at the root of the neck, and receiving several lymphatic trunks before terminating in the venous circulation. 15. Termination of the trunk of the right lymphatic duct.

THE THORACIC DUCT.—This is the centre of the lymphatic system. It commences in the abdomen by a triangular dilatation, called *receptaculum chyli*, which is situated on the front of the body of the second lumbar vertebra. From this it ascends through the aortic opening of the diaphragm to the fourth dorsal vertebra, where it inclines to the left, passes behind the arch of the aorta, ascends by the side of the æsophagus to the root of the neck, and curving forward and downward pours its contents into the venous blood at the junction of the left subclavian with the left internal jugular vein. In size it is about equal to the diameter of a goose-quill. Its termination is provided with valves to prevent the admission of venous blood. It receives as branches four or five large trunks, which unite to form the chylous receptacle, the trunks of the lacteals, a large trunk from the liver; also branches from the thoracic viscera and parieties, and trunks from the left side of the head, neck, and upper extremity.

THE DUCTUS LYMPHATICUS DEXTER.—This is a short trunk which receives the lymphatic vessels from the right side of the head, neck, right arm, right lung, right side of the chest, and some branches from the liver. Like the thoracic duct, it is provided with valves, where it discharges its contents into the veins, at the point before mentioned.

Lymphatics of the Head and Neck.—The principal *superficial glands* are the *occipital*, *posterior auricular*, *parotid*, *zygomatic*, *buccal*, and *submaxillary*, situated as their names indicate, and the *cervical*, extending along the course of the external jugular vein. The *deep glands* are numerous and large around the internal jugular veins and carotid arteries, extending from the base of the skull to the root of the neck.

The *superficial vessels* are disposed in *occipital*, *temporal* and *facial* groups, which converge to the deep cervical, parotid, and submaxillary glands. The *deep vessels* are the *meningeal* and *cerebral*, which pass through foramina at the base of the skull to terminate in the deep cervical glands.

Lymphatics of the Upper Extremity.—The *superficial glands* are few and small in the arm and fore-arm. The principal chain of deep glands accompanies the brachial artery. The *axillary glands* are large and numerous; a small chain of them extends along the lower border of the large pectoral muscle to the mammary gland. They receive the lymphatics of the integuments of the chest and the mammary gland.

The *superficial vessels* commence upon the fingers, and course along the fore-arm to the elbow, where they are arranged in two groups, which extend upward to the axillary glands of the armpit.

The *deep vessels* accompany the blood-vessels, communicate occasionally with the superficial, and enter the axillary and subclavian glands.

Lymphatics of the Lower Extremity.—The *superficial inguinal glands* are those of the groin; the smallest group extends along the course of Poupart's ligament, and receives vessels of the walls of the abdomen, gluteal region, perineum, and genital organs; the largest group clusters around the termination of the internal saphenous vein, and receives the vessels of the lower extremities. The *deep glands* are the *anterior tibial*, *popliteal*, *deep inguinal*, *gluteal*, and *ischiatic*, situated in the regions after which they are named.

The *superficial vessels* are divisible into an *internal* group, commencing on the dorsum of the foot, and ascending the leg along the internal saphenous vein to the glands of the groin, and an *external* group, which commences on the outer side of the foot and back part of the ankle, and accompanies the external saphenous vein to the popliteal glands.

The *deep vessels* follow the deep veins and arteries, and, after joining the deep inguinal glands, communicate with the numerous glands around the iliac vessels.

Most of the efferent lymphatics from the superficial inguinal glands communicate with the large gland in the femoral ring, by which a communication is established between the lymphatics of the trunk and those of the lower extremity.

Lymphatics of the Trunk.—These may be arranged into three groups: 1. *Superficial;* the *superficial vessels* of the upper part of the trunk converge to the axillary glands, and to those at the root of the neck. Those of the lower half of the trunk, gluteal region, perineum, and external organs of generation, converge to the upper group of superficial inguinal glands. 2. *Deep;* the *deep glands* are the *intercostal,* situated on each side of the vertebral column, the *internal mammary,* in the intercostal spaces beside the internal mammary arteries, and the *anterior* and *posterior mediastinal,* situated about the large vessels at the root of the heart, and extending along the course of the aorta and œsophagus in the mediastinum, communicating with the deep cervical, intercostal, and abdominal glands; the *lumbar,* numerously situated around the common iliac vessels, aorta, and vena cava; the *external iliac,* placed around the external iliac vessels; the *internal iliac,* located along the course of the internal iliac vessels, and the *sacral,* placed on the concave surface of the sacrum. The *deep vessels of the thorax* are the *intercostal,* following the course of the intercostal arteries; the *internal mammary,* which commence in the walls of the abdomen, and, communicating with the epigastric, ascend to the root of the neck; the *diaphragmatic,* which pursue the direction of their corresponding veins. The *deep vessels of the abdomen* are continued upward from the thigh, beneath Poupart's ligament, and along the external iliac vessels to the lumbar glands, receiving in their course the epigastric, circumflexa ilii, and ilio-lumbar vessels. Those from the walls of the pelvis and from the gluteal, ischiatic, and obturator vessels, follow the course of the internal iliac arteries, and unite with the lumbar lymphatics; and the lumbar vessels, after receiving all the lymphatics from the lower extremities, pelvis, and loins, terminate by several large trunks of the receptaculum chyli. 3. *Visceral;* the *lymphatic vessels of the lungs* are of large size, distributed throughout their textures and surfaces, and converge to the numerous glands around the roots of the lungs and bifurcation of the trachea. These *bronchial glands* in the adult are of a variable brownish tint, and in old age present a deep black color

Those of the *heart* follow the course of its blood-vessels to the glands around the arch of the aorta, and to the bronchial glands. The *lymphatic vessels of the liver* proceed from its different parts to the glands, along the course of the hepatic artery and lesser curve of the stomach, mediastinal glands, to those situated around the inferior cava, and to the lumbar glands; those from the gall-bladder, which are large, and form a remarkable plexus, enter the glands in the right border of the lesser omentum.

Those of the *spleen* and *pancreas* pass through the splenic glands, and those along the course of the splenic vein, and join the aortic glands before entering the thoracic duct.

Those of the *stomach* proceed variously to the glands along its lesser and greater curves, and to the splenic, pyloric, and aortic glands.

The lymphatics of the *small intestines* are of two kinds: those which run upon the surface and belong to their structure, and those which commence in the substance of the mucous membrane, and are called lacteals. Both enter the *mesenteric glands*. These glands are situated between the layers of the mesentery, in the meshes formed by the superior mesenteric artery. They are most numerous and largest near the duodenum, and near the termination of the ileum.

The *lacteals* commence by tubular mouths, which open into a fine network, situated in the sub-mucous tissue, from whence they proceed to the mesenteric glands, and thence to the thoracic duct.

Those of the *large intestines* proceed in two different directions: the vessels of the cæcum, ascending and transverse colon, traverse their own proper glands, and then enter the mesenteric, and those of the descending colon and rectum proceed to the lumbar glands.

Those of the *kidneys* follow the blood-vessels to the lumbar glands, situated around the aorta and inferior cava; those of the supra-renal capsules, which are very large and numerous, terminate in the renal.

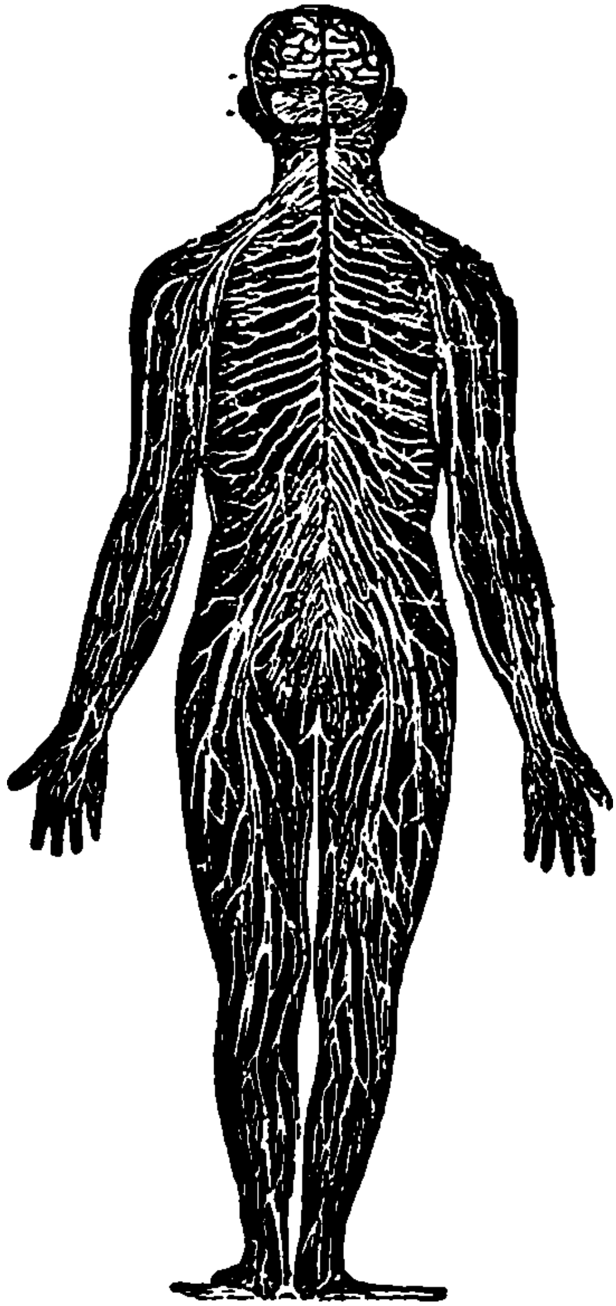
Those of the *pelvic viscera* terminate in the sacral and lumbar glands.

CHAPTER VIII.

OF THE NERVES—NEUROLOGY.

THE nervous system may be divided into two sub-systems—the *cerebro-spinal* and the *organic*. The former comprises the brain, spinal marrow, the nerves of sensation and the nerves of motion; the latter embraces the nerves and ganglions which preside over the development and functional changes of the body; this division of the nervous structure has been called the *sympathetic*, *ganglionic*, and, more properly, the *organic system*. This system is essential to animal existence; the lowest animals are destitute of the cerebro-spinal structure.

Fig. 84.



NERVOUS SYSTEM.

The nervous tissue is enclosed in membranes, or sheaths, and consists of two pulpy materials, one of which is of a white color—the *medullary* substance, and the other gray-colored—the *cineritious* substance. The *medullary structure* is fibrous, the fibres being looped at their terminations, and containing a central stripe, called the *cylinder axis of Purkinje*. The *cineritious* is more vascular, and composed of kidney-shaped globules, containing a vesicular nucleus with a nucleolus. These globules are soft, and of a yellow or brownish color.

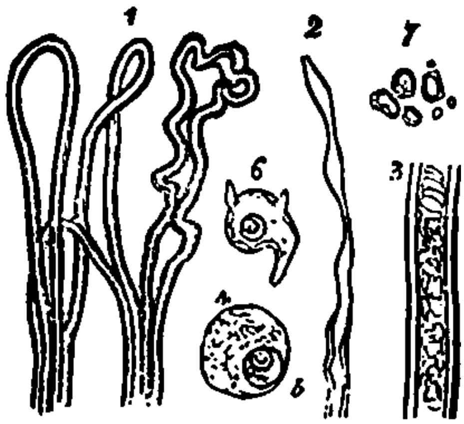
The *ganglions* and *nervous centres* consist of a mixture of white fibres and gray globules. The sheath of the nerves is called *neurilemma*, and the enclosed matter *neurine*. The trunks of nerves frequently interchange trunks or fasciculi, forming *anastomoses;* and a combination of these anastomoses into a network forms a *plexus*.

Numerous small elliptical bodies, attached to the ulnar and digital nerves, are called *Pacinian corpuscles;* these have no terminal loops, being the only exception to the general rule.

Microscopic observation makes out the elements of the nervous system to be, white nerve-fibres, gray nerve-fibres, *nerve-cells*, and *nerve-granules*.

Fig. 85 represents the microscopic elements of the nervous structure. 1. Mode of termination of white nerve-fibres in loops; three of these loops are simple, the fourth is convoluted. The latter is found in situations where a high degree of sensation exists. 2. A white nerve-fibre from the brain, showing the varicose or knotty appearance produced by traction or pressure. 3. A white nerve-fibre enlarged to show its structure, a tubular envelope and a contained substance—neurilemma and neurine. 4. A nerve-cell, showing its composition of a granular-looking capsule and granular contents. 5. Its nucleus containing a nucleolus. 6. A nerve-cell, from which several processes are given off; it contains also a nucleated nucleus. 7. Nerve-granules.

Fig. 85.



MINUTE NERVOUS STRUCTURE.

White nerve-fibres compose most of the brain, spinal cord, and cerebro-spinal nerves, and enter into the structure of the organic system. They terminate in the various internal organs, at the surface of the body, and in the substance of the cerebro-spinal axis, by forming loops. In size they vary from $\frac{1}{2000}$ to $\frac{1}{14000}$ of an inch in diameter.

Gray nerve-fibres are smaller in diameter, and less transparent. They constitute the principal part of the organic system, and are also present in the cerebro-spinal nerves, most abundantly in those of sensation.

The *nerve-cells* vary from $\frac{1}{300}$ to $\frac{1}{1250}$ of an inch in diameter. They are composed of a capsular sheath, containing a reddish-gray granular substance, and one or more nuclei and nucleoli, the nucleus being attached to the sheath. Nerve-cells are found in the gray substance of the brain and spinal cord, in the ganglions of the cerebro-spinal nerves, and in the organic nerves and their ganglia. From the circumference of the nerve-cells arise one or more delicate thread-like processes, from $\frac{1}{1000}$ to $\frac{1}{10000}$ of an inch in diameter, which are the origins of the gray nerve-fibres.

The *nerve-granules* exist in the forms of minute homogeneous particles, aggregated particles, and nucleated corpuscles, varying in diameter between $\frac{1}{6000}$ and $\frac{1}{15000}$ of an inch. They serve as a bond of connection between the fibres and cells of the brain and spinal cord, and enter into the various ganglia.

A *nerve* is a collection of nerve-fibres into small bundles, or fasciculi; each fasciculus being invested by a distinct neurilemma. Several of these fasciculi are again collected into larger bundles, which are also enclosed in a separate neurilemma; then again the larger fasciculi are collected into a grand bundle, which is enclosed in a general neurilemma, or sheath, of white fibrous tissue

THE BRAIN.

The brain is the mass of nervous substance contained within the cranium. It is divided into *cerebrum*, *cerebellum*, and *medulla oblongata*. Its investing membranes are called *dura mater*, *arachnoid*, and *pia mater*. The brain and its membranes together constitute the *encephalon*.

Membranes of the Brain.—The external covering is the *dura mater*, a strong, whitish fibrous membrane which adheres to the internal surface of the cranium, and is prolonged into the spinal column under the name of *theca vertebralis;* but there it is not adherent to the bones. From its internal surface processes extend inward to support and protect different parts of the brain, and externally other processes for sheaths for the nerves passing out of the skull and spinal column. Its internal processes are the *falx cerebri*, which extends vertically across the median line from the crista galli of the ethmoid bone to the tentorium, dividing the cerebrum into *right* and *left hemispheres;* the *tentorium*, which stretches horizontally across the cranium, separating the cerebrum from the cerebellum; and the *falx cerebelli*, which divides the cerebellum into two lobes or hemispheres.

The *arachnoid membrane* is the middle covering and the serous membrane of the cerebro-spinal centre. It is very thin and transparent. It surrounds the nerves until their exit from the brain, where it is reflected back upon the dura mater. It does not enter into the ventricles.

The *pia mater* s the internal covering, vascular, consisting of innumerable blood-vessels held together by a thin layer of cellular tissue. It invests the whole brain and each of its convolutions by extending through all the fissures between them. It contains usually a number of small granular bodies, called the *glandulæ Pacchioni;* these are larger in old persons, and are considered by some anatomists to be of morbid origin. The pia mater is the nutrient membrane of the brain.

The Cerebrum.—The cerebral portion of the brain is an oval mass divided superiorly into two hemispheres by the great longitudinal fissure. Each hemisphere is divided on its *under surface* into *anterior*, *middle*, and *posterior lobes*. The *anterior* rests upon the roof of the orbit, the middle is received into the middle fossa at the base of the skull, and the posterior is supported by the tentorium. The surface of the cerebrum presents a number of slightly convex elevations, constituting the convolutions, called *gyri*, which are separated from each other by sulci or fissures of various depths. The interior cerebral substance is medullary, and the exterior cineritious to the depth of one or two lines

The external surface of the cerebrum is seen in Fig. 86. *a a.* The scalp turned down. *b b.* Cut edges of the skull bones. 3. The dura mater suspended by a hook. 4. The left hemisphere.

Fig 86.

THE BRAIN EXPOSED.

The anatomical distinctions of the cerebrum are the following:

Crura cerebri; two thick white cords diverging from the anterior border of the pons varolii, their fibres terminating in the hemispheres. A layer of medullary matter occupies a triangular space between them, which is called the *locus perforatus.*

Eminentiæ mammillares; two white globular bodies, near the size of a pea, between the crura and in front of the locus perforatus.

Tuber cinereum; a soft gray mass in front of the eminentiæ mammillares, and behind the chiasm of the optic nerves.

Infundibulum; a hollow, conical, reddish body resting on the tuber cinereum, and attached by its apex to the pituitary gland.

Pituitary gland; a vascular mass, consisting of two lobes, which occupies the sella turcica.

Longitudinal fissure; the sulci which separates the hemispheres laterally, and contains the falx cerebri.

Corpus callosum; a white arched band, forming the *great commissure* between the two hemispheres at the bottom of the longitudinal fissure. It is about an inch broad and three and a half inches long. Its fibres are mostly medullary matter; a few, however, are cineritious; these pass longitudinally, and are called the *raphé.*

Septum lucidum; a vertical partition separating the lateral ventricles. It is in contact superiorly with the corpus callosum, and below with the fornix.

Fornix; a triangular arch, the base of which is continuous with the corpus callosum behind; its apex divides into two *crura,* which terminate in the eminentia mammillares; its under surface is called *lyra.* Under these crura is the *foramen of Munro,* which communicates between the third and the two lateral ventricles.

Velum interpositum; a triangular process of pia mater under the fornix, containing in its edges a plexus of veins, called *plexus choroides.*

Pineal gland; a small, reddish-gray, conical body, situated upon the tubercula quadrigemina, and connected with the optic tubercles by two *crura.* This little thing is memorable from having been regarded by the ancients as the seat of the soul.

Tubercula quadrigemina; four prominences over the junction of the pons and crura cerebri. Under them is a passage between the third and fourth ventricles, called the *aqueduct of Sylvius,* or *iter a tertio ad ventriculum quartum.*

Corpus striatum; a gray oblong mass medullary within, situated in each lateral ventricle.

Thalamus opticus; an oval body behind the corpus striatum on each side. It is a mixed mass of medullary and cineritious matter, and has three prominences, called *corpora geniculata.* It is connected with its fellow by a gray substance, which is called the *soft commissure.*

Tenia striata; a thin slip of medullary matter occupying the groove between the corpus striatum and thalamus opticus.

Hippocampus major; a scroll extending into the inferior cornu of the lateral ventricle; its extremity resembles a foot, and is called the *pes hippocampi.*

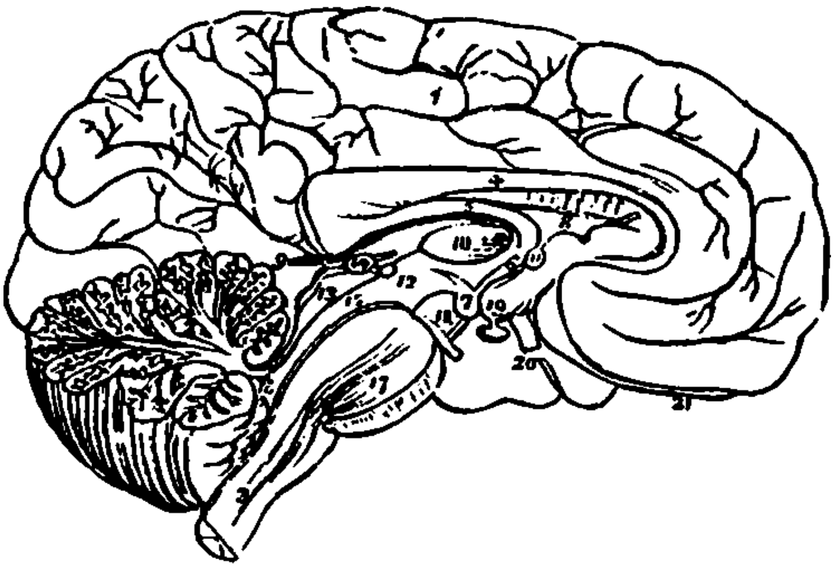
Corpus fimbriatum; a thin edge of medullary matter on the concave side of the hippocampus major; beneath it is a layer of cineritious substance, having a serrated appearance, called the *fascia dentata.*

Hippocampus minor; a conical elevation, resembling the spur of a cock, pointing backward into the posterior cornu.

Ventricles; five in number. The *lateral* exist in each hemisphere, and contain the corpus striatum and thalamus opticus; the roof is formed by the corpus callosum. In each are three angular depressions, called *cornua;* the posterior contains the hippocampus minor, the inferior the hippocampus major, the anterior is vacant. They are partially separated by the septum lucidum, but communicate with each other and with the third by the foramen of Munro. The *third ventricle* is the space between the thalami optici. Its roof is formed of the velum interpositum and fornix, and its floor by the locus perforatus and the tuber cinereum. Its front is traversed by the anterior commissure, a medullary cord extending between the corpora striata, and by the posterior commissure, which extends transversely between the thalami optici. It communicates with the fourth by the aqueduct of Sylvius, and with the lateral by the foramen of Munro. The *fourth ventricle* is situated between the pons Varolii, cerebellum, and medulla oblongata. Its floor is the calamus scriptorius, and its roof is the *valve of the brain*

It communicates only with the third Laterally it is limited by the pia mater and arachnoid. The *fifth ventricle* is situated between the laminæ of the septum lucidum, and has no communication with the others.

Fig. 87.



MESIAL SURFACE OF THE BRAIN

Fig. 87 represents the mesial surface of a longitudinal section of the brain. 1. Inner surface of left hemisphere. 2. Divided centre of the cerebellum, showing the arbor vitæ. 3. Medulla oblongata. 4. Corpus callosum. 5. Fornix. 6. One of the crura of the fornix. 7. One of the corpora albicantia, pea-shaped bodies between the crura cerebri. 8. Septum lucidum. 9. Velum interpositum. 10. Section of the middle commissure in the third ventricle. 11. Section of the anterior commissure. 12. Section of the posterior commissure. 13. Corpora quadrigemina. 14. Pineal gland. 15. Aqueduct of Sylvius. 16. Fourth ventricle. 17. Pons Varolii, through which are seen passing the diverging fibres of the corpora pyramidalia. 18. Crus cerebri of the left side; the third nerve arising from it. 19. Tuber cinereum, from which projects the infundibulum, having the pituitary gland appended to its extremity. 20. One of the optic nerves. 21. The left olfactory nerve terminating anteriorly in a rounded bulb.

THE CEREBELLUM.—The cerebellar portion constitutes one sixth or one seventh of the brain. It is an oblong, flattened body, situated between the occiput and tentorium. Its external substance is cineritious, and the internal medullary. It is divided by a longitudinal fissure into two hemispheres; in the upper part of this fissure is a ridge, called *vermis superior;* in front of this is an elevation, called *monticulus;* in the lower part of the fissure is a smaller ridge, called *vermis inferior*. Two small protuberances are seen at the root of the crura cerebelli, the lower of which is called *lobulus amygdaloides*, and the upper *lobulus nervi pneumogastrici*. Extending from the lower surface of the cerebellum to the *corpora restiformia* is a thin gray plate, called *the valve of the brain*. The substance of the cerebellum, on a section being made in either lobe, presents an arborescent arrangement of medullary matter, called *arbor vitæ*. A gray mass in the trunk of this medullary tree, with serrated edges, is called *corpus dentatum*. The cerebellum is associated with the rest of the encephalon by means of three pairs of rounded cords, called *superior*, *middle*, and *inferior peduncles*. Its two hemispheres are united by the commissure called *pons Varolii;* this consists of transverse fibres, separated into two layers by the fasciculi of the corpora pyramidalia and corpora olivaria. These two layers, the upper and lower on each side, are collected together to form the *crura cerebelli.*

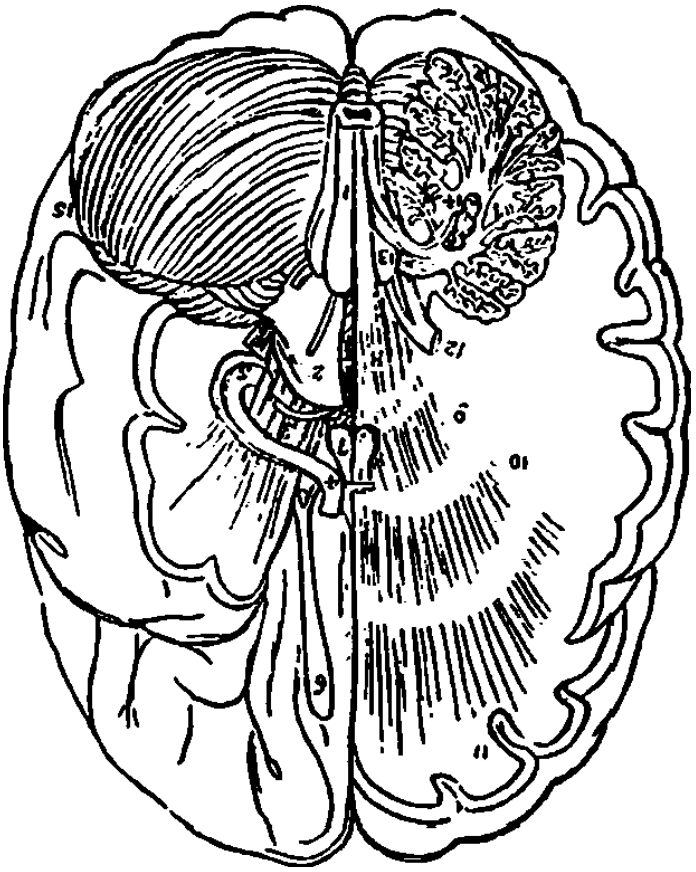
THE MEDULLA OBLONGATA.—This is the upper enlarged part of the spinal cord, about an inch in length, conical in shape, extending from the pons Varolii to the atlas. It is separated anteriorly and posteriorly by vertical fissures into two symmetrical lateral cords, or columns, each column being subdivided by small grooves into three smaller cords; these are the *corpora pyramidalia,* two narrow tapering cords on either side of the anterior fissure, whose fibres decussate freely about an inch below the pons; the *corpora olivaria,* two oblong convex bodies, half an inch in length, behind the corpora pyramidalia, from which they are separated by a fissure—a section of them exhibits an arrangement of cineritious matter, called corpus fimbriatum; and the *corpora restiformia,* which comprehend the posterior half of each lateral column. That part of the posterior fissure between them is called *calamus scriptorius,* across which pass transverse fibres of medullary matter. Two slightly convex columns of the medulla oblongata, which enter into the formation of the floor of the fourth ventricle, are called *funiculi teretes,* or *posterior pyramids.*

The fibres composing the columns of the medulla oblongata have a peculiar arrangement on its upper part; those of the corpora pyramidalia and olivaria enter the pons Varolii, and are prolonged through the crura cerebri, thalami optici, and corpora striata to the hemispheres of the cerebrum; while those of the corpora restiformia are reflected backward into the cerebellum, and form its inferior peduncles. These fibres were termed by Gall the *diverging fibres.* They constitute both the cerebrum and cerebellum; while another set of fibres, called *converging,* associate their symmetrical halves and distant parts of the same hemispheres. These converging fibres constitute the *commissures* of the brain already mentioned. The corpus callosum is the commissure of the hemispheres; the fornix, septum lucidum, the bodies called anterior, middle, and posterior commissures, and the peduncles of the pineal gland, connect different parts of the cerebrum, while the pons Varolii connects the hemispheres of the cerebellum.

The gray matter which is intermixed with the white fibres of the medulla oblongata was regarded by Gall and Spurzheim as the channels of nutrition; this supposition is strengthened by the great vascularity of the former substance, which enables it to convey a large proportion of the elements of growth and development.

In Fig. 88 are seen several sections of the base of the brain, the distribution of the diverging fibres. 1. Medulla oblongata. 2. Half of the pons Varolii. 3. Crus cerebri, crossed by the optic nerve (4), and spreading out into the hemisphere, where it is called *corona radiata*. 5. Optic nerve. 6. Olfactory nerve. 7. Corpora albicantia. 8. Fibres of the corpus pyramidale passing through the pons. 9. The fibres passing through the thalamus opticus. 10. The fibres passing through the corpus striatum. 11. Their distribution to the hemisphere. 12. Fifth nerve. 13. Fibres of the corpus pyramidale, which pass outward with the corpus restiforme into the cerebellum. 14. Section through one of the hemispheres of the cerebellum, showing a body called corpus rhomboideum in the centre of its white substance, and the arbor vitæ. 15. The opposite hemisphere.

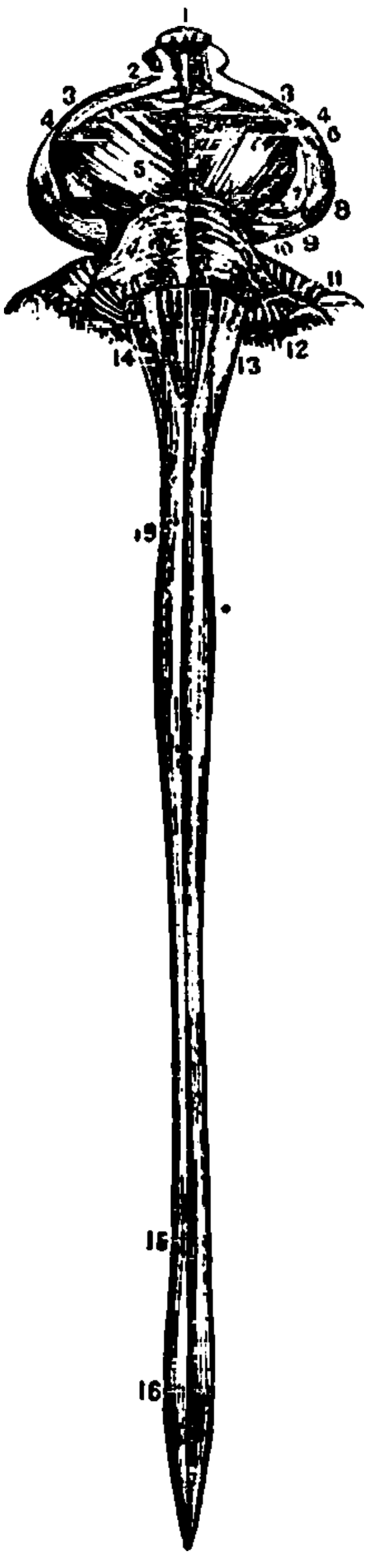
Fig. 88.



BASE OF THE BRAIN.

THE SPINAL CORD.—The spinal column contains the *spinal cord*, *medulla spinalis*, its *membranes*, and the *roots* of the *spinal nerves*. Its outer membrane is the *theca vertebralis*, continuous with the dura mater of the skull; the central is the *arachnoid*, a continuation of the serous membrane of the brain, and the internal is the prolongation of the *pia mater*, which is more firm and fibrous, and less vascular, than in the brain. The anterior are separated from the posterior roots of the spinal nerves throughout the entire length of the cord, by their processes of pia mater, called *membrana dentata*. A transverse section of the spinal marrow exhibits an arrangement of gray matter internally and medullary externally. It extends from the pons Varolii to the first or second lumbar vertebra, where it terminates in a rounded point. Its diameter varies in different parts, and exhibits three enlargements, the uppermost being the *medulla oblongata*, the middle corresponding with the origin of the nerves of the upper extremities, and the lower corresponding with the origin of nerves that supply the lower extremities. It is divided into lateral halves by *anterior* and *posterior longitudinal fissures*, which extend deeply into its substance. Each lateral half is divided by a lateral sulcus, or fissure, into anterior and posterior columns, the anterior giving origin to the nerves of *motion*, and the posterior to those of *sensation*. Another slight fissure indicates

Fig. 89.



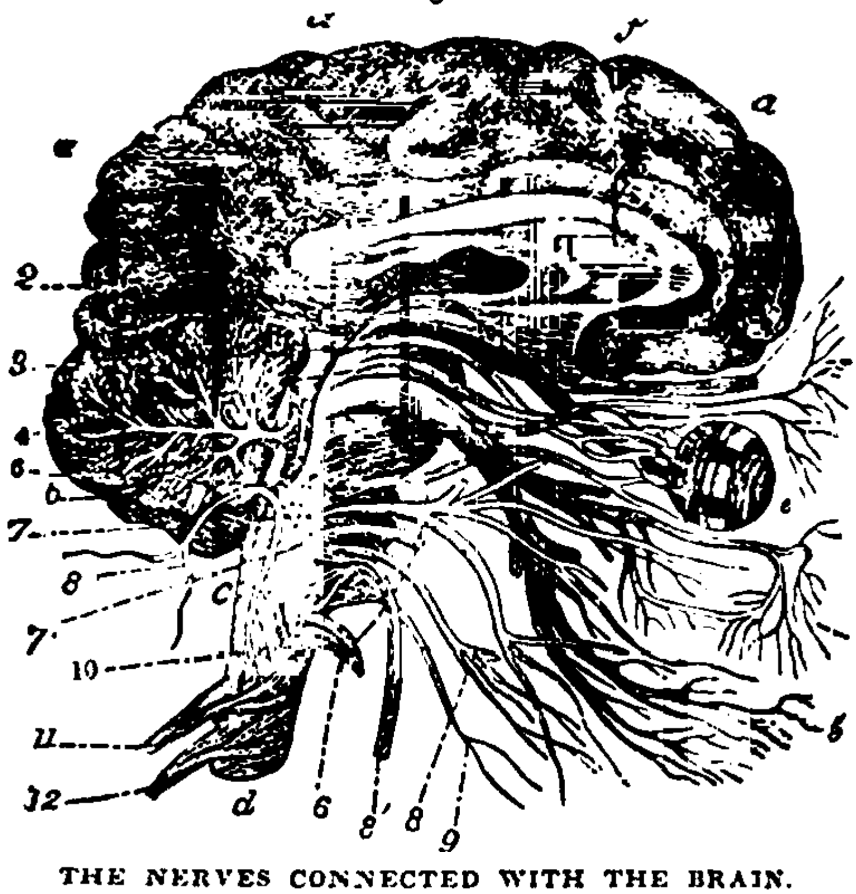
SPINAL CORD.

a middle lateral column, which Sir Charles Bell supposed to pertain to the respiratory nerves, though such functional arrangement has not yet been demonstrated.

In Fig. 89 are seen the relations of the spinal marrow to the medulla oblongata, pons Varolii, and cerebellum, as well as the several enlargements in its course.

THE CRANIAL NERVES.—These are so called from their emerging through the foramina at the base of the cranium. There are *nine pairs* of them, all of which are named numerically and functionally.

Fig. 90.



THE NERVES CONNECTED WITH THE BRAIN.

Fig. 90 shows the origin of the cranial nerves. The numbers are placed against the corresponding pairs of nerves. 11 and 12 are spinal nerves. *a a a*. Cerebrum. *b*. Cerebellum. *c*. Medulla oblongata. *d*. Medulla spinalis. *f*. Corpus callosum.

First Pair—Olfactory; the nerves of smelling. Each arises by three roots, which unite in the fissure of Sylvius; passing forward it enlarges into a bulbous mass of white and gray substance, which rests on the cribriform plate of the ethmoid bone. From this *bulbous olfactorius* the nerves are given off which are distributed upon the mucous membrane of the nose.

Second Pair—Optic; the nerves of seeing. Each is a large cord arising from the thalamus opticus and tubercula quadrigemina, winding around the crus cerebri as a flattened band, under the name of *tractus opticus*, joining its fellow in front of the *tuber cinereum*, forming a chiasm called the *optic commissure*, then proceeding forward it diverges from its fellow, and passes through the optic foramen to the eyeball, pierces the sclerotic and choroid coats, and expands into the nervous membrane called the *retina*.

Third Pair—Motores oculorum; nerves of motion. They arise from the crus cerebri, pass forward between the posterior cerebral and superior cerebellar artery, and through the sphenoidal foramen to be distributed to all the muscles of the eyeball except the external rectus and superior oblique. Each sends a branch to the ophthalmic ganglion, from which proceed the ciliary nerves that supply the iris.

Fourth Pair—Pathetici; nerves of motion, and the smallest of the cerebral. Each patheticus arises from the valve of the brain (valve of Viessens), winds around the crus cerebri, passes along the cavernous sinus, and entering the orbit at the sphenoidal fissure, is distributed to the superior oblique muscle. In the sinus it gives off a *recurrent branch* to the lining membrane.

In Fig. 91 is seen the distribution of the fifth pair of nerves. 1. Orbit. 2. Antrum of the upper jaw. 3. Tongue. 4. Lower jaw. 5. Root of the fifth pair, forming the ganglion of Casser. 6. Ophthalmic branch. 7. Superior maxillary. 8. Inferior maxillary. 9. Frontal branch. 10. Lachrymal. 11. Nasal. 12. Internal nasal. 13. External nasal. 14. External and internal frontal. 15. Infra-orbitary. 16. Posterior dentals. 17. Middle dental. 18. Anterior dental. 19. Labial and palpebral branches of the infra-orbital. 20. Orbitar. 21. Pterygoid. 22. Masseter, temporal, pterygoid, and buccal branches. 23. Lingual branch, joined at an acute angle by the chorda tympani. 24. Inferior dental, terminating in 25. Mental branches. 26. Superficial temporal. 27. Auricular branches. 28. Mylo-hyoid branch.

Fig. 91.

TRIFACIAL NERVES.

Fifth Pair—Trifacial; the largest cranial nerves, and the principal nerves of sensation of the head and face, arise, like the spinal nerves, from two roots.

Each trifacial commences in a tract of yellowish matter in front of the floor of the fourth ventricle, and passing forward through an opening in the border of the tentorium, near the extremity of the petrous bone, spreads out into a large semilunar ganglion, called *Casserian*, the anterior root, which is much the smallest, merely lying against the under surface, but not forming a part of the ganglion. This ganglion divides into the ophthalmic, superior maxillary, and inferior maxillary branches.

The *ophthalmic nerve* is a short trunk, three fourths of an inch long; it passes out at the sphenoidal foramen, and divides into three branches; the *frontal* passes through the supra-orbiter foramen to the integument of the forehead, supplying also the conjunctiva and upper eyelid; it gives off a *supra-trachlear* branch to the inner angle of the eye and root of the nose. The *lachrymal* is the smallest branch, and is distributed to the lachrymal gland, temple, cheek, and inner portions of the orbit. The nasal passes forward between the two heads of the external rectus muscle, and enters the nose by the opening at the side of the crista galli, where it divides into an *internal* branch, supplying the anterior part of the mucous membrane, and an *external*, distributed to integuments at the extremity of the nose. Within the orbit the nasal nerve gives off a *ganglionic* branch, which forms the superior long root of the ciliary ganglion, *ciliary branches* to the iris, and an *infra-trochlear* to the lachrymal sac, caruncula lachrymalis, conjunctiva, and inner angle of the orbit.

The *superior maxillary nerve* passes through the foramen rotundum, crosses the spheno-maxillary fossa, enters the canal in the floor of the orbit, emerges on the face through the infra-orbital foramen, where it divides into several branches, distributed to the lower eyelid and conjunctiva, muscles, and integument of the upper lip, nose, and cheek, forming a plexus with the facial nerves. The *orbital* branch traverses the infra-orbital canal, and enters the orbit at the infra-orbital foramen, where it divides into a *temporal* branch, which passes through a canal in the malar bone to supply the integuments of the temple region, and a *malar* branch, which emerges upon the cheek through an opening in the malar bone, to communicate with branches of the infra-orbital and facial nerves. Two branches ascend from Meckel's ganglion, and join the orbital nerve as it crosses the spheno-maxillary fossa, called pterygo-palatine. The *posterior dental* branches pass through small foramina in the back surface of the upper jaw, and run forward to the base of the alveolus, supplying the back teeth and gums. The *middle* and *anterior dental* branches descend to the corresponding teeth and gums; previously to their distribution the dental nerves form a plexus in the outer wall of the upper maxillary bone, above the alveolus, from which filaments are given off to the pulps of the teeth, gums, mucous membrane of the nose, and palate.

The Inferior Maxillary Nerve is the largest division of the fifth pair; it emerges at the foramen ovale, and divides into external and internal trunks. The *external* divides into five branches—the *masseteric*, two *temporal*, *buccal*, and *internal pterygoid*, all of which are distributed to the muscles of the temporal and maxillary regions; the last-named branch is connected by filaments with the otic ganglion. The *internal* trunk divides into three branches; the *gustatory*, which is distributed by numerous filaments to the papillæ and mucous membrane of the tongue; the *inferior dental*, which proceeds to the dental foramen, which it enters, and runs along the canal of the lower jaw, supplying the teeth and gums, and terminating in two branches; *incisive*, which goes to the front teeth; and *mental*, which passes out at the mental foramen, to be distributed to the muscles and integuments of the chin and lower lip; the inferior dental gives off a *mylo-hyoidean* branch to the mylo-hyoid and digastric muscles; and the *anterior auricular*, which originates by two roots, passes backward behind the articulation of the lower jaw, where it forms a plexus, from which an *ascending* or *temporal* branch is given off to the temporal region, and a *descending* branch, which supplies the parotid gland and external parts of the ear, supplying a few filaments to the tympanum.

Sixth Pair—Abducentes; nerves of motion; each arises from the corpus pyramidale, proceeds forward parallel with the basilir artery, and, ascending, passes through the cavernous sinus; entering the orbit through the sphenoidal fissure to be distributed to the external rectus muscle. A palsy of this nerve produces internal squinting.

Seventh Pair—Facial and Auditory; nerves of motion; the seventh pair consists of two nerves; the smaller and internal is the *facial*, or *portio dura*, arising from the corpus restiforme; the larger and external is the *auditory*, or *portio mollis*, arising from the calamus scriptorius. The *facial nerve* enters the meatus auditorius internus along with the auditory, passes through the canal called aqueduct of Fallopius, and emerges at the stylo-mastoid foramen, then penetrates the parotid gland, and at the ramus of the lower jaw divides into *temporo-facial* and *cervico-facial* trunks, which split into numerous branches, forming looped communications, called *pes anserinus*, to be distributed upon the side of the face from the temple to the neck; in its course it communicates extensively with the neighboring branches of nerves; it also sends off the following branches: *tympanitic*, to the stapedius muscle; *chorda tympani*, to the tympanum, which it crosses, and, passing through the fissura Glasseri joins the gustatory nerve between the pterygoid muscles, with which it descends to the submaxillary ganglion; the *posterior auricular*, to the muscles of the ear; the *stylo-hyoid* and *digastric*, to those muscles. The *auditory nerve* divides at the bottom of the meatus into *cochlear* and *vestibular* branches, which are distributed to the internal ear.

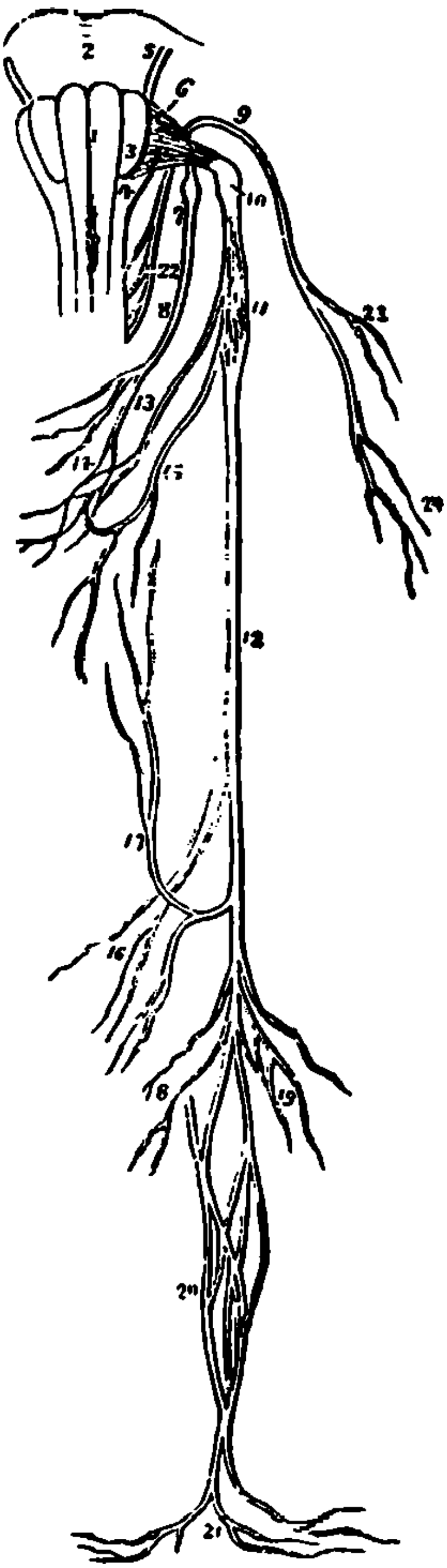
Eighth Pair; consists of three nerves; glosso-pharyngeal, pneumogastric, and spinal accessory, which some authors reckon as the ninth, tenth, and eleventh pairs.

The *glosso-pharyngeal nerve* arises from the groove between the corpus olivare and restiforme, emerges at the foramen lacerum posterius, and curves forward to be distributed to the mucous membrane of the base of the tongue and fauces, tonsils, and mucous glands of the mouth. Within the jugular fossa it presents a ganglionic enlargement, called *ganglion jugulare;* near its origin is also a small ganglion, called *petrosal*, or *Anderschian*. Its branches are: *Communicating*, which proceed from the petrosal ganglionic plexus, and, in common with those of the facial and sympathetic, form a complicated plexus at the base of the skull; *tympanitic* (Jacobson's nerve), which proceeds from the petrosal ganglion, and, entering the bony canal in the jugular fossa, divides into six branches, distributed upon the inner wall of the tympanum, forming a plexiform communication (tympanic plexus) with the sympathetic and fifth pair; it sends branches of *distribution* to supply the fenestra rotunda, fenestra ovalis, and Eustachian tube, and *communicating* branches to the carotid plexus, otic ganglion, and petrosal branch of the Vidian nerve; the *muscular*, which are sent to the stylo-pharyngeas, stylo-hyoid, and digastric muscles; the *pharyngeal*, which are distributed to the pharynx; the *lingual*, which go to the base of the tongue, fauces, and epiglottis; and the *tonsillitic*, which form a plexus around the base of the tonsils, and supply filaments to the fauces and soft palate.

The *pneumogastric nerve* arises immediately below the former, and emerges from the skull through the same foramen; soon after passing from the skull it enlarges into a ganglion, *plexus gangliformis*, nearly an inch in length, surrounded by an irregular plexus of white nerves which communicate with each other, with other divisions of the eighth pair, and with the trunk of the pneumogastric below. Descending to the root of the neck, the *right* pneumogastric passes between the subclavian artery and vein to the posterior mediastinum, then behind the root of the lung to the œsophagus, which it accompanies to the stomach. The *left* enters the chest parallel with the left subclavian artery, crosses the arch of the aorta, and descends behind the root of the lung, and along the anterior surface of the œsophagus to the stomach.

In Fig. 92 is seen a representation of the origin and distribution of the eighth pair. 1, 3, 4. Medulla oblongata. 1 is the corpus pyramidale of one side. 3. Corpus olivare. 4. Corpus restiforme. 2. Pons Varolii. 5. Facial nerve. 6. Origin of the glosso-pharyngeal. 7. Ganglion of Andersch. 8. Trunk of the nerve. 9. Spinal accessory nerve. 10. Ganglion of the pneumogastric. 11. Its plexiform ganglion. 12. Its trunk. 13. Its pharyngeal branch forming the pharyngeal plexus (14), assisted by a branch from the glosso-pharyngeal (8), and one from the superior laryngeal (15). 16. Cardiac branches. 17. Recurrent laryngeal branch. 18. Anterior pulmonary branches. 19. Posterior pulmonary branches. 20. Œsophageal plexus. 21. Gastric branches. 22. Origin of the spinal accessory. 23. Its branches distributed to the sterno-mastoid muscle. 24. Its branches to the trapezius muscle.

Fig. 92



EIGHTH PAIR OF NERVES

The branches of the pneumogastric are: *Communicating*, which connect with the facial, glosso-pharyngeal, spinal accessory, hypo-glossal, and sympathetic; *auricular*, which passes through a small canal in the petrous portion of the temporal bone to the pinna, sending filaments to the facial; *pharyngeal*, which assists to form, on the middle constrictor muscle, the pharyngeal plexus, which is distributed to the muscles and mucous membrane of the pharynx; the *superior laryngeal*, distributed to the arytenoideus muscle and mucous membrane of the larynx, communicating behind the cricoid cartilage with the recurrent laryngeal, and giving off the *external laryngeal*, which sends a twig to the pharyngeal plexus, and supplies the inferior constrictor and circo-thyroid muscles and thyroid gland; *cardiac*, two or three branches which cross the lower part of the common carotid, to communicate with the cardiac branches of the sympathetic, and with the great cardiac plexus; *recurrent laryngeal*, which passes upward from near the pulmonary branches to the larynx, giving off branches to the heart, lungs, œsophagus, and trachea, and is distributed to all the muscles of the larynx, except the circo-hyroid, communicating with the superior and external laryngeal and sympathetic nerves; *anterior pulmonary*, distributed to the anterior aspect of the root of the lungs, and forming, with the branches of the great cardiac plexus, the *anterior pulmonary* plexus; *posterior pulmonary*, which supply the posterior aspect of the root of the lungs, and forming, with branches from the great cardiac plexus, the *posterior pulmonary plexus;* and the *gastric*, which are the terminal filaments of the two pneumogastric nerves, spread out upon the anterior and posterior surfaces of the stomach, and also distributed to the omentum, spleen, pancreas, liver, and gall-bladder, communicating with the solar plexus.

NOTE.—The superior laryngeal nerve is regarded by some anatomists as the *nerve of sensation* to the larynx, being distributed mainly to its mucous membrane. The recurrent is the proper motor nerve of the larynx, being distributed to its muscles. The two pneumogastric nerves divide into numerous branches upon the œsophagus, which communicate with each other, and form the *œsophagal plexus.*

The *spinal accessory* nerve arises from the spinal cord as low down as the fourth cervical nerve, escapes at the jugular foramen, and divides into two branches, one of which sends filaments to the superior pharyngeal nerve, and the other, which is the proper continuation of the nerve, descends obliquely backward, and piercing the sterno-mastoid muscle, is distributed to the trapezius, communicating with the upper cervical nerves.

Ninth Pair—Hypoglossal; nerves of motion; each arises from the groove between the corpus pyramidale and corpus olivare, by numerous filaments which unite into two bundles, and emerge from the cranium at the anterior condyloid foramen; then passing between the internal carotid artery and internal carotid vein, and curving around the occipital artery, sends branches to the muscles of the tongue, being distributed principally to the genio-hyo-glossus. Its branches are: *communicating*, which connect with the pneumogastric spinal accessory, cervical and sympathetic; *descendens noni*, a long, slender twig which descends upon the sheath of the carotid vessels, forming a loop with a long branch from the second and third cervical, from the convexity of which branches are sent off to the sterno-hyoid, sterno-thyroid, and omohyoid muscles; and *thyro-hyoidean*, distributed to the thyro-hyoid muscle.

THE SPINAL NERVES.—Of these there are thirty-one pairs, each arising by two roots, an anterior motor and a posterior sensitive; the posterior are larger, and have more numerous filaments than the anterior. In the intervertebral foramina the posterior roots enlarge into a ganglion, after which both roots unite and form a spinal nerve, which passes out of the foramen, and then divides into an *anterior* branch, which supplies the front portion of the body, communicating with the ganglions of the sympathetic, and forming plexuses which give off the principal nerves to the muscles of the trunk and extremities, and a *posterior*, which supplies the muscles of the back. The spinal nerves are divided into *cervical*, *dorsal*, *lumbar*, and *sacral*

CERVICAL NERVES.—Eight pairs: the first is called *sub-occipital;* it passes out of the spinal canal, between the occiput and atlas; and the last passes out between the last cervical and first dorsal vertebra. The anterior branches of the four upper form the *cervical plexus;* the posterior branches, *posterior cervical plexus.* The anterior branches of the four lower cervical, with the first dorsal, form the *brachial plexus.*

The *cervical plexus* sends off the following: *superficialis colli*, which divides into a *descending* branch, distributed to the integument on the side and front of the neck, and an *ascending* branch, which supplies the integument of the chin and lower parts of the face; *auricularis magnus*, the largest of the ascending branches, which divides at the parotid gland into an *anterior* branch, distributed to the gland, adjacent integument, and external ear, and a *posterior*, which pierces the parotid gland, crosses the mastoid process, and is then divided into branches to supply the integument of the side of the head and back part of the pinna, sending off several facial branches to the cheek; *occipitalis minor*, which arises from the second cervical, and is distributed to the muscles and integument of the external ear and occipital region; *acromiales* and *claviculares*, two or three large branches distributed to the integument of the upper and front part of the chest; *communicating*, filaments which connect with the sympathetic, pneumogastric, and hypoglossal; *muscular*, distributed to the trapezius, levator anguli, scapulæ, and rhomboidei muscles; *communicans noni*, a long, slender branch forming a loop with the descendens noni over the sheath of the carotid vessels; and *phrenic* (the internal respiratory of Charles Bell), which descends to the root of the neck, crosses the subclavian artery, and enters the chest between it and the subclavian vein, passes through the middle mediastinum and in front of the root of the lung to the diaphragm, to which it is distributed, its filaments communicating with the phrenic, solar, and hepatic plexuses.

The *posterior cervical plexus* gives off *musculo-cutaneous* branches to the ligamentum nuchæ, integument of the back part of the neck, and posterior region of the scalp; and the *occipitalis major*, which is distributed to the muscles of the neck and integument of the scalp.

The *brachial plexus* is broad in the neck, narrowing as it descends into the axilla, enlarging again at its lower part, where it divides into six terminal branches, which are distributed to the upper extremity and chest. From the plexus are sent off *superior muscular* branches to the subclavius and rhomboidei muscles, *short thoracic* to the two pectoral and deltoid muscles, *long thoracic* (external respiratory of Bell) to the serratus magnus muscle, *supra-scapular* to the supra-spinatis and infra-spinatis muscles, *subscapular* to the subscapularis muscle, and *inferior muscular* to the latissimus dorsi and teres major. The terminal branches are: the *external cutaneous*, which, piercing the coraco-brachialis muscle, passes between the biceps and brachialis anticus to the outer side of the elbow, where it perforates the fascia, and divides into two branches; the *external* follows the course of the radial vein, communicating with branches of the radial nerve on the back of the hand, and supplying the coraco-brachialis, biceps, brachialis anticus, and integuments on the outer side of the fore-arm; the *internal cutaneous*, which passes down the inner side of the arm with the basilic vein, piercing the deep fascia about the middle of the upper arm, and dividing into two branches; the *anterior* descends along the palmarus longus to the wrist, supplying the integument in its course; the posterior supplies the integument over the olecranon and inner condyle, and descends the fore-arm along the ulnar vein to the wrist, supplying the integument on the inner side of the fore-arm; the *lesser internal cutaneous*, a long, slender branch which descends on the inner side of the external cutaneous to be distributed to the integument of the elbow; the *median*, which arises by two heads, embracing the axillary artery, crosses the brachial artery at its middle, descends to the inner bend of the elbow, runs down the fore-arm between the flexor sublimis and profundus, and beneath the annular ligament into the palm of the hand, where it divides into *muscular*, *anterior interosseous*, *superficial palmar*, and *digital* branches, to be distributed to the structures of the fore-arm, wrist, and fingers; the *ulnar*, which arises with the internal head of the median, runs down the inside of the arm to the groove between the internal condyle and olecranon, where it is superficial and easily compressed—giving rise to the painfully thrilling sensation along the inside of the fore-arm and little finger when a blow is made on it against the inner condyle—after which it descends along the inner side of the fore-arm, crosses the annular ligament, and divides into *superficial palmar* and *deep palmar* branches, which, with *muscular*, *articular*, and *anastomotic* branches given off along its course, are distributed to the structures of the arm, fore-arm, wrist, and hand, and communicate with the other surrounding branches of nerves; the *musculo-spiral* *nerve*, the largest branch of the brachial plexus, which descends in front of the tendons of the latissimus dorsi and teres major muscles, winds around the humerus in the spiral groove, and passes to the elbow, where, after sending off *muscular* branches, and the *spiral cutaneous* to the nerves, muscles, and integument in its course, it divides into the *posterior interosseous* and *radial* branches; the *radial* runs along the radial side of the fore-arm, and about two inches above the wrist penetrates the deep fascia, and divides into *external* and *internal* branches, which are distributed to the hands and fingers; the *interosseous* supplies all the muscles on the posterior aspect of the fore-arm, and a descending branch of it forms a large gangliform swelling on the back of the wrist, from which branches are distributed to the joint; and the *circumflex nerve*, which arises with the former, winds around the neck of the humerus with the posterior circumflex artery, and terminates in numerous branches, distributed to the deltoid muscle, after sending off *muscular* and *cutaneous* branches to the muscles and integuments of the shoulder and arm.

The Dorsal Nerves.—There are twelve pairs of dorsal nerves. Each nerve, as it emerges from the intervertebral foramen, divides into *dorsal* and *intercostal* branches. The *dorsal* pass backward between the transverse processes of the vertebræ, where each divides into a *muscular* and a *musculo-cutaneous* branch, distributed to the muscles and integument of the back; the *intercostal* branches, which are the true *intercostal nerves*, receive filaments from the adjoining ganglia of the sympathetic, and pass forward with the intercostal vessels in the intercostal spaces, supplying the intercostal muscles in their course; near the sternum they pierce the intercostal and pectoral muscles, supply the mammary glands, and are finally distributed to the muscles and integument in front of the chest and abdomen.

The Lumbar Nerves.—Of these there are five pairs; the first passes out between the first and second lumbar vertebræ, and the last between the lower lumbar vertebra and sacrum. At their origin the *anterior* branches communicate with the lumbar ganglia of the sympathetic, and pass obliquely outward behind the psoas magnus muscle, where they intercommunicate and anastomose to form the *lumbar plexus*. The *posterior* branches divide into *internal* branches, which are distributed to the adjacent muscles and integuments, and *external*, which intercommunicate, and, after supplying the deep muscles, are distributed to the integument of the gluteal region. The *lumbar plexus* gives off the following branches: 1. *Musculo-cutaneous*; which divides into a *superior* branch, and this, after winding around the crest of the ilium, divides into *abdominal* and *scrotal* branches, the former of which is distributed to the integument of the groin and around the pubis, and the latter accompanies the spermatic cord in the male, and round ligament in the female, to supply the integument of the scrotum and internal labium; and an *inferior* branch, which passes along the spermatic cord, to be distributed to the genital organs. 2. *External cutaneous;* which passes into the thigh beneath Poupart's ligament, and divides into a *posterior* branch, which supplies the integument of the thigh, and an *anterior* branch, which is distributed to the integument on the outer border of the thigh and to the articulation of the knee. 3. *Genito-crural;* which runs on the anterior surface of the psoas magnus muscle to near Poupart's ligament, where it divides into a *genital* branch, which descends along the spermatic canal, to be distributed to the spermatic cord and cremaster muscle in the male, and the round ligament and external labium in the female, and a *crural* branch, which enters the sheath of the femoral vessels, and is distributed to the anterior aspect of the thigh. 4. *Crural, or femoral;* the largest division of the lumbar plexus is formed by the union of branches from the second, third, and fourth lumbar nerves, passes into the thigh beneath Poupart's ligament, then spreads out and divides into numerous branches: a. *cutaneous*, two nerves which perforate the sartorius muscle, and are distributed to the integument of the middle and lower part of the thigh and knee; b. *muscular*, round, large twigs, distributed to the muscles of the anterior aspect of the thigh, sending filaments to the periosteum and knee joint; c. *aponeurotic*, to the sheath of the femoral vessels and adjacent muscles; d. *short saphenous*, which divides at the sheath of the femoral vessels into a *superficial* branch, which runs down to the knee joint, and terminates by communicating with the long saphenous nerve, and a *deep* branch, which divides at the termination of the femoral artery into several filaments, which communicate with other nerves to form a plexus, some of whose filaments are distributed to the integument on the posterior part of the thigh; e. *long saphenous*, which enters the femoral sheath, and descends along the inside of the leg with the internal saphenous vein, crosses in front of the inner ankle, and is distributed to the integument on the inner side of the foot. In its course it receives a communicating branch from the obturator, near the division of the femoral artery, and another at the internal condyle, and gives off a *femoral cutaneous* branch, a *tibial cutaneous* branch, and an *articular* branch, to the integument of the inner and back part of the thigh, the inner aspect of the leg, around the knee joint, the front and outer aspect of the leg, and the ankle joint. 5. *Obturator;* formed by a branch from the third and another from the fourth lumbar nerve, passes through the angle of bifurcation of the common iliacs, and along the brim of the pelvis to the obturator foramen, where it joins the obturator artery. After emerging from the pelvis it gives off twigs to the obturator externus muscle, and divides into four branches; *three anterior*, which supply the adductor brevis, pectineus, adductor longus, and gracilis muscles, and a posterior which ramifies in the adductor magnus; from the anterior branches a *communicating* filament proceeds to unite with the long saphenous, and a *long cutaneous* branch descends to the inner side of the knee, where it communicates with the long saphenous; and from the posterior branch an *articular* branch is given off, which accompanies the popliteal artery, to be distributed to the back part of the synovial membrane of the knee joint. 6. *Lumbar sacral;* descends over the base of the sacrum into the pelvis, and forms a part of the sacral plexus.

THE SACRAL NERVES.—There are six pairs of sacral nerves; the first pass out of the vertebral canal through the first sacral foramina, and the two last between the sacrum and coccyx. The posterior are very small, and are distributed to the integument over the sacrum and coccyx and gluteal region. The *anterior* diminish in size from above downward; they are distributed to the muscles and integuments around the coccyx and anus; many of their branches are connected in the formation of the sacral plexus; they send communicating branches to the hypogastric plexus, and receive branches from the sacral ganglia of the sympathetic.

THE SACRAL PLEXUS.—The sacral plexus is formed by the lumbo-sacral and anterior branches of the four upper sacral nerves. It is triangular in form, its base corresponding to the sacrum, and its apex to the lower part of the great ischiatic foramen. Its branches are: 1. *Visceral;* three or four branches, which ascend by the rectum and bladder in the male, and in the female upon the side of the rectum, the vagina, and bladder, supplying those viscera, and communicating with the hypogastric plexus. 2. *Internal muscular;* given off within the pelvis; an *obturator* branch to the obturatus internus, a *coccygeal* branch, and a *hæmorrhoidal* nerve, which descends to the rectum, supplying the spincter and integument. 3. *External muscular;* several branches, distributed to the capsule of the hip joint and surrounding muscles. 4. *Gluteal;* passes out of the pelvis with the gluteal artery, and divides into a *superior* branch, which goes to the gluteus medius and minimus, and an *inferior*, which is distributed with the above, and also to the tensor vaginæ femoris. 5. *Internal pudic;* passes out of the pelvis with the former, and divides, beneath the obturator fascia, into a *superior* branch *(dorsalis penis)*, which accompanies the dorsal artery of the penis to the glans, and is there distributed, supplying filaments to the corpus cavernosum, integument, and prepuce, and an *inferior* branch *(perineal nerve)*, which supplies the scrotum, and sends branches to the integuments of the under part of the penis, prepuce, sphincter ani, transversus perinei, and accelerator urinæ, and terminates by ramifying in the corpus spongiosum. In the female the internal pudic is distributed to the parts analogous to those of the male; the *superior* branch supplies the clitoris, and the inferior the vulva and parts in the perineum. 6. *Lesser ischiatic;* passes out of the pelvis through the great ischiatic foramen, and divides into *muscular* branches *(inferior gluteal)*, which are distributed to the gluteus maximus; and *cutaneous*, which send ascending filaments to the gluteal integument; the *perineal cutaneous nerve*, down the inside of the testis to the scrotum and integument on the under side of the penis; and the *middle posterior cutaneous*, which is distributed to the integuments of the thigh and leg at the middle of the calf. 7. *Great ischiatic;* this is the largest nervous cord in the whole body. It is a prolongation of the sacral plexus, and measures, at its exit from the great sacro-ischiatic foramen, three fourths of an inch in breadth. It descends between the trochanter major and tuberosity of the ischium, and along the back part of the thigh to its lower third, where it divides into terminal branches, called *popliteal* and *peroneal.* Previous to its division it sends off *muscular* branches to the semi-tendinous, semi-membranosus, and adductor magnus, and *articular* branches, which descend to be distributed to the capsule and synovial membrane of the knee joint.

The *popliteal nerve* passes down externally to the vein and artery, and after sending off *muscular* branches to the gastrocnemius, soleus, plantaris, and popliteus, an *articular* to the interior of the knee joint, and a *communicating*, a large nerve descending between the heads of the gastrocnemius, and forming below the knee, with a connecting branch from the peroneal nerve, the external saphenous nerve, it becomes the *posterior tibial.* The *external saphenous* penetrates the deep fascia below the fleshy part of the gastrocnemius, and passes down the leg along the outer border of the tendo-Achillis, winds around the outer malleolus, and is distributed to the outer side of the foot and little toe, sending numerous filaments to the integument of the heel and sole of the foot.

The *posterior tibial nerve* continues along the back of the leg from the lower border of the popliteus muscle to the back of the inner ankle, where it divides into the internal and external plantar nerve; in its course it sends *muscular* branches to the deep muscles, one or two filaments which entwine around the fibular artery, and then terminate in the integument, and *plantar* cutaneous branches, which pass down the inner side of the os calcis, to be distributed to the integument of the heel.

The *internal plantar nerve* crosses the posterior tibial vessels, to enter the sole of the foot, and is distributed to the toes, integument, and tarsal and metatarsal articulations.

The *external plantar nerve* is smaller than the former, and is distributed to the outer side of the foot, the little toe, and outer side of the second.

The *peroneal nerve* passes down by the tendon of the biceps, crosses the head of the gastrocnemius to the neck of the fibula, where it divides into the anterior tibial and musculo-cutaneous.

The *anterior tibial nerve* descends the anterior aspect of the leg with the artery to the ankle, where it passes beneath the annular ligament, and accompanies the dorsalis pedis artery to supply the adjoining sides of the great and second toes, distributing, in its course, filaments to the muscles and articulations of the tarsus and metatarsus.

The *musculo-cutaneous nerve* passes downward in the direction of the fibula, and at the lower third of the leg, where it pierces the deep fascia, and divides into two *peroneal cutaneous* branches, which pass in front of the ankle joint, to be distributed to the integument of the foot and toes, after sending filaments to adjacent muscles, and communicating branches to the saphenous and anterior tibial nerves.

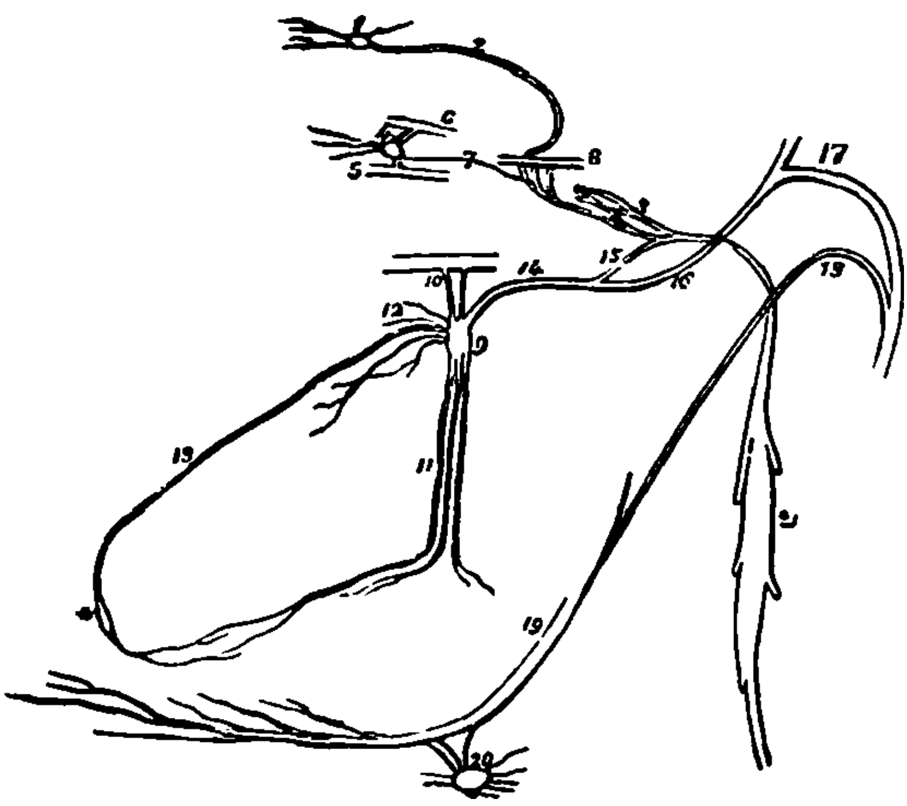
THE ORGANIC NERVES.

The organic nerves, commonly called the sympathetic or ganglionic system, consist of a series of ganglia extending along both sides of the vertebral column, which distribute branches to all the internal organs and viscera, and communicate with all the other nerves of the body.

The branches of distribution accompany the arteries which supply the different organs, and form communications around them called *plexuses*, which are named after the arteries, as mesenteric, hepatic, splenic, etc., plexuses.

CRANIAL GANGLIA.—There are five ganglia in the head: 1. *Ganglion of Ribes*, situated upon the anterior communicating artery; it is the superior point of union between the chains of opposite sides of the body. 2. *Ciliary ganglion*, a small, flattened body within the orbit, between the optic nerve and external rectus muscle; its branches of distribution supply the coats of the eye.

Fig. 93.



CRANIAL GANGLIA.

Fig. 93 is a representation of cranial ganglia of the organic system. 1. Ganglion of Ribes. 2. A filament by which it communicates with the carotid plexus (3). 4. Ciliary or lenticular ganglion, giving off ciliary branches to the globe of the eye. 5. Part of the inferior division of the third nerve, receiving a short, thick branch (the short root) from the ganglion. 6. Part of the nasal nerve, receiving a longer branch (the long root) from the ganglion. 7. A slender filament (the sympathetic root), sent directly backward from the ganglion of the carotid plexus. 8. Part of the sixth nerve in the cavernous sinus, receiving two branches from the carotid plexus. 9. Meckel's ganglion (spheno-palatine). 10. Its ascending branches, communicating with the superior maxillary nerve. 11. Its descending, or palatine branches. 12. Its internal branches, spheno-palatine, or nasal. 13. The naso-palatine branch, one of the nasal branches. 14. Posterior branch of the ganglion, the Vidian nerve. 15. Its carotid branch communicating with the carotid plexus. 16. Its petrosal branch, joining the intumescentia gangliformis of the facial nerve. 17. Facial nerve. 18. Chorda tympani, which descends to join the gustatory. 19. Gustatory nerve. 20. Submaxillary ganglion, receiving the corda tympani and other filaments from the gustatory. 21. Superior cervical ganglion of the sympathetic.

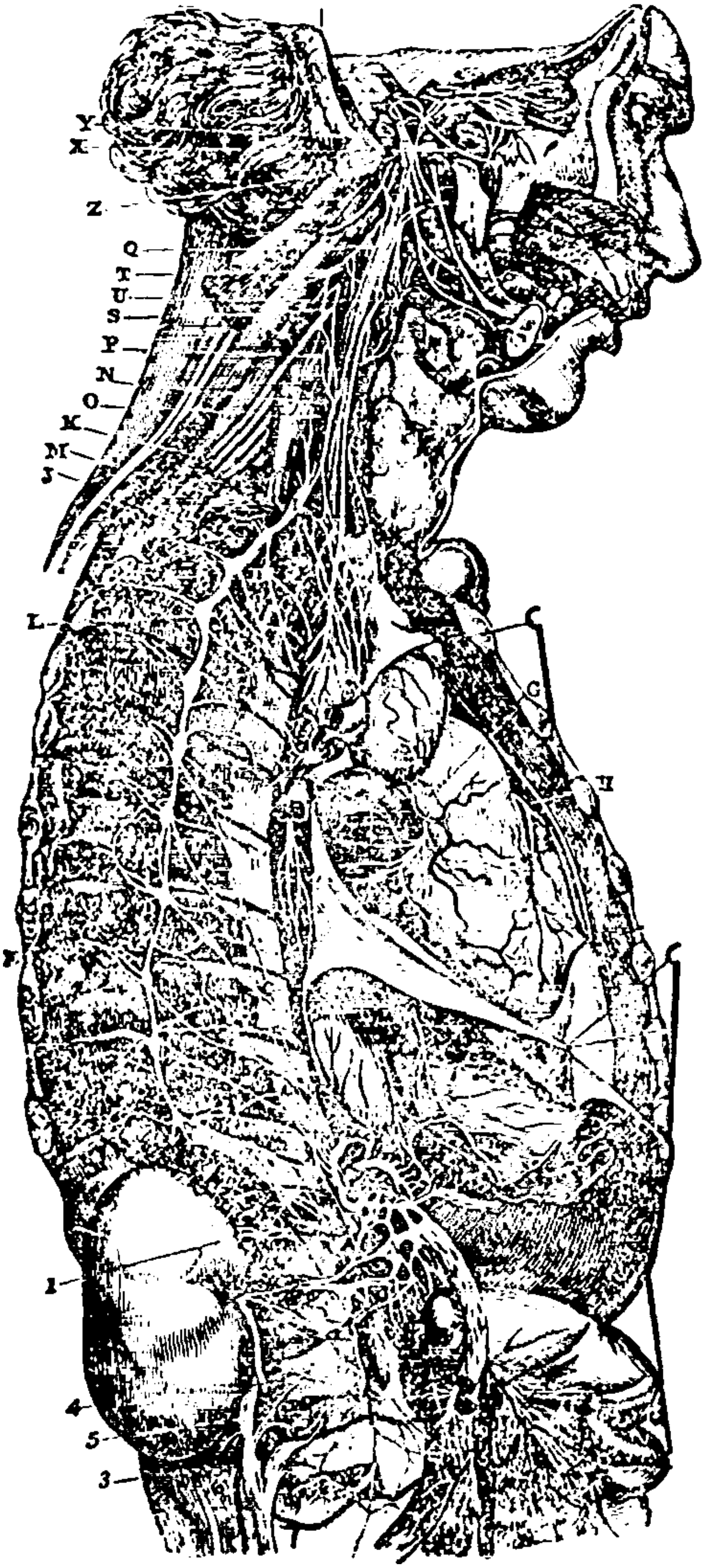
3. *Spheno-palatine ganglion* (Meckel's), the largest of the cranial ganglia, situated in the spheno-maxillary fossa. Its branches of distribution are: *nasal*, or *spheno-palatine*, four or five in number, which enter the nasal fossa through the spheno-palatine foramen, and supply the mucous membrane and spongy bones of the nose, and the upper part of the pharynx and the Eustachian tube; the *naso-palatine* to the septum of the nose and palate; the *anterior palatine* to the hard palate, bones of the nose, and the antrum; the *middle palatine* to the tonsil, soft palate, and uvulva; and the *posterior palatine* to the hard palate, gums, tonsil, and soft palate. Its communicating branches join the superior maxillary, abducens, and optic nerves, and the ciliary ganglion. The *posterior* branch is the *Vidian* or *pterygoid* nerve, which passes to the foramen lacerum, and divides into *carotid* and *petrosal* branches to the carotid plexus and the gangliform enlargement of the facial nerve;

it also sends a filament to the otic ganglion. 4. *Otic ganglion* (Arnold's), is a small, oval ganglion, situated on the inferior maxillary nerve, immediately below the foramen ovale. It sends off two branches of distribution, one to the tensor palati muscle, and one to the tensor tympani, and branches of communication to the auricular, chorda tympani, nervi molles, facial, and Vidian nerves, and the facial and Casserian ganglions. 5. *Submaxillary ganglion*, a small, triangular ganglion upon the submaxillary gland; it sends branches of distribution to the gland and Wharton's duct, and communicating branches to the gustatory, facial, and nervi molles.

THE CAROTID PLEXUS.—The *carotid plexus* is formed of the divisions of the ascending branch of the superior cervical ganglion in the carotid canal, where they form several loops with each other around the artery, together with branches derived from the petrosal branch of the Vidian. The continuation of this plexus onward by the side of the sella turcica is called the *cavernous plexus*. It is the centre of communication between all the cranial ganglia, and being derived from the superior cervical ganglion, between the cranial ganglia and those of the trunk, it also communicates with most of the cerebral nerves, and distributes filaments with each of the branches of the internal carotid, which accompany those branches in all their ramifications.

CERVICAL GANGLIA.—The cervical ganglia are three in number on each side. 1. *Superior cervical;* a long, grayish-colored ganglion, extending from within an inch of the carotid foramen in the petrous bone to the third cervical vertebra. It sends a *superior* branch to the carotid canal, whose divisions and intercommunications with each other, and with the petrosal branch of the Vidian, constitute the carotid plexus before described; an *inferior* or descending branch to the middle cervical; numerous *external* branches to the glosso-pharyngeal, pneumogastric, hypoglossal, and the first three cervical nerves; three *internal* branches, to the pharyngeal plexus, superior laryngeal nerve, and superior cardiac nerve; and *anterior* branches, called from their softness *nervi molles*, which accompany the carotid artery with its branches, around which they form intricate plexuses, and occasionally small ganglia. 2. *Middle cervical* (thyroid ganglion); of small size, situated opposite the fifth cervical vertebra, and resting on the inferior thyroid artery. It sends a *superior* branch to the superior cervical ganglion; *inferior* branches to the inferior cervical ganglion; *external* branches to the third, fourth, and fifth cervical nerves; and *internal* branches to the inferior thyroid plexus and artery, and middle cardiac nerve.

Fig. 94.



GANGLIONIC SYSTEM.

In Fig. 94 is presented a view of the organic or sympathetic system. A A A A. Semilunar ganglion and solar plexus. B. Small splanchnic nerve. C. Great splanchnic nerve. D D D. Thoracic ganglion. E. Internal branches. F. External branches. G. Right coronary plexus. H. Left coronary plexus. I Inferior cervical ganglion. J. Inferior twigs. K. External threads. L. Internal twigs. M. Anterior threads. N. Middle cervical ganglion. O. Interior twigs. P. External twigs. Q. Superior cervical ganglion. R. Superior branches. S. Inferior branch. T. External branches. U. Submaxillary gland. V. Vidian nerve. W. Naso-palatine branch. X. Spheno-palatine ganglion. Y. Ophthalmic ganglion. Z. Auditory nerve. 1. Renal plexuses. 2. Lumbar ganglia. 3. Internal branches. 4. External branches. 5. Aortic plexus

3. *Inferior cervical*; of a semilunar form, situated upon the base of the transverse process of the seventh cervical vertebra, and hence called "*vertebral ganglion.*" It sends *superior* branches to the middle cervical ganglion; *inferior*

to the first thoracic ganglion; *external* to the dorsal nerves and vertebral plexus; and *internal* branches to the inferior cardiac nerve.

The Cardiac Nerves.—The *superior cardiac* arises from the lower part of the superior cervical ganglion, and, descending the neck, passes behind the arteria innominata, and joins the *cardiac ganglion* below the arch of the aorta, receiving in its course branches from the pneumogastric, and sending filaments to the thyroid gland and trachea. The *middle cardiac* proceeds from the middle cardiac ganglion; it is the largest of the three nerves, and at the root of the neck divides into several branches, and communicates with the superior and inferior cardiac, the pneumogastric, and recurrent nerves, and descends to the *great cardiac plexus* at the bifurcation of the trachea. The *inferior cardiac* arises from the inferior cervical ganglion, communicates with the recurrent laryngeal and middle cardiac, and descends to the great cardiac plexus.

The *cardiac ganglion* is a variable enlargement beneath the arch of the aorta, which receives the superior cardiac nerves and a branch from the pneumogastric, and gives off numerous branches to the cardiac plexuses. The *great cardiac plexus* is situated upon the bifurcation of the trachea, above the right pulmonary artery, and behind the arch of the aorta; the *anterior cardiac plexus* is situated in front of the ascending aorta, near its origin; the *posterior cardiac plexus* rests upon the posterior part of the ascending aorta, near its origin. These plexuses intimately intercommunicate with each other and with the neighboring nerves, and supply the heart. Two sets of branches from the posterior cardiac constitute the *posterior coronary plexus;* and the *anterior* and *posterior pulmonary plexuses* are formed in part by branches from the great cardiac plexus.

Thoracic Ganglia.—There are twelve *thoracic* or *dorsal* ganglia on each side, resting upon the head of the ribs; their form is irregular, but they present the peculiar gray color and pearly lustre of the other organic ganglia. They send *superior* and *inferior* branches, to communicate with the ganglia above and below, two or three *external* branches to the roots of each of the spinal nerves, *internal* branches to the pulmonary, œsophageal, and cardiac plexuses, and *splanchnic*, several large cords from the lower ganglion, which unite to form the *splanchnic nerve.*

The *great splanchnic nerve* arises from the sixth dorsal ganglion, and, receiving branches from the seventh, eighth, ninth, and tenth, descends in front of the vertebral column, within the posterior mediastinum, pierces the diaphragm, and terminates in the semilunar ganglion. The *lesser splanchnic* (renal) is formed by filaments from the three lower dorsal ganglia, pierces the diaphragm, and descends to join the *renal plexus.*

The *semilunar ganglion* is a large, irregular body, pierced by numerous openings, and appearing like an aggregation of smaller ganglia with intervening spaces. It is situated by the side of the cœliac axis, upon the aorta, and communicates with the ganglion of the opposite side, both above and below that trunk, forming a gangliform circle, from which branches pass off radiatingly in all directions; hence the entire circle is called the *solar plexus.* It is undoubtedly the *presiding centre,* or *great brain* of the organic system, and probably the starting point in the development of all organized beings. Various sensations usually referred to the heart have, no doubt, their source in this ganglion.

The *solar plexus receives* the great splanchnic and part of the lesser splanchnic nerves, the termination of the right pneumogastric, branches from the right phrenic, and sometimes filaments from the left, and *transmits* numerous filaments to accompany, as plexuses, all the branches given off by the abdominal aorta, being the *phrenic, gastric, hepatic splenic, supra-renal, renal, superior mesenteric, spermatic,* and *inferior mesenteric plexuses,* all derived from the solar plexus.

LUMBAR GANGLIA.—There are four lumbar ganglia on each side, situated upon the anterior part of the bodies of the lumbar vertebræ. Their *superior* and *inferior* branches communicate with the ganglia above and below; their *external* branches communicate with the lumbar nerves; and their *internal* branches interlace around the abdominal aorta, constituting the *lumbar aortic plexus,* and again over the promontory of the sacrum, forming the *hypogastric plexus,* which distributes branches to all the viscera of the pelvis.

SACRAL GANGLIA.—The *sacral ganglia* are four or five in number on each side, situated near the anterior sacral foramina. Their *superior* and *inferior* branches communicate with the ganglia above and below; the *external* with the sacral nerves; and the *internal* are distributed to the pelvic viscera, sending branches to the hypogastric plexus. The lower sacral ganglia give off branches which join the *azygos ganglion* on the coccyx, which connects the ganglionic system inferiorly, as the ganglion of Ribes does superiorly.

CHAPTER IX.

ORGANS OF THE EXTERNAL SENSES.

THE organs of sense, which bring the animal machine into relation with external objects, are five; four of them, the apparatus of smell, sight, hearing, and taste, are situated within the head, while the organ of touch, resident in the skin, is distributed over the entire surface.

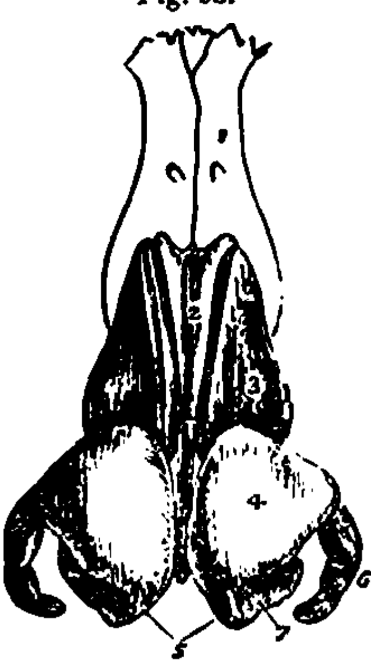
THE ORGAN OF SMELL.

The external parts of the organ of smell are called the *nose*, and the internal parts the *nasal fossæ*.

THE NOSE.—The anatomical parts of the nose are: The *nostrils*, which overhang the mouth, and are so constructed that the odors of all substances must be received by the nose before they can be introduced within the lips; the *columna*, or partition between the nostrils; the *vibrissæ*, stiff hairs which project across the openings, and guard their entrance; the fibro-cartilaginous *integument*, which forms the tip, called *lobulus*, and wings, called *alæ;* the *muscles*, already described; the *bones—nasal* and *nasal processes of the superior maxillary;* the *mucous membrane*, lining its interior; the *arteries*, from the facial and supra coronary; and the *nerves*, which are the facial, infra-orbital, and nasa branch of the ophthalmic.

Fig. 95 shows the fibro-cartilages of the nose. 1. One of the nasal bones. 2. Fibro-cartilage of the septum. 3. Lateral fibro-cartilage. 4. The alar fibro-cartilage. 5. Central portions of the alar fibro-cartilages, which constitute the columna. 6. Appendix of the alar fibro-cartilage. 7. Nostril.

Fig. 95.



NASAL CARTILAGES.

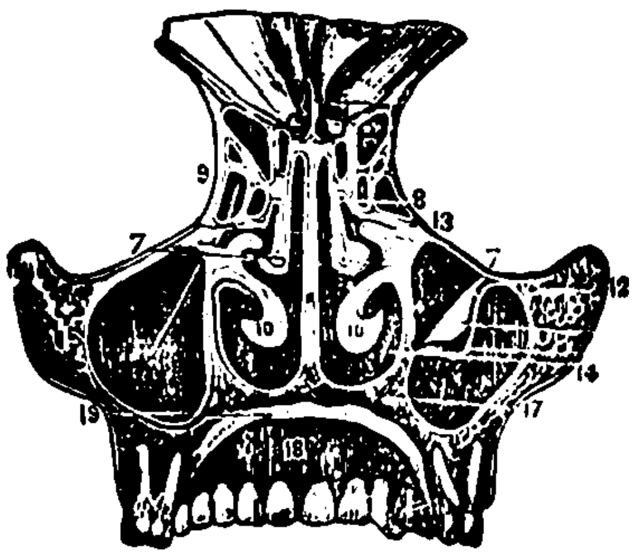
NASAL FOSSÆ.—The *nasal* fossæ are two irregular compressed cavities extending backward from the nose to the pharynx. They are bounded above by the lateral cartilage of the nose, and the nasal, sphenoid, and ethmoid bones; below by the hard palate. On the outer wall of each fossa are three projecting processes, called *spongy bones;* the two superior belong to the ethmoid, and the inferior is a separate bone; they increase the surface upon which the mucous membrane is spread out. The spaces between the upper and middle, the middle and lower, and lower and floor of the nostrils are the *superior*, *middle*, and *inferior meatuses.*

In the superior meatus are several openings into the nasal fossæ of the *sphenoidal* and *posterior ethmoidal cells*; in the middle the *anterior ethmoidal cells*, the *frontal sinuses*, and the *antrum maxillare*; and in the inferior the termination of the *nasal duct*.

The *mucous membrane* of the nasal fossæ is called *pituitary* or *Schneiderian*; it is continuous with the lining membrane of the gastro-pulmonary cavities, and extends into the sphenoidal and ethmoidal cells, frontal sinus, and antrum, through the nasal duct to the eye, where it is continuous with the conjunctiva; along the Eustachian tubes into the tympanum and mastoid cells, and through the posterior nerves into the pharynx and mouth, thence through the lungs and alimentary canal. Its surface is furnished with a delicate columna epithelium, supporting innumerable vibratile cilia.

The *arteries* of the nasal fossæ are the anterior and posterior ethmoidal branches from the ophthalmic, and the spheno-palatine and pterygo-palatine from the internal maxillary. The *nerves* are: The olfactory, the spheno-palatine branches from Meckel's ganglion, and the nasal branch of the ophthalmic. The ultimate filaments of the olfactory terminate in papillæ.

Fig. 96.



NASAL CAVITIES.

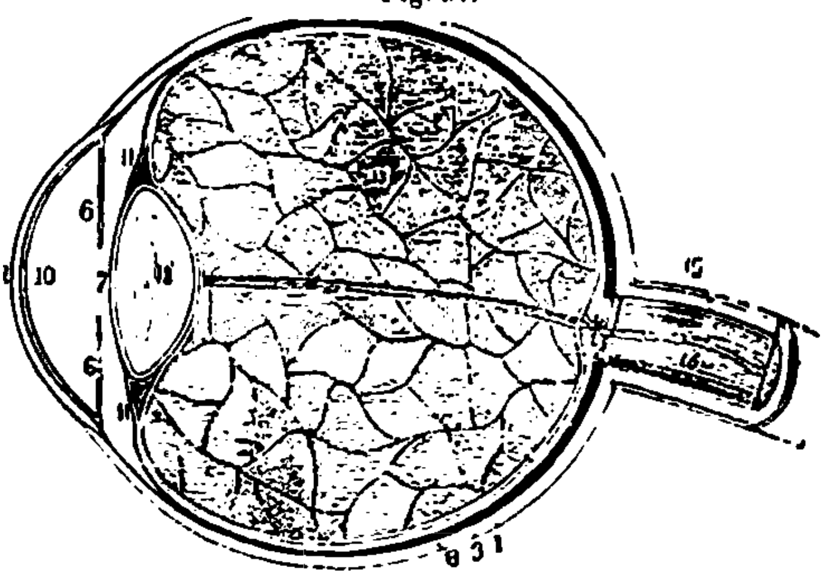
Fig. 96 is a vertical section of the middle part of the cavities of the nose. 7. Middle spongy bones. 8. Superior part of the nasal cavities. 10. Inferior spongy bones. 11. Vomer. 12. Upper jaw. 13. Middle meatus. 14. Inferior meatus. 17. Palatine process of the upper jaw. 18. Roof of the mouth, covered by mucous membrane. 19. A section of the mucous membrane.

OF THE ORGAN OF SIGHT.

The structures of the visual organ may be conveniently divided into three classes: the *coats*, *humors*, and *appendages* of the eye. The eyeball is of a spherical form, about one inch in diameter. The globe of the eye is composed of three *coats*, or *tunics*, and three *humors*.

OUTER COAT, OR FIRST TUNIC.—The first coat of the eyeball is formed of the *sclerotic* and *cornea*. The sclerotic is a dark, fibrous membrane, investing about four fifths of the globe. Its anterior surface is covered with a tendinous layer, called the *tunica albuginea*, which is derived from the expansion of the tendons of the four recti muscles. A part of the tunica albuginea is covered by a mucous membrane called the *conjunctiva*, which constitutes the "white of the eye." The sclerotic forms a thin, sieve-like plate, called *lamina cribrosa*, at the entrance of the optic nerve; this lamina is full of openings for the passage of nervous filaments. The largest of these openings in the centre is called the *porus opticus*, through which the *arteria centralis retinæ*—central artery of the retina—enters the eyeball. The cornea constitutes the anterior fifth of the globe. It is circular, transparent, and resembles a watch-glass. It is received into the grooved edge of the sclerotic in the manner that a watch-glass is received into its case. It is composed of four layers, the external being the white membrane, or conjunctiva, before mentioned.

Fig. 97.

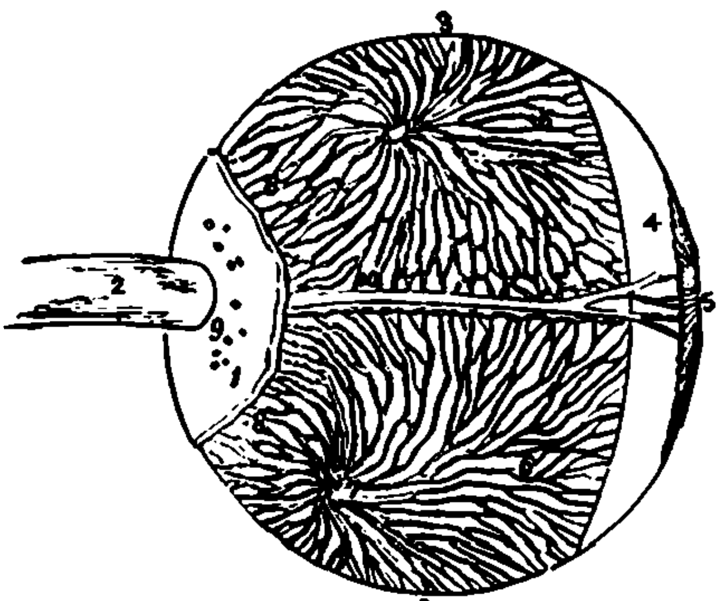


SECTION OF THE GLOBE.

Fig. 97 is a longitudinal section of the globe of the eye. 1. The sclerotic, thicker behind than in front. 2. The cornea, received within the anterior margin of the sclerotic, and connected with it by means of a beveled edge. 3. The choroid, connected anteriorly with (4) the ciliary ligament, and (5) the ciliary processes. 6. The iris. 7. The pupil. 8. The third layer of the eye, the retina, terminating anteriorly by an abrupt border at the commencement of the ciliary processes. 9. The canal of Petit, which encircles the lens (12); the thin layer in front of this canal is the zonula ciliaris, a prolongation of the vascular layer of the retina to the lens. 10. The anterior chamber of the eye, containing the aqueous humor; the lining membrane by which the humor is secreted is represented in the diagram. 11. The posterior chamber. 12. The lens, more convex behind than before, and enclosed in its proper capsule. 13. The vitreous humor enclosed in the hyaloid membrane, and in cells formed in its interior by that membrane. 14. A tubular sheath of the hyaloid membrane, which serves for the passage of the artery of the capsule of the lens. 15. The neurilemma of the optic nerve. 16. The arteria centralis retinæ, imbedded in the centre of the optic nerve.

MIDDLE COAT.—The second tunic is formed of the *choroid*, *ciliary ligament*, *iris*, and *ciliary processes*. The *choroid* is a vascular membrane, of a rich brown color externally, and of a deep black on its inner surface. Posteriorly it has an opening for the passage of the optic nerve; it is connected anteriorly with the iris, ciliary processes, and with the junction of the sclerotic and cornea, by a dense white structure, called the ciliary ligament, which surrounds the circumference of the iris, like a ring. The choroid membrane is composed of three layers, the external being principally an arrangement of veins, called *venæ vorticosæ.* The middle layer is formed by the ramification of minute arteries. The internal layer is a delicate cellular structure, containing the *pigmentum nigrum*, or coloring matter of its posterior surface.

Fig. 98.



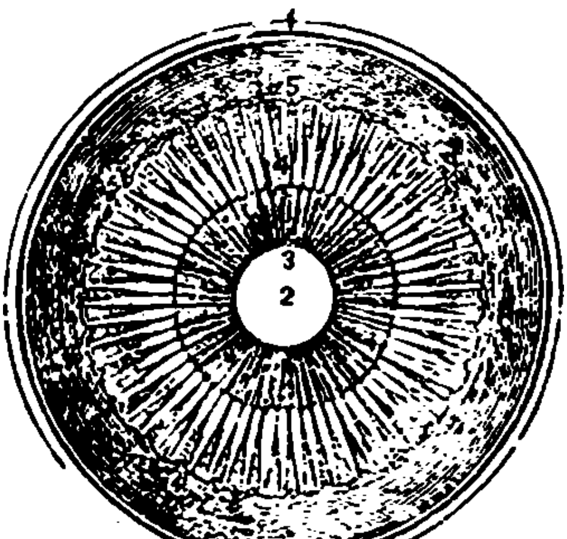
DISSECTION OF THE EYEBALL.

Fig. 98 is a dissection of the eyeball, showing its second tunic, and the mode of the distribution of the venæ vorticosæ of the choroid. After Arnold. 1. Part of the sclerotic coat. 2. The optic nerve. 3 3. The choroid coat. 4. The ciliary ligament. 5. The iris. 6 6. The venæ vorticosæ. 7 7. The trunks of the venæ vorticosæ at the point where they have pierced the sclerotica. 8 8. The posterior ciliary veins, which enter the eyeball in company with the posterior ciliary arteries, by piercing the sclerotic at 9. 10. One of the long ciliary nerves, accompanied by a long ciliary vein.

The *ciliary ligament* forms a circle round the iris, connecting the cornea and sclerotic at their junction with the iris and external membrane of the choroid.

The *iris*, or rainbow, is so denominated from its variety of colors in different individuals. It makes a partition between the front and back chambers of the eye, and has a circular opening near its centre, called the *pupil of the eye.* The iris is composed of two layers; the anterior is muscular, consisting of both circular fibres which surround the pupil, and radiating fibres from the centre to the circumference; the combined contraction of these fibres diminishes the diameter of the pupil.

Fig. 99.



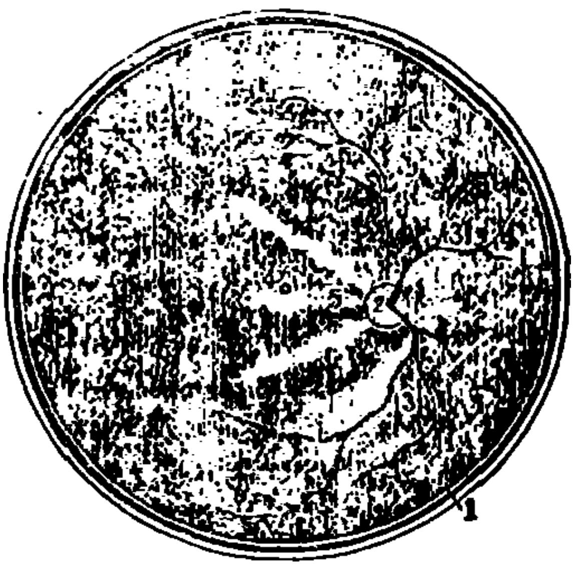
ANTERIOR SEGMENT

Fig. 99 is the anterior segment of a transverse section of the globe of the eye, seen from within. 1. The divided edge of the three tunics; sclerotic, choroid (the dark layer), and retina. 2. The pupil. 3. The iris, the surface presented to view in this section being the uvea. 4. The ciliary processes. 5. The scalloped anterior border of the retina.

The *ciliary processes* consist of

triangular folds of the middle and internal layers of the choroid. Their circumference connects with the ciliary ligament; they are covered with a thick black pigment.

Fig. 100.



POSTERIOR SEGMENT.

Fig. 100 is the posterior segment of a transverse section of the globe of the eye, seen from within. 1. The divided edge of the three tunics. The membrane covering the whole internal surface is the retina. 2. The entrance of the optic nerve with the arteria centralis retinæ piercing its centre. 3 3. The ramifications of the arteria centralis. 4. Foramen of Soemmering, in the centre of the axis of the eye; the shade from the side of the section obscures the limbus luteus, which surrounds it. 5. A fold of the retina, which generally obscures the foramen after the eye has been opened.

Inner Coat.—The third tunic is the *retina*. It is formed of three layers. The external is a mere *film*; the middle or *nervous* is the expansion of the optic nerve, enveloping the vitreous humor, and extending forward to the ciliary processes; the inner membrane is the *vascular*, composed of ramifications of arteries and veins. The anterior margin of the retina is connected with the anterior surface of the lens by a thin vascular layer, called *zonula ciliaris*. There is a circular spot in the retina, in the centre of the back part of the globe, called the *foramen of Soemmering*, surrounded by a yellowish halo, called *limbus luteus*.

Humors of the Eye.—The *aqueous humor* occupies the two chambers of the eye. The *anterior chamber* is the space bounded by the cornea in front, and the iris and pupil behind; the *posterior chamber* is the very small space between the pupil and posterior surface of the iris in front, and the ciliary processes, crystalline lens, and zonula ciliaris behind. Both chambers are lined by a thin membrane, which secretes the fluid of the aqueous humor, which does not exceed five or six drops in bulk.

The *vitreous humor* makes the greater part of the bulk of the globe of the eye. It is a glassy, transparent fluid, enclosed in a delicate membrane, called the *hyaloid*. The inner surface of the hyaloid is disposed in thin lamellæ or plates reflected inward, forming different apartments or cells, like the transverse section of an orange, for holding the vitreous humor.

The *crystalline humor*, or *lens*, is situated behind the pupil, surrounded by the ciliary processes, and embedded in the front part of the vitreous, from which it is separated by the hyaloid membrane. The *capsule of the lens* is an elastic, transparent membrane which surrounds it. The lens is formed of concentric layers, the external being soft, the middle firmer, and the interior still firmer. The *canal of Petit* is a small triangular channel around the circumference of the lens.

Uses of the Structures.—The ocular group of muscles has already been described.

The firm sclerotic coat gives shape and form to the eye, and protects its complicated and delicate tissues. The transparent cornea furnishes a medium for the transmission of the rays of light. The choroid supports the nutritive vessels, and by the black pigment of its posterior surface absorbs the scattered rays of light, that might otherwise confuse the image impressed on the retina. The iris regulates the quantity of light admitted through the pupil, by contracting when the rays are too strong, and expanding when the light is more feeble. The humors refract the rays so as to impress the object on the retina in the most favorable manner for distinct vision

APPENDAGES OF THE EYE.

These are the *eyebrows*, *eyelids*, *eyelashes*, *conjunctiva*, *caruncula lachrymalis*, and the *lachrymal apparatus*.

The *eyebrows*, called *supercilia*, are projecting arches of integument covered with short thick hairs, forming the upper boundary of the orbit of the eye.

The *eyelids*, called *palpebræ*, are valvular layers in front of the eye. The elliptical space between is divided into the *outer* and *inner canthus*. The inner canthus is prolonged into a triangular space toward the nose, which is called the *lacus lachrymalis*. The *lachrymal papilla* is a small angular projection at the commencement of the lacus lachrymalis on each side, each of which papilla has a small orifice at its apex, called *punctum lachrymale*, and constituting the commencement of the lachrymal canal. The thin, firm, fibro-cartilaginous bands supporting the edges of the eyelids are called the *tarsal cartilages*; in their internal surface are embedded a number of secreting tubes or follicles, called the *Meibomian glands*.

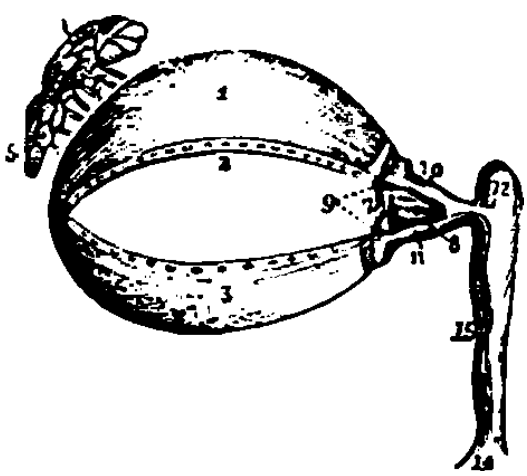
The *eyelashes*, called *cilia*, are triple rows of long thick hairs, curling upward from the upper lid, and downward from the lower; an arrangement which prevents their interlacing each other.

The *conjunctiva* covers the anterior surface of the eye, and is so reflected on the lids as to form their inner layer. The duplicates formed between the globe and lids of the eye are called the *superior and inferior palpebral sinuses.*

The *caruncula lachrymalis* is a small reddish body occupying the lacus lachrymalis at the inner canthus. It is composed of an assemblage of mucous follicles, and secretes the whitish matter usually found at the inner angle of the eye. On the outer side of the caruncula is a fold of the conjunctiva, called *plica semilunaris;* this is the *membrana nictitans* in birds, and the rudiment of the third lid in animals.

Fig. 101 is a representation of the appendages of the eye. 1. The superior tarsal cartilage. 2. The lower border of the cartilage, on which are seen the openings of the Meiboomian glands. 3. The inferior tarsal cartilage; along the upper border of this cartilage the openings of the Meibomian glands are likewise seen. 4. The lachrymal gland—its superior or orbital portion. 5. Its inferior or palpebral portion. 6. The lachrymal ducts. 7. The plica semilunaris. 8. The caruncula lachrymalis. 9. The puncta lachrymalia of the lachrymal canals. 10. The superior lachrymal canal. 11. The inferior lachrymal canal. 12. The lachrymal sac. 14. The dilatation of the nasal duct, where it opens into the inferior meatus of the nose. 15. The nasal duct

Fig. 101.



APPENDAGES OF THE EYE.

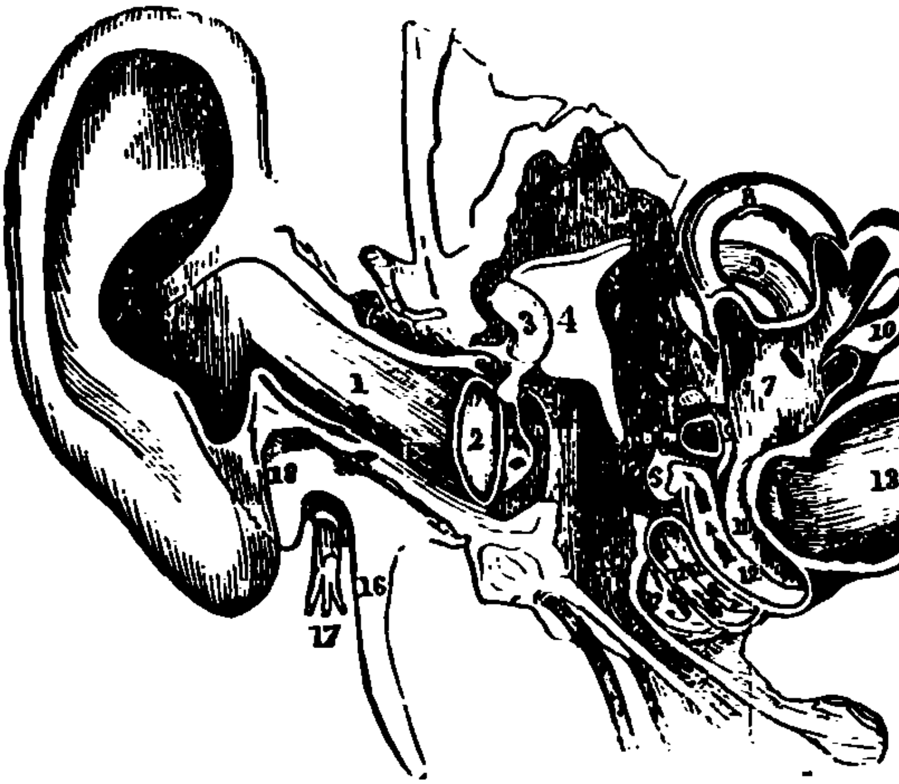
The lachrymal apparatus consists of the *lachrymal gland with its excretory duct*, the *puncta lachrymalia*, the *lachrymal canals*, the *lachrymal sac*, and the *nasal duct.*

The *lachrymal gland* is situated at the outer and upper part of the orbit. It secretes the *tears*, which are ordinarily conveyed away by small ducts which run a short distance between the conjunctiva, and then open on its surface a little above the upper border of the tarsal cartilages. The *lachrymal canals* commence at the *puncta lachrymalia* and run inward to the lachrymal sac. The *superior* duct first ascends, then turning suddenly inward, forms an abrupt angle; the *inferior* duct, by descending, and then turning abruptly inward, forms a similar angle. The *lachrymal sac* is the upper extremity of the nasal duct. It consists of a mucous membrane covered by a fibrous expansion of the tendons of the orbicularis and tensor tarsi muscles. The *nasal duct* is a short canal, three fourths of an inch long, running downward, backward, and outward to the inferior meatus of the nose, terminating there in an enlarged orifice.

OF THE ORGAN OF HEARING.

The auditory apparatus is divided anatomically into the *external ear*, *tympanum*, or middle ear, and *labyrinth* or internal ear.

Fig. 102.



STRUCTURE OF THE EAR.

Fig. 102 is a representation of all parts of the ear. 1. Meatus auditorius externus. 2. Drum of the ear, or tympanum. 3, 4, 5. The bones of the ear. 7. Vestibule, the central part of the labyrinth. 8, 9, 10. The semicircular canals. 11, 12. The channels of the cochlea. 13. Auditory nerve. 14. Eustachian tube, the channel from the middle ear to the throat.

THE EXTERNAL EAR.—The *external ear* consists of the *pinna*, a funnel-shaped cartilaginous plate, which collects the vibrations of air, and the *meatus*, the tube which conveys them to the tympanum.

The *pinna* presents several folds and hollows upon its surface; a prominent rim, called *helix*, a curved ridge within it, called *antihelix;* this divides above, and encloses a space called *scaphoid fossa;* the pointed process over the opening of the ear is called *tragus;* a tubercle opposite *antitragus;* the dependent portion of the pinna is the *lobulus;* a space between the helix and antihelix is called *fossa innominata;* and the large central space to which all the channels converge is the *concha*, which opens into the *meatus*.

The *muscles* of the pinna are the *major helicis, minor helicis, tragicus, antitragicus*, and *transversus auriculæ;* they are merely rudimentary in the human ear, but in many animals are large and active.

The *meatus auditorius* is about an inch in length, extending inward and a little forward from the concha to the tympanum, and narrower in the middle than at either extremity. In the substance of its lining membrane are *ceruminous* glands, which secrete the ear-wax. Short stiff hairs stretch across its interior, to prevent the ingress of insects and dust.

The *pinna* derives a plentiful supply of *arteries* from the anterior auricular branch of the temporal, and the posterior auricular from the carotid. Its *nerves* are branches derived from the anterior auricular of the fifth, the posterior auricular of the facial, and the auricularis magnus of the cervical plexus.

TYMPANUM.—The *middle ear* is an irregular bony cavity within the petrous portion of the temporal bone. It is bounded externally by the membrana tympani, and filled with air, which enters by the Eustachian tube.

Fig. 103.

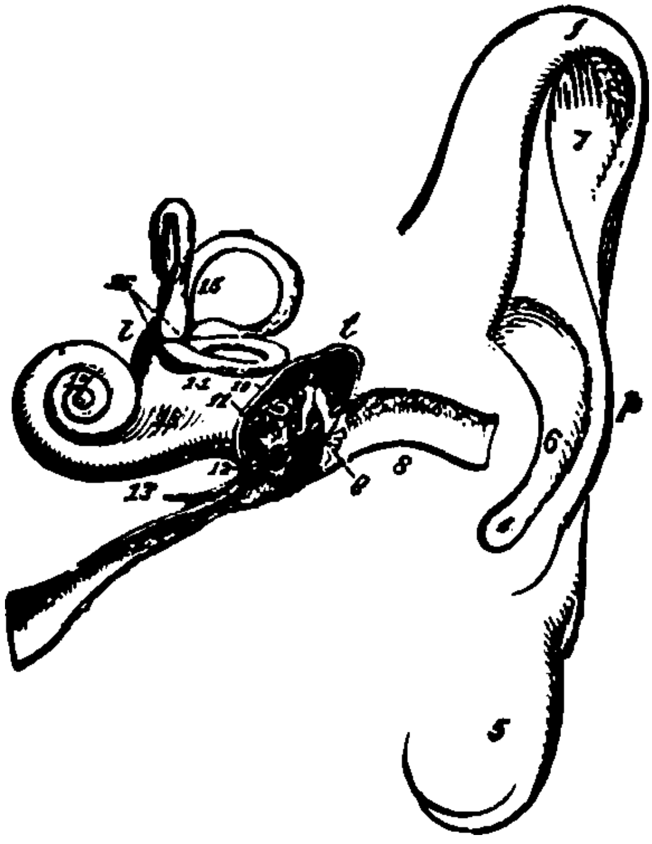


DIAGRAM OF THE EAR.

Fig. 103 is a diagram exhibiting the principal divisions and parts of the ear. *p.* Pinna. *t.* Tympanum. *l.* Labyrinth. 1. Upper part of the helix. 2. Antihelix. 3. Tragus. 4. Antitragus. 5. Lobulus. 6. Concha. 7. Upper part of the fossa innominata. 8. The meatus. 9. Membrana tympani, divided by the section. 10. The three small bones of the ear, malleus, incus, and stapes, crossing the area of the tympanum; the foot of the stapes blocks up the fenestra ovalis upon the inner wall of the tympanum. 11. The promontory. 12. Fenestra rotunda; the dark opening above the bones leads into the mastoid cells. 13. Eustachian tube; the little canal upon this tube contains the tensor tympani muscle in its passage to the tympanum. 14. Vestibule. 15. The three semicircular canals, horizontal, perpendicular, and oblique. 16. The ampullæ upon the perpendicular and horizontal canals. 17. Cochlea. 18. A depression between the convexities of the two tubuli which communicate with the tympanum and vestibule; one is the scala tympani, terminating at 12; the other the scala vestibuli.

The *membrana tympani* is a thin, semi-transparent membrane, placed obliquely across the meatus, concave externally and convex toward the tympanum, and composed of an external *epidermal*, a middle *muscular*, and an internal *mucous* coat.

The proper bones of the ear (*ossicula auditûs*), viz., *malleus*, *incus*, and *stapes*, are contained in the tympanum. The *malleus* (hammer-like) consists of a head, neck, and handle called *manubrium*, which is connected with the membrana tympani by its whole length. The *incus* has an imagined resemblance to an anvil, from which circumstance its name is derived; it consists of a flattened body and two processes; its body articulates with the head of the malleus. The *stapes* is shaped like a stirrup; its head articulates with a process of the incus called *os orbiculare*. These bones are connected together and held in their places by various ligaments, and moved upon themselves by four muscles, called *tensor tympani*, *laxator tympani*, *laxator tympani minor*, and *stapedius*.

There are ten *foramina*, or openings, in the tympanum, five large and five small. The *large* openings are, *meatus auditorius*, already described; *fenestra ovalis*, communicating between the tympanum and vestibule; *fenestra rotunda*, communicating between the vestibule and cochlea; a large, irregular opening by which the *mastoid cells* communicate with the upper and posterior circumference of the tympanum; and the *Eustachian tube*, a communicating canal between the tympanum and pharynx. The *small* openings are two for the entrance and exit of the *chorda tympani;* one situated in a fissure called *Glasseri*, for the *laxator tympani;* one immediately above the opening of the Eustachian tube, for the *tensor tympani;* and one for the *stapedius*, at the apex of a conical body called the *pyramid*. Above the fenestra ovalis is a *rounded ridge* formed by a projection of the *aquæductus Fallopii*. Beneath the fenestra ovalis is the *promontory* formed by a projection of the first turn of the cochlea, the surface of which presents three grooves for lodging the tympanic branches of Jacobson's nerve.

The *arteries* of the tympanum are derived from the internal maxillary, internal carotid, and posterior auricular. Its *nerves* are branches from the facial, the chorda tympani, the tympanic branches of Jacobson's, and a filament from the otic ganglion.

THE INTERNAL EAR.—The term *labyrinth* is applied to the internal ear on account of the complexity of its communications. It consists of a bony and a membranous portion. The osseous labyrinth presents a series of cavities channeled through the substance of the petrous bone, and is situated between the cavity of the tympanum and meatus auditorius internus. It is divided into vestibule, semicircular canals, and cochlea.

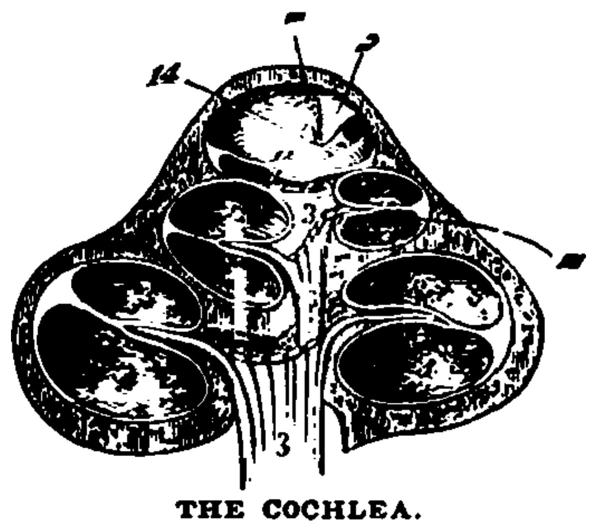
The *vestibule* is a small, three-cornered cavity within the inner wall of the tympanum; its corners are called *cornua*, or *ventricles*. The semicircular canals open into it by five orifices behind, and the cochlea by a single one in front. The fenestra ovalis is on its outer wall, and on its inner several small holes, a cluster of which is called *macula cribrosa*, for the entrance of a portion of the auditory nerve. The *scala vestibuli* is the termination of the vestibular canal of the cochlea. The *aquæductus vestibuli* is the commencement of the small canal which opens under the osseous scale upon the posterior surface of the petrous bone.

The *semicircular canals* are three bony channels, communicating with the vestibule into which they open by both extremities, each extremity being expanded like a flask, and called *ampulla.*

The *cochlea* (snail-shell) forms the anterior part of the labyrinth. It is a tapering, osseous canal, one inch and a half in length; and makes two turns and a half spirally around a central axis, called the *modiolus*, which is a porous mass of bone perforated by numerous filaments of the cochlear nerve. The canal of the cochlea is partially divided into two passages (*scalæ*) by a thin, porous plate of bone, called *lamina spiralis*, which terminates at the apex with a hook-shaped process called *hamulus;* this is covered by the *cupola.* The two scalæ communicate over the hamulus by an opening called *helicotrema.* Near the termination of the scala tympani is the small opening of the cochlear æqueduct. The internal surface of the osseous labyrinth is lined by a fibro-serous membrane, which exteriorly serves as a periosteum, and internally as a serous membrane, secreting a limpid fluid called *aqua labyrinthi.*

Fig. 104 shows the cochlea divided parallel with its axis through the centre of the modiolus. 1. Modiolus. 2. The infundibulum. 3, 3. Cochlear nerve. 4, 4. The scala tympani of the first turn of the cochlea. 5, 5. Scala vestibuli of the first turn; the septum between 4 and 5 is the lamina spiralis. 8. Loops formed by filaments of the cochlear nerve on the lamina spinalis. 9, 9. Scala tympani of the second turn of the cochlea. 10, 10. Scala vestibuli of the second turn. 11. Half turn of the scala vestibuli; the dome over it is the cupola. 14. Helicotrema; a bristle is passed through it, in front of which is the hamulus.

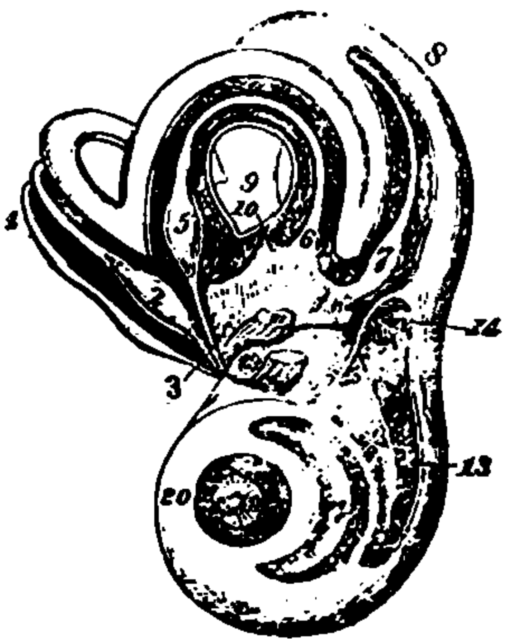
Fig. 104



THE COCHLEA.

The *membranous labyrinth* is in form a perfect counterpart of the vestibule and semicircular canals, but smaller in size. In structure it is composed of four layers; an *external*, or *serous*, a *vascular*, a *nervous*, and an *internal*, or *serous.* Its cavity is filled with a limpid fluid, and contains two small calcareous masses, called *otoconites;* and it consists of a small sac, *sacculus communis*, of three *semicircular membranous canals*, and a small round sac, *sacculus proprius*.

Fig. 105.



THE LABYRINTH.

Fig. 105 is the labyrinth of the left ear, laid open to exhibit its cavities and the membranous labyrinth. 1. Cavity of the vestibule. 2. Ampulla of the superior semicircular canal. 4. The superior canal, with its contained membranous canal. 5. Ampulla of the inferior canal. 6. Termination of the membranous canal of the horizontal semicircular canal in the sacculus communis. Ampulla of the middle semicircular canal. 8. The same canal with its membranous canal. 9. Common canal. 10. Membranous common canal. 11. Otoconite of the sacculus communis. 12. Sacculus proprius; its otoconite is seen through its membranous parietics. 13. First turn of the cochlea. 14. Extremity of the scala tympani, corresponding with the fenestra rotunda. 15. Lamina spiralis. 18. Half turn of the cochlea. 19. Lamina spiralis, terminating in its falciform extremity. The dark space included within the falciform curve of the extremity of the lamina spiralis is the helicotrema. 20. The infundibulum.

The *auditory nerve* divides, in the meatus auditorius internus, into a vestibular and a cochlear branch. The *vestibular* nerve divides into three branches, which are distributed to the various parts; in the substance of the sacculi and ampullæ the nervous filaments radiate in all directions, anastomosing with each other, and forming interlacements and loops, finally terminating upon the inner surface of the membrane in minute papillæ, resembling those of the retina. The *auditory nerve* divides into numerous filaments, which enter the foramina in the base of the cochlea, and are distributed to the tissue of the lamina spiralis. The *arteries* of the labyrinth are derived mainly from the auditory branch of the superior cerebellar artery.

THE ORGAN OF TASTE.

The tongue is composed of *longitudinal, transverse, oblique*, and *vertical* muscular fibres, between which is a quantity of adipose substance; it is connected posteriorly with the os hyoides by a muscular attachment; and to the epiglottis by mucous membrane, which forms the three folds called *fræna epiglottidis;* and on each side with the lower jaw by the same membrane, which forms a fold in front beneath its under surface, called *frænum linguæ.*

The surface of the tongue is covered by a dense layer, which supports its *papillæ*, of which there are four kinds. 1. *Papillæ circumvallatæ*, or *lenticular*, are of large size, and fifteen or twenty in number, situated near the root, and arranged in two rows, which meet at the middle line, like the branches of the letter A. At their point of meeting is a deep mucous follicle, called *foramen cæcum*. 2 and 3. *Papilla conicæ* and *papillæ filiformes*, conical and filiform in shape, cover the surface of the tongue in front of the circumvallatæ; their extremities are pierced by a minute aperture, hence they may be regarded as follicles rather than sentient points, the true sentient organs being extremely minute papillæ occupying their surface as well as that of the other papillæ. 4. *Papillæ fungiformes*, or *capitatæ*, are larger than the former, have rounded heads, and are irregularly dispersed over the dorsum of the tongue; a number of these are seen at the tip.

Behind the papillæ, at the root of the tongue, are a number of *mucous glands*.

Fig. 106.

THE TONGUE.

The tongue and its papillæ are seen in Fig. 106. 1. The raphe, which sometimes bifurcates in the dorsum, as in the figure. 2, 2. Lobes of the tongue; the rounded eminences on this part of the organ and near its tip are the fungiform papillæ; the smaller papillæ, among which the former are dispersed, are the conical and filiform papillæ. 3. Tip of the tongue. 4, 4. Its sides, on which the papillæ are arranged in fringed and lamellated forms. 5, 5. The A-shaped row of papillæ circumvallatæ. 6. Foramen cæcum. 7. Mucous glands at the root of the tongue. 8. Epiglottis. 9, 9. Fræna epiglottidis. 10, 10. Greater cornua of the hyoid bone.

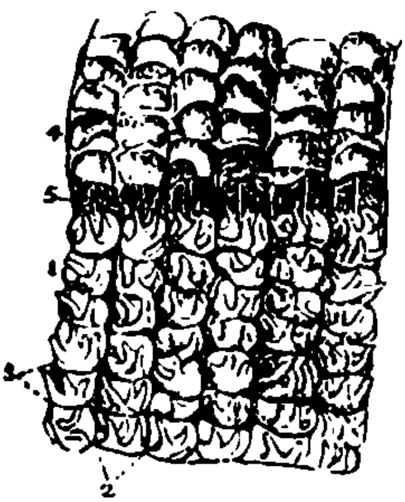
The tongue is abundantly supplied with blood by the lingual *arteries*. Its *nerves* are of large size, and three in number. The nerve of common sensation and taste is the *gustatory* branch of the fifth pair, which is distributed to the papillæ; the *glosso-pharyngeal* supplies the mucous membrane, follicles, and glands, and is a nerve of sensation and motion; the *hypo-glossal* is the principal motor nerve, distributed to the muscles. The chorda tympani, sent from the facial nerve to the lingualis muscle, must be added to the motor influence.

THE ORGAN OF TOUCH.

The *skin*, which is continuous with the mucous membrane of the internal cavities, is composed of two layers—*derma* and *epiderma*.

The *derma*, or *cutis* (true skin), is chiefly composed of elastic cellulo-fibrous tissue, abundantly supplied with blood-vessels, lymphatics, and nerves. It is divided into a deep stratum, called *corium*, the structure of which is dense, white, and coarse, forming a network of channels, by which the branches of vessels and nerves pass to the superficial layer; and a superficial stratum, called *papillary*, which is raised in the form of papillæ, or conical prominences, each being composed of a convoluted capillary vessel and a convoluted nervous loop.

Fig. 107



INTEGUMENT OF THE HAND.

Fig. 107 shows the anatomy of a portion of the skin taken from the palm of the hand. 1. Papillary layer, marked by longitudinal furrows (2), which arrange the papillæ into ridges. 3. Transverse furrows, which divide the ridges into small quadrangular clumps. 4. The rete mucosum raised from the papillary layer and turned back. 5, 5. Perspiratory ducts drawn out straight by the separation of the rete mucosum from the papillary layer.

The *epiderma*, or *cuticle* (scarf-skin), envelops and protects the derma, of which it is a product. Its external surface is hard and horny, its internal soft and cellular; this surface or layer is called the *rete mucosum*. The whole epidermal structure is laminated, the plates or scales increasing in density from the inner to the outer surface.

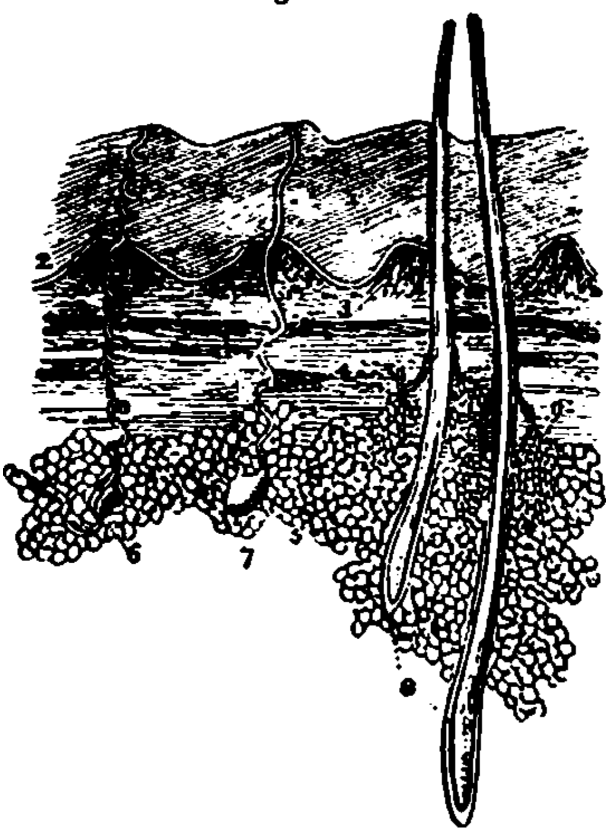
The *pores* of the epiderma are the openings of the perspiratory ducts, hair follicles, and sebiparous glands. The *arteries* of the derma divide into innumerable intermediate vessels, forming a capillary plexus in the superficial strata and papillary layer. No *lymphatics* have been discovered in the papillæ, but they are supposed to be interwoven with the capillary and mucous plexuses in the superficial strata of the derma.

Appendages of the Skin.—These are the nails, hair, sebiparous glands, and perspiratory glands and ducts.

The *nails* are a part of the epiderma, and identical in structure; they are implanted in a fold of the derma, called *matrix*, which acts the part of a follicle; at the bottom of the groove of the follicle are a number of filiform papillæ, which produce the margin of the root, and, by the successive formation of new cells, push the nail onward in its growth. The concave surface of the nail is in contact with the derma, and the latter is covered by papillæ, which detain the nail in place, and increase its thickness by the addition of newly-formed cells on its under surface

In Fig. 108 are seen—1. The epiderma. 2. Its deep layer, the rete mucosum. 3. Two of the quadrangular papillary clumps composed of minute conical papillæ, such as are seen in the palm of the hand or sole of the foot. 4. Deep layer of the derma, the corium. 5. Adipose cells. 6. A sudoriparous gland with its spiral duct, as are seen in the palm of the hand and sole of the foot. 7. Another sudoriparous gland with a straighter duct, such as is seen in the scalp. 8. Two hairs from the scalp, enclosed in their follicles; their relative depth in the skin is preserved. 9. A pair of sebiparous glands, opening by short ducts into the follicle of the hair.

Fig. 108.



ANATOMY OF THE SKIN

The *hairs* are horny appendages, produced by the involution of the epiderma, constituting the *follicle*, and subsequent evolution of the same structure, constituting the *shaft* of the hair. Hairs are variable in length and thickness in different parts of the body. Their free extremity is generally pointed, and sometimes split into filaments; the central extremity, called the *bulb*, is implanted deeply in the integument, extending through the epiderma into the cellular tissue, where it is surrounded by adipose cells. The hair is formed from its follicle by a process identical with the formation of the epiderma by the papillary layer of the derma.

The *color* of the hair, and also of the epiderma, is owing to the coloration of the primitive granules, of which the cells are composed.

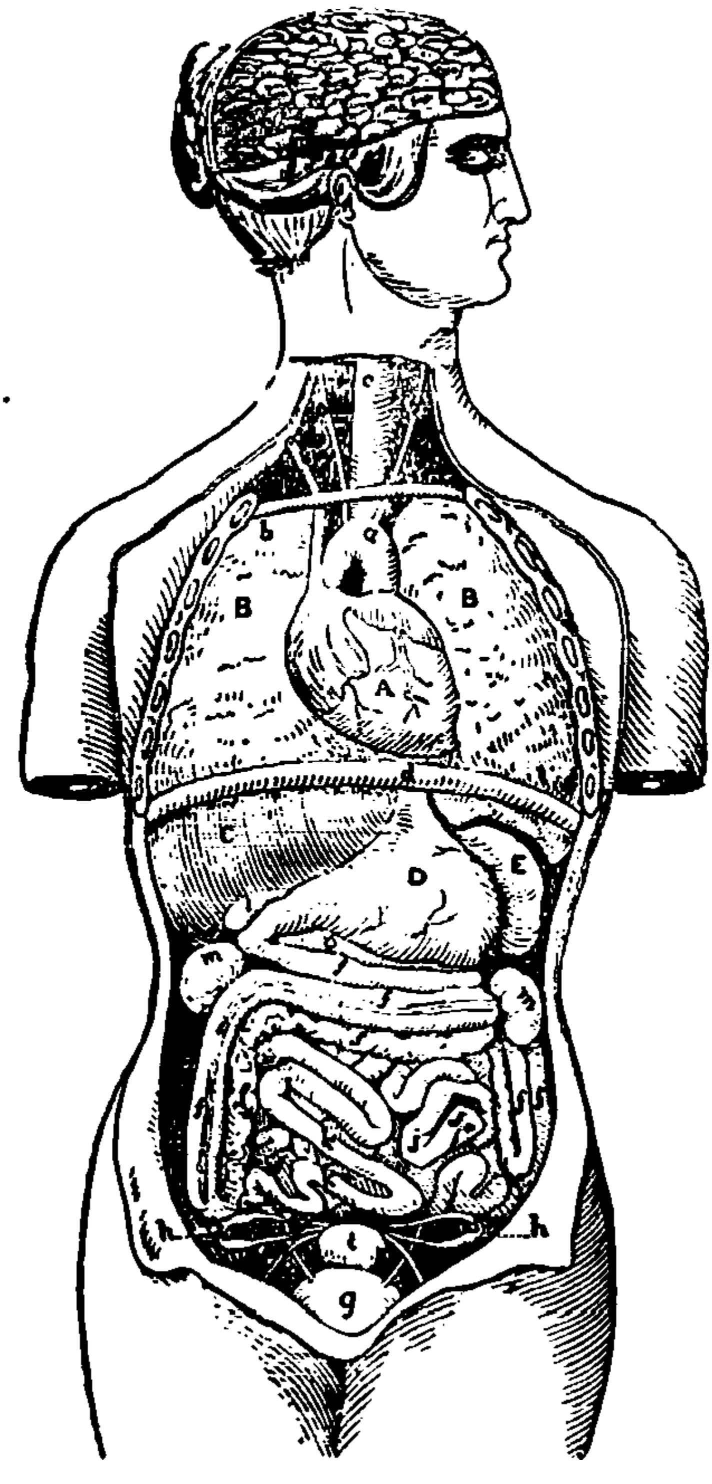
The *sebiparous glands*, which are embedded in the derma, are sacculated glandular bodies, of a complex variety of structure, from a pouch-like follicle to a lobulated gland. In some situations their excretory ducts open on the surface of the epiderma, and in others they terminate in the follicles of the hairs. In the meatus auditorius the sebiparous glands, called *ceruminous*, are large, and in the eyelids are the largest in the body, and are there called *Meibomian*.

The *sudoriparous glands* are deeply situated in the corium and subcutaneous tissue, and surrounded by areolar tissue. They are small oblong bodies, composed of convoluted tubuli, or a congeries of globular sacs, opening in a common efferent duct, which ascends through the derma and epiderma, and terminates on the surface by an oblique funnel-shaped aperture or pore

CHAPTER X.

OF THE VISCERA—SPLANCHNOLOGY.

Fig. 109.



VITAL SYSTEM

THOSE organs of the body called viscera, occupy three great internal cavities, the cranio-spinal, thorax, and abdomen. The first is occupied by the brain and spinal marrow already described; the thoracic cavity, or chest, contains the heart, lungs, and thymus gland; the abdominal cavity proper contains the stomach and intestines, liver, pancreas, spleen, kidneys, and supra-renal capsules; and its lower portion, called the pelvis, contains the bladder and internal organs of generation.

The relative situation of the principal viscera may be seen in Fig. 109.

A. Heart. B, B. Lungs. C. Liver. D. Stomach. E. Spleen. *m*, *m*. Kidneys. *g*. Bladder. *d* is the diaphragm which forms the partition between the thorax and abdomen. Under the latter is the cardiac orifice of the stomach, and at the right extremity, or pit of the stomach, is the pyloric orifice.

THORACIC VISCERA.

THE HEART.—The heart, which is the central organ of circulation, is a strong, muscular organ, enclosed in a proper membrane, called *pericardium*, and situated between two layers of pleura, which constitute the mediastinum.

The *pericardium* (heart-case) consists of an external fibrous and an internal serous layer.

The *heart* is placed oblique between the lungs, with its apex pointing to the space between the fifth and sixth ribs, two or three inches from the sternum on the left side. It consists of two auricles, right and left, and two ventricles, also right and left. The right is the venous, and the left the arterial side of the heart.

The *right auricle* is larger than the left; its interior, called *sinus*, presents five openings and two valves.

The *openings* are: the *superior cava*, which pours the venous blood from the upper part of the body into its upper part; the *inferior cava*, which returns the blood of the lower half of the body into its lower part; the *coronary vein*, which returns the blood from the substance of the heart; the *foramina Thebeseii*, small pore-like openings through which the venous blood oozes from the muscular structure into the auricles; and *auriculo-ventricular*, the communication between the auricle and ventricle.

The *valves* are: the *Eustachian*, which belongs to the fœtal circulation, and serves to direct the placental blood from the inferior cava through the foramen ovale into the left auricle; and the *coronary*, a semilunar fold across the mouth of the coronary vein.

There are two *relicts of the fœtal structure*, the *annulus ovalis*, situated on the partition (*septum arcularium*) between the two auricles, occupying the place of the foramen ovale of the fœtus; and the *fossa ovalis*, an oval depression corresponding with the fœtal foramen ovale, and closed at birth by a thin valvular layer.

The *proper structure* of the auricle is divided into an intervening portion between the openings of the cavas, called *tuberculum Loweri*, and numerous small parallel columns of muscular fibres situated in the *appendix auricula*.

The *right ventricle* receives the venous blood from the right auricle, and transmits it to the lungs. Its anterior side is convex the greater proportion of the front of the heart; its posterior and lower side is flat, resting upon the diaphragm. It contains two openings, two sets of valves, and a muscular and tendinous structure.

The openings are, the *auricular ventricular*, the communication between the right auricle and ventricle; and the *opening* of the *pulmonary artery*, which is situated close to the septum between the ventricles.

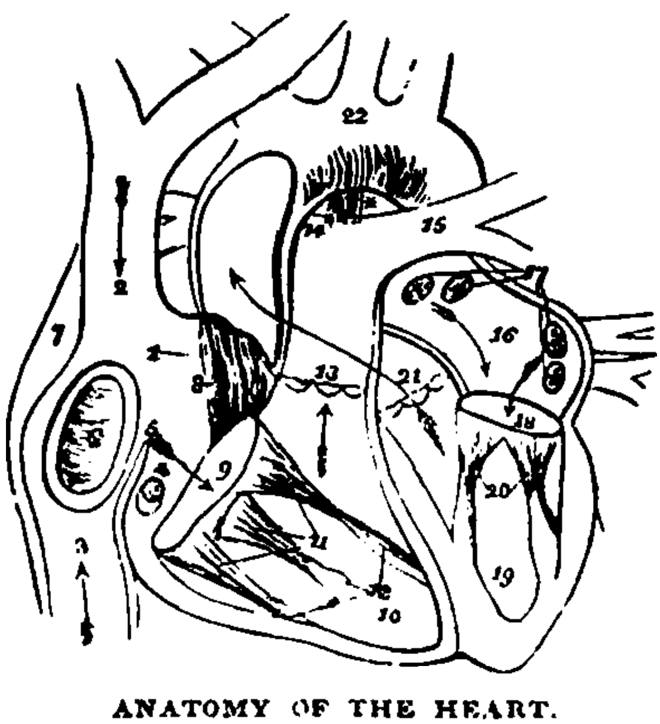
The *valves* are, the *tricuspid*, three triangular folds of the lining membrane, strengthened by a layer of fibrous tissue, connected by their base around the auriculo-ventricular opening, and prevent the regurgitation of blood into the auricle during the contraction of the ventricle; and the *semilunar*, three in number, situated around the commencement of the pulmonary artery.

The *muscular and tendinous* apparatus belongs to the tricuspid valves It consists of thick muscular columns (*columnæ carneæ*), and their tendons (*chordæ tendineæ*), which stand out from the walls of the ventricles, and serve as muscles to the valves.

The *left auricle* receives the arterial blood from the lungs; it is smaller and thicker than the right. It has *four openings for the pulmonary veins*, two from the right and two from the left lung; and an *auriculo-ventricular opening*, which communicates between it and the left ventricle. Its *musculi pectinati* are fewer in number than in the right auricle, and are situated only in the appendix auriculæ.

The *left ventricle*, which receives the blood from the left auricle and sends it through the aorta, forms the apex of the heart; its figure is conical externally and internally. Its openings are, the *auriculo-ventricular*, between the auricle and ventricle, and the *aortic*. Its valves are the *mitral*, attached around the auriculo-ventricular communication to prevent the retrograde passage of the blood, and, like the tricuspid, are furnished with a muscular apparatus; and the *semilunar* placed around the commencement of the aorta.

Fig. 110.

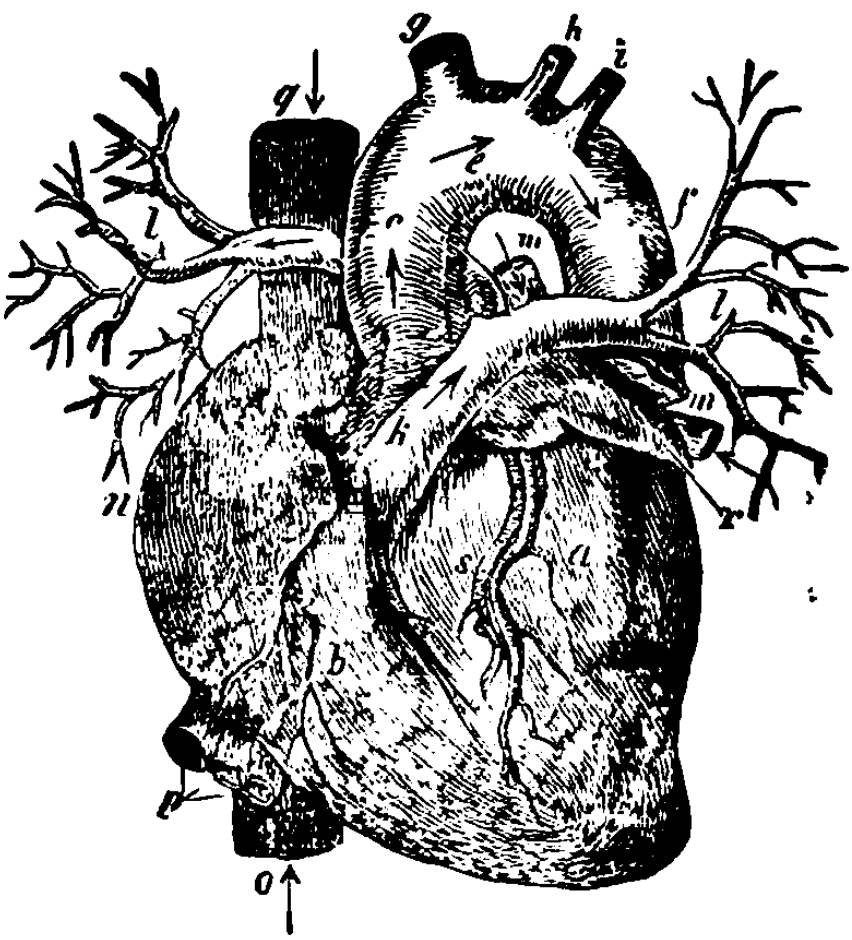


ANATOMY OF THE HEART.

Fig. 110 is a general view of the internal structure of the heart. 1. Right auricle. 2. Entrance of the superior cava. 3. Entrance of the inferior cava. 4. Opening of the coronary vein, half-closed by the valve. 5. Eustachian valve. 6. Fossa ovalis, surrounded by the annulus ovalis. 7. Tuberculum Loweri. 8. Musculi pectinati in the appendix auriculæ. 9. Auriculo-ventricular opening. 10. Cavity of right ventricle. 11. Tricuspid valve, attached by the chordæ tendinæ to the carneæ columnæ (12). 13. The pulmonary artery, guarded at its commencement by three semilunar valves. 14. Right pulmonary artery, passing beneath the arch and behind the ascending aorta. 15. Left pulmonary artery, crossing in front of the descending aorta. * Remains of the ductus anteriosus, acting as a ligament between the pulmonary artery and arch of the aorta. The arrows mark the course of the venous blood through the right side of the heart 16. Left auricle. 17. Openings of the fourth pulmonary veins. 18. Auriculo-ventricular opening. 19. Left ventricle. 20. Mitral valve, attached by its chordæ tendinæ to two large columnæ carneæ, which project from the walls of the ventricle. 21. Commencement and course of the ascending aorta behind the pulmonary artery, marked by an arrow; the entrance of the vessels is guarded by three semilunar valves. 22. Arch of the aorta. The comparative thickness of the two ventricles is shown in the diagram. The course of the blood through the left side of the heart is denoted by arrows.

The *general structure* of the heart is an arrangement of strong muscular fibres, disposed in several layers, so as to form fibrous rings and bands, which afford it the greatest possible amount of strength for its bulk. Its *arteries* are the *anterior* and *posterior coronary*; its *veins* empty into the right auricle by the common coronary; its *lymphatics* terminate in the glands about its root; and its *nerves* are derived from the cardiac plexuses, which are formed by communicating filaments from the ganglionic and pneumogastric.

Fig. 111.



THE HEART.

Fig. 111 is an external view of the heart. *a*. Left ventricle. *b*. Right ventricle. *c*, *e*, *f*. Aorta arising from the left ventricle. *g*. Arteria innominata. *h*. Left subclavian artery. *i*. Left carotid. *k*. Pulmonary artery. *l*, *l*. Its right and left branches. *m*, *m*. Veins of the lungs. *n*. Right auricle. *o*. Ascending cava. *q*. Descending cava. *r*. Left auricle. *s*. Left coronary artery. *P*. Portal veins, which return the blood from the liver and bowels.

ORGANS OF VOICE AND RESPIRATION.

The cartilaginous and muscular structure at the upper part of the windpipe, called the larynx, constitutes the apparatus of voice; the lungs and trachea are the organs of respiration.

OF THE LARYNX.

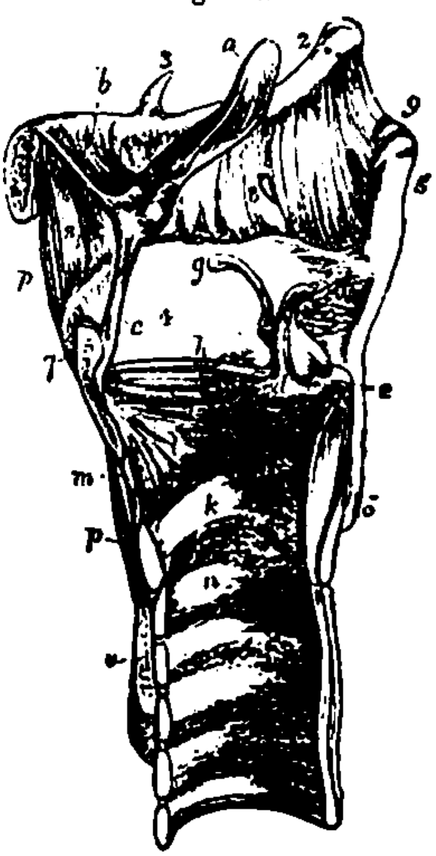
The larynx is a short tube, of an hour-glass form, situated at the upper and front part of the neck, composed of *cartilages*, *ligaments*, *muscles*, *vessels*, *nerves*, and *mucous membrane*.

The cartilages are: 1. *Thyroid* (shield-like), which consists of two lateral portions *(alæ)* meeting at an angle in front, and forming the projecting part of the throat, called *pomum Adami* (Adam's apple). Each ala forms a rounded border posteriorly, which terminates above in a *superior cornu*, and below in an *inferior cornu*. 2. *Cricoid* (like a ring), a circular ring, narrow in front and broad behind, where it has two rounded surfaces, which articulate with the arytenoid cartilages. The œsophagus is attached to a vertical ridge on its posterior surface. 3. Two *arytenoid* (pitcher-like); triangular in form, and broad and thick below, where they articulate with the upper border of the cricoid; above they are pointed and prolonged by two small pyriform cartilages, called *cornicula laryngis*, which form part of the lateral wall of the larynx, and afford attachment to the chorda vocalis and several of the articulating muscles. 4. Two *cuneiform*; small cylinders, about seven lines in length, and enlarged at each extremity; they are attached by the lower end to the arytenoid, and their upper extremity forms a prominence on the border of the aryteno-epiglottidean fold of membrane; they are occasionally wanting. 5. *Epiglottis*; shaped like a cordate leaf, and situated immediately in front of the opening of the larynx, which it closes when the larynx is drawn up beneath the base of the tongue, as in the act of swallowing. The laryngeal cartilages ossify more or less in old age, particularly in the male.

The *ligaments* are: 1. Three *thyro-hyoidean*, which connect the thyroid cartilage with the os hyoides. 2. Two *capsular crico-thyroid*, which articulate the thyroid with the cricoid, and with their synovial membranes from the articulation between the inferior cornu and sides of the cricoid. 3. The *crico-thyroidean membrane*, a fan-shaped layer of elastic tissue, attached by its apex to the lower border of the thyroid, and by its expanded margin to the upper border of the cricoid and base of the arytenoid; above it is continuous with the lower margin of the chorda vocalis. 4. Two *capsular crico-arytenoid*, which connect those cartilages. 5. Two *superior thyro-arytenoid*, thin bands between the receding angle of the thyroid and the anterior inner border of each arytenoid; the lower border constituting the upper boundary of the ventricle of the larynx. 6. Two *inferior thyro-arytenoid*, the *chordæ vocales*, which are thicker than the superior, and, like them, composed of elastic tissue. Each ligament, or vocal chord, is attached in front to the receding angle of the thyroid, and behind to the anterior angle of the base of the arytenoid. The inferior border of the chorda vocalis is continuous with the lateral expansion of the crico-thyroid ligament.

The superior border forms the lower boundary of the ventricle of the larynx. The space between the two chordæ vocales is the *glottis*, or *rima glottidis*. 7. Three *glosso-epiglottic*, folds of mucous membrane connecting the anterior surface of the epiglottis with the root of the tongue. 8. The *hyo-epiglottic*, an elastic band connecting the anterior aspect of the epiglottis with the hyoid bone. 9. The *thyro-epiglottic*, a slender elastic slip embracing the apex of the epiglottis, and inserted into the thyroid above the chordæ vocales.

Fig. 112.

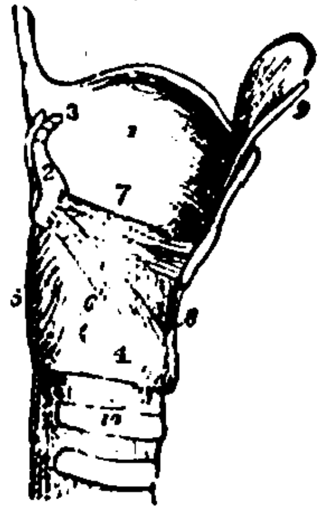


LIGAMENTS OF THE LARYNX.

Fig. 112 is a vertical section of the larynx, showing its ligaments. 1. Body of the os hyoides. 2. Its great cornu. 3. Its lesser cornu. 4. The ala of the thyroid. 5. Its superior cornu. 6. Its inferior cornu. 7. Pomum Adami. 8, 8 Thyro-hyoidean membrane; the opening near the posterior numeral transmits the superior laryngeal nerve and artery. 9. Thyro-hyoidean ligament. *a*. Epiglottis. *b*. Hypo-epiglottic ligament. *c*. Thyro-epiglottic. *d*. Arytenoid cartilage. *e* Outer angle of its base. *f*. Corniculum laryngis. *g*. Cuneiform cartilage. *h*. Superior thyro-arytenoid ligament. *i*. Chorda vocalis, or inferior thyro arytenoid; the elliptical space between the two thyro-arytenoid is the laryngeal ventricle. *k*. Cricoid cartilage. *l*. Lateral portion of the crico-thyroidean membrane. *m*. Its central portion. *n*. Upper ring of the trachea, which is received within the ring of the cricoid cartilage. *o*. Section of the isthmus of the thyroid gland. *p, p*. The levator of the glandulæ thyroideæ

The *muscles* are eight in number: five larger ones of the chordæ vocales and glottis, and three smaller of the epiglottis. The origin, insertion, and use of each is expressed by its name. They are the *crico-thyroid*, *posterior* and *lateral crico-arytenoid*, *thyro-arytenoid*, *arytenoid*, *thyro-epiglottic*, and *superior* and *inferior arytenoepiglottic*. The posterior crico-arytenoid opens the glottis; the arytenoid approximates the arytenoid cartilages posteriorly, and the crico-arytenoideus lateralis and thyro-arytenoidei anteriorly; the

Fig. 113.



THE LARYNX LATERALLY.

Fig. 113 is a side view of the larynx, one ala of the thyroid cartilage being removed. 1. Remaining ala. 2. One of the arytenoid cartilages. 3. One of the cornicula laryngis. 4. Cricoid cartilage. 5. Posterior crico-arytenoid muscle. 6. Crico-arytenoideus lateralis. 7. Thyro-arytenoideus. 8. Crico-thyroidean membrane. 9. One half of the epiglottis. 10. Upper part of the trachea.

latter also close the glottis mesially. The crico-thyroidei are tensors of the vocal chords, and with the thyro-arytenoidei, regulate their position and vibrating length. The remaining muscles assist in regulating the tension of the vocal chords by varying the position of their cartilages.

The *aperture* of the larynx is a triangular opening, broad in front and narrow behind; bounded in front by the epiglottis, behind by the arytenoid muscle, and on the sides by folds of mucous membrane. The cavity is divided into two parts by an oblong constriction produced by the prominence of the vocal chords; the part above the constriction is broad above and narrow below, and the part beneath is narrow above and broad below; while the space included by the constriction is a narrow, triangular fissure, the *glottis*, bounded on the sides by the chordæ vocales and inner surface of the arytenoid cartilages, and behind by the arytenoid muscle; it is nearly an inch in length, somewhat longer in the male than female. Immediately above the prominence caused by the chorda vocalis, and extending nearly its length on each side of the cavity of the larynx is the *ventricle of the larynx*, an elliptical fossa which serves to isolate the chord.

The *mucous membrane* lines the entire cavity of the larynx, its prominences and depressions, and is continuous with that of the mouth and pharynx, which is prolonged through the trachea and bronchial tubes into the lungs. In the ventricles of the larynx the membrane forms a cæcal pouch, called *sacculus laryngis*, on the surface of which are the openings of numerous follicular glands, whose secretion lubricates the vocal chords.

The *arteries* of the larynx are derived from the superior and inferior thyroid; the *nerves* are the superior laryngeal and recurrent laryngeal branches of the pneumogastric.

OF THE TRACHEA.

The *trachea* (windpipe) commences opposite the fifth cervical vertebra, and extends to the third dorsal, where it divides into the right and left bronchi, the *right bronchus* passing off to the upper part of the right lung at nearly right angles, and the *left*, which is smaller, descending obliquely beneath the arch of the aorta of the left lung.

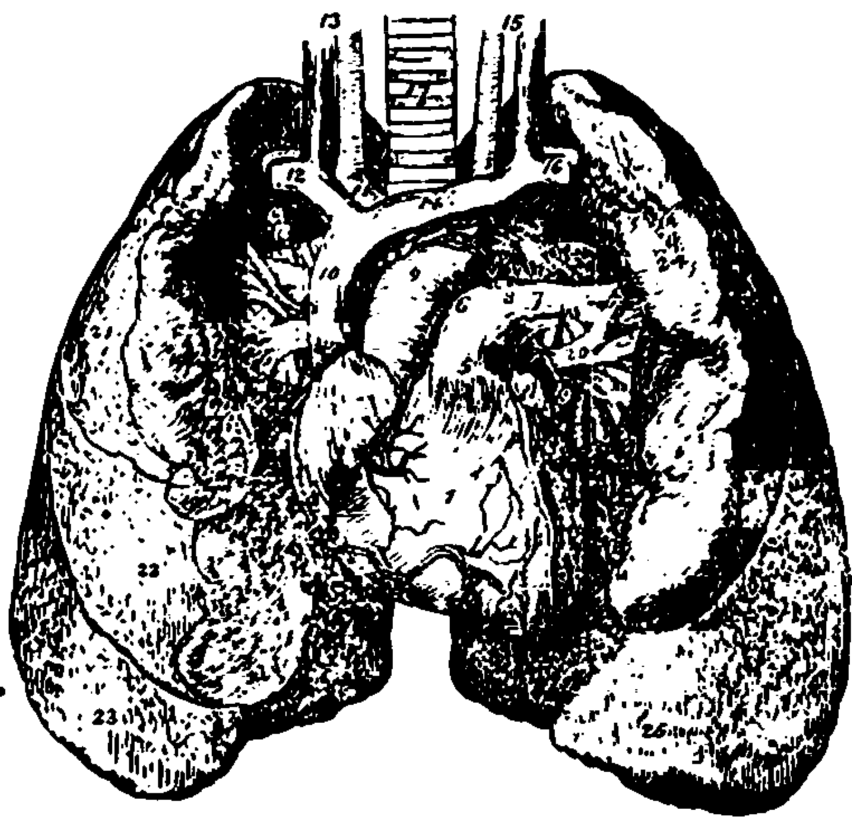
It is composed of fifteen to twenty *cartilaginous rings*, which form the anterior two thirds of its cylinder; *fibrous membrane*, which forms the posterior third of the tube; *mucous membrane*, which lines it internally; *longitudinal elastic fibres*, situated beneath the mucous membrane; and *muscular fibres*, which form a thin, transverse layer between the extremities of the cartilages; their posterior surface is covered by cellular tissue, in which are lodged the tracheal glands, which secrete the lubricating mucus.

THE THYROID GLAND.

In structure this body is composed of a dense aggregation of minute independent membranous cavities, enclosed by a plexus of capillary vessels, and connected by cellular tissue. The cavities are filled with cyto-blasts and cells. It is situated upon the trachea, above the sternum, being divided into two lobes, one of which is placed on each side; the connection between the lobes is called the *isthmus*. This gland is larger in children and females than in adults and males. It is profusely supplied with *blood* by the superior and inferior thyroid arteries; its *nerves* are derived from the superior laryngeal and sympathetic. The function of this organ is entirely unknown. Its enlargement constitutes the disease called goitre, or bronchocele.

OF THE LUNGS.

Fig. 114.



HEART AND LUNGS.

Fig. 114 represents the anterior aspect of the anatomy of the heart and lungs. 1. Right ventricle; the vessels to the left of the number are the middle coronary artery and veins. 2. Left ventricle. 3. Right auricle. 4. Left auricle. 5. Pulmonary artery. 6. Right pulmonary artery. 7. Left pulmonary artery. 8. Remains of the ductus arteriosus. 9. Aortic arch. 10. Superior cava. 11. Arteria innominata; in front of it is the right vena innominata. 12. Right subclavian vein; behind it is its corresponding artery. 13. Right common carotid artery and vein. 14. Left vena innominata. 15. Left carotid artery and vein. 16. Left subclavian artery and vein. 17. Trachea. 18. Right bronchus. 19. Left bronchus. 20, 20. Pulmonary veins; 18, 20, from the root of the right lung; and 7, 19, 20, the root of the left. 21. Upper lobe of right lung. 22. Its middle lobe. 23. Its inferior lobe. 24. Superior lobe of left lung. 25. Its lower lobe.

The lungs are two conical organs occupying the cavity of the chest on each side of the heart, from which they are separated by a membranous partition, the mediastinum. They are tapering above, where they extend beyond the level of the first rib, and broad and concave below, where they rest on the convex surface of the diaphragm. Their color is pinkish-gray, variously mottled and marked with black. Each lung is divided into two lobes by a long, deep fissure, and in the right lung the upper lobe is subdivided by a second fissure.

The *root* of each lung, which retains it in position, comprises the pulmonary artery and veins, and bronchial tubes, with the bronchial vessels and pulmonary plexuses of nerves.

The *structure* of the lungs is composed of ramifications of the bronchial tubes, terminating in intercellular passages and air-cells, and the ramifications of the pulmonary artery and vein, bronchial arteries and veins, lymphatics and nerves, the whole held together by cellular tissue, and called the *parenchyma*.

The *bronchial tubes*, on entering the lungs, divide into two branches, and each of these divide and subdivide until lost in intercellular passages, and these, after several bifurcations, ultimately terminate by a cæcal extremity, which is the air-cell. The structure of the bronchial tubes is changed from cartilaginous to membranous after they have arrived within one eighth of an inch of the surface of the lung, and diminished to a diameter between one thirtieth and one fiftieth of an inch.

The *pulmonary artery*, which transmits the venous blood to the lungs, terminates in a minute network of capillary vessels, distributed through the walls of the air-passages and air-cells; these converge to form the pulmonary veins, which return the arterial blood to the heart.

The *lymphatics* of the substance and surface of the lungs terminate in the bronchial glands.

The *nerves*, derived from the ganglionic and pneumogastric, form *anterior* and *posterior plexuses* upon the front and back of the root of the lungs, from which branches follow the course of the bronchial tubes to supply the intercellular passages and air-cells.

THE PLEURA.

Each lung is invested and sustained by the *pleura*, a serous membrane, which invests it as far as the root, and is then reflected upon the sides of the chest and across the diaphragm. The part enclosing the lung is called *pleura pulmonalis*, and that in contact with the parieties of the chest, the *pleura costalis;* the two reflected portions in the middle of the chest form a septum, called *mediastinum*, which divides the thorax into two pulmonary cavities; this portion is distinguished into *anterior*, *posterior*, and *middle* portions, the latter containing the heart and its pericardium, the ascending aorta, the superior vena cava, the bifurcation of the trachea, the pulmonary arteries and veins, and the phrenic nerves.

THE ABDOMINAL VISCERA.

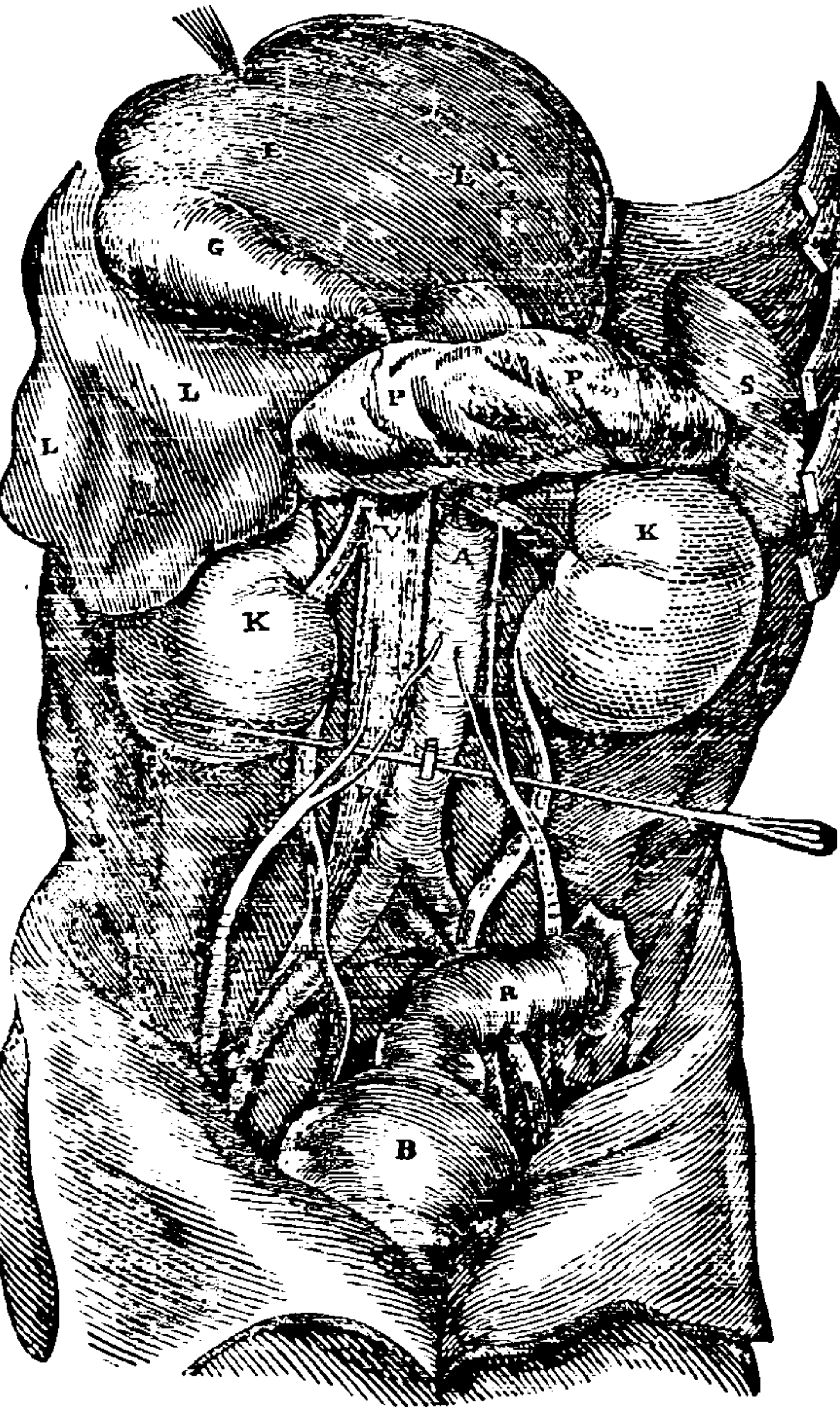
The abdominal cavity is bounded above by the diaphragm, below by the pelvis, in front and laterally by the lower ribs and abdominal muscles, and behind by the vertebral column and abdominal muscles; it contains the alimentary canal, liver, pancreas, spleen, and kidneys, with the supra-renal capsules.

ABDOMINAL REGIONS.—For convenience the abdominal cavity is divided into *nine* regions, by two transverse lines around the body, one parallel with the inferior convexity of the ribs, and the other with the highest points of the crests of the ilia; and two perpendicular lines, one at each side, drawn from the cartilage of the eighth rib to the middle of Poupart's ligament; the central region of the upper zone is called the *epigastric*, and its lateral divisions *right* and *left hypochondriac;* the middle region of the middle zone is the *umbilical*, the two lateral the *lumbar;* the middle of the lower zone is the *hypogastric*, and the two lateral the *iliac*. In the upper zone is found the liver, extending from the right to the left side; the stomach and spleen on the left, and the pancreas and duodenum behind; in the middle zone the transverse colon, upper part of the ascending and descending colon, omentum, small intestine, mesentery, and, behind, the kidneys and supra-renal capsules. In the lower zone is the inferior portion of the omentum and small intestine, the cæcum, ascending and descending colon with the sigmoid flexure, and the ureters.

The *peritoneum* is the serous membrane of the abdominal cavity; it invests each viscus separately, and is then reflected upon the surrounding parieties, enclosing the whole in a sac. The diaphragm is lined by two layers, which, descending to the upper surface of the liver, form its *coronary* and *lateral ligaments;* and, after surrounding the liver and meeting at its under surface, pass to the stomach, forming the *lesser omentum*. After surrounding the stomach they descend in front of the intestines, forming the *great omentum;* they then surround the transverse colon, and pass backward to the spine, forming the *meso-colon*, where the layers separate. The *posterior* ascends in front of the pancreas and aorta to the diaphragm; the *anterior* descends, and, after investing all the small intestines, returns to the spine, thus forming the *mesentery*. Descending into the pelvis, it forms the *meso-rectum*, and a pouch called the *recto-vesical fold*, between the rectum and bladder;

it then ascends upon the neck of the bladder, forming its *false ligaments*, and returns upon the front walls of the abdomen to the diaphragm.

Fig. 115.



ABDOMINAL CAVITY

Fig. 115 exhibits the abdominal cavity, with the intestines mostly removed. L. Liver turned up to show its under surface. G. Gall-bladder. P. Pancreas. K. Kidneys. S. Spleen. A. Descending aorta. V V. Ascending vena cava. R. Rectum. B. Bladder.

In the female it is reflected on the posterior surface of the vagina and both surfaces of the uterus, forming on each side the *broad ligament* of the latter viscus.

The *great omentum* consists of four layers, the two which descend from the stomach again returning upon themselves to the transverse colon; a quantity of adipose matter is deposited around the vessels which ramify through it. Its function is to protect the intestines from cold and friction, and facilitate their movements upon each other in their peristaltic action.

The *mesentery* retains the small intestines in their places, and gives passage to the mesenteric arteries, veins, nerves, and lymphatics.

There are small, irregular pouches of the peritoneal membrane, filled with fat, and situated like fringes upon the large intestines, which are called *appendices epploicæ*. The *gastro-phrenic ligament* is a duplicature extending from the diaphragm to the lesser curve of the stomach and extremity of the œsophagus; the *gastro-splenic omentum* is a duplicature connecting the stomach and spleen.

In *structure* a serous membrane consists of an external cellular fibrous layer, which is vascular and adherent to surrounding structures, and an internal dense and smooth layer, deficient of vessels. In general character serous membranes resemble a shut sac, and secrete a fluid resembling the serum or watery part of the blood.

THE ALIMENTARY CANAL.

The *alimentary canal* is a continuous tube from the mouth to the anus, musculo-membranous in structure, and distributed into various portions, called mouth, pharynx, œsophagus, stomach, and intestines; the intestines are subdivided into the small, which are distinguished into duodenum, jejunum, and ileum; and large intestines, distinguished into cæcum, colon, and rectum.

THE MOUTH.—The mouth is an irregular cavity, containing the organs of taste and instruments of mastication.

The *lips* are two fleshy folds attached to the surface of the jaws, and formed externally of common integument, internally of mucous membrane, with layers of muscles and numerous small glands between.

The *cheeks* (buccæ) form the sides of the face, and are constituted similarly to the lips; their glands are called *buccal*.

The *hard palate* is a dense structure of mucous membrane, fibrous tissue, glands, vessels, and nerves, firmly connected to the palate processes of the upper maxillary and palate bones. Its middle line is marked by an elevated raphé, on each side of which are transverse ridges and grooves.

The *gums* are thick, dense folds of mucous membrane attached to the periosteum of the alveolar processes, and remarkable for their insensibility.

The *tongue* has been already described.

The *soft palate* (velum pendulum palati) is a fold of mucous membrane, with glands and muscles, at the back part of the mouth, continuous above with the hard palate; the *uvula* is a small rounded process hanging from the middle of its inferior border.

The *tonsils* (amygdalæ) are two glandular almond-shaped bodies on each side of the fauces, between folds of the mucous membrane of the soft palate, which are called the *anterior* and *posterior pillars*. They are composed of an assemblage of mucous follicles opening on the surface of the glands.

The *isthmus of the fauces* is the space included between the soft palate and root of the tongue; it is the opening between the mouth and pharynx.

The *salivary glands* communicate with the mouth by their excretory ducts; they are the parotid, submaxillary, and sublingual. The *parotid*, the largest, is situated immediately in front of the external ear, extending deeply behind the ramus of the lower jaw. Embedded in its substance are the external carotid artery, temporo-maxillary vein, and facial nerve. Its excretory duct opens on the internal surface of the cheek opposite the second molar tooth of the upper jaw. The *submaxillary* is situated in the posterior angle of the submaxillary triangle of the neck, and behind the lower jaw. Its excretory duct opens on the papillæ under the tongue, by the side of the frænum linguæ. The *sublingual* is a flattened body beneath the mucous membrane of the floor of the mouth, on each side of the frænum linguæ. Its secretion is poured into the mouth by seven or eight small ducts, which open on each side of the frænum linguæ. In structure the salivary glands are conglomerate, consisting of lobes made up of small lobules, and these of still smaller lobules, the smallest lobule being composed of granules, which are minute cæcal pouches, formed by the dilatation of the extreme ramifications of the ducts.

THE PHARYNX.—The *pharynx* is a musculo-membranous sac between the mouth and œsophagus. Its anterior part is incomplete, and has opening into it the two posterior nares, the two Eustachian tubes, mouth, larynx, and œsophagus.

THE ŒSOPHAGUS.—The *œsophagus* is the continuation of the alimentary canal from the pharynx to the stomach. In its descending course along the spine it inclines to the left in the neck, to the right in the upper part of the thorax, and to the left again as it passes through the posterior mediastinum. It terminates at the cardiac orifice of the stomach about the tenth dorsal vertebra.

THE STOMACH.—The *stomach* is an expansion of the alimentary tube, its *greater* or *splenic end* being situated in the left hypochondriac region, where it is in contact with the concave surface of the spleen, and its *lesser* or *pyloric end* extending into the epigastric region. Above it forms a *lesser curvature*, and below a *greater curvature;* its opening into the œsophagus is the *cardiac orifice*, and its opening into the duodenum the *pyloric orifice*. (See fig. 107.)

THE SMALL INTESTINE.—The *small intestine* is about twenty-five feet in length, extending from the pylorus to the cæcum. Its first division is the *duodenum*, about twelve fingers' breadth in length. It ascends obliquely backward to the under surface of the liver, then descends perpendicularly in front of the right kidney, and then passes transversely across the third lumbar vertebra. A little below its middle it receives the ductus communis choledochus from the liver, and pancreatic duct from the pancreas. The second division is called *jejunum;* it forms the upper two fifths of the small intestine; it is thicker to the touch than the other portions, and has a pinkish tinge. The third division is the *ileum;* it is smaller in diameter, and thinner in texture, and paler than the jejunum. It opens into the colon at an obtuse angle, in the right iliac fossa.

THE LARGE INTESTINE.—The *large intestine* is about five feet in length, sacculated in appearance, and divided into the cæcum, colon, and rectum. The *cæcum* is the most dilated portion of the intestinal tube, forming a blind pouch, or cul-de-sac. Attached to its extremity is a worm-shaped tube, from one to five or six inches in length, called *appendix vermiformis;* it is the rudiment of the long cæcum found in all mammiferous animals except man and the higher quadrupeds. The *colon* is divided into *transverse*, *ascending*, and *descending*, and in the right iliac fossa it makes a remarkable curve upon itself, called the *sigmoid flexure*. The *rectum* is the termination of the large intestine; it descends in front of the sacrum, and near the extremity of the coccyx curves backward, and terminates at the *anus*, which is situated a little more than an inch in front of the coccyx. The integument around the anus is covered with hairs, and arranged into numerous radiated plates, which are obliterated during the passage of fæces. (See fig. 107.)

STRUCTURE OF THE ALIMENTARY CANAL.—The pharynx has mucous, fibrous, and muscular coats; the œsophagus has only mucous and muscular coats; the stomach and intestines have mucous, muscular, and serous coats. The mucous is the internal coat, the muscular the middle, and the serous the external.

The *mucous coat* very closely resembles the cutaneous covering of the exterior; it is composed of three layers, an *epithelium*, a *mucous proper*, and a *fibrous*. The *epithelium* is the epiderma of the mucous membrane. The *proper mucous* layer is analogous to the papillary layer of the skin. In the stomach it forms polyhedral cells, into the floor of which the gastric follicles open; in the small intestine it presents numerous minute projecting papillæ, called *villi*, which give the surface a velvety appearance; in the large intestine the surface resembles the cellular network of the stomach. The *fibrous layer* (formerly called "*nervous coat*") is the membrane of support, as the corium is to the papillary layer of the skin.

The *muscular coat* of the pharynx consists of the muscles already described; that of the rest of the alimentary canal is composed of two planes of muscular fibres, one of which is external and longitudinal, and the other internal and circular.

The *serous coat* is a layer of membrane derived from the peritoneum.

In the œsophagus the mucous membrane is disposed in *longitudinal plicæ;* in the stomach it is formed into plaits, or *rugæ;* at the pylorus it forms a spiral fold, which constitutes a part of the *pyloric valve;* in the lower part of the duodenum, the whole length of the jejunum, and upper part of the ilium, it forms valvular folds, called *valvulæ conniventes;* at the termination of the ilium in the cæcum it forms two projecting folds, called *ileo-cæcal valve;* in the cæcum and colon it is raised into cresentric folds; and in the rectum it forms three valvular folds.

The *glands* and *follicles* of the intestinal structure are situated in the loose cellular or areolar tissue of the mucous coat, connecting the mucous with the fibrous layer. The *pharyngeal glands* are large and numerous around the posterior nares; the *œsophageal glands* are small lobulated bodies opening upon its surface by a long, oblique excretory duct; the *gastric follicles* are long tubular bodies situated perpendicularly side by side throughout the mucous membrane of the stomach, and intended probably for the secretion of the gastric juice; the *duodenal glands* are small flattened granular bodies, resembling in structure small salivary glands, and opening on the surface by minute excretory ducts; the *solitary glands* are small saccular cavities in the small intestines, without an excretory duct, and in the large intestine small circular prominences, with a minute excretory opening in the centre; the *aggregate*, or *Peyer's glands*, are circular patches surrounded by simple follicles, near the lower end of the ilium; and the *simple follicles* are small pouches of mucous layer, dispersed in immense numbers over the whole mucous membrane.

The *arteries* of the alimentary canal are the pterygo-palatine, ascending pharyngeal, superior thyroid, and inferior thyroid, in the neck; œsophageal in the thorax; gastric, hepatic, splenic, superior, and inferior mesenteric, in the abdomen; and inferior mesenteric, iliac, and internal pudic, in the pelvis. The *veins* from the abdominal portion of the canal unite to form the vena portæ. The *lymphatics* and *lacteals* open into the thoracic duct. The *nerves* of the pharynx are derived from the glosso-pharyngeal, pneumogastric, and ganglionic; those of the stomach are the pneumogastric, and ganglionic branches from the solar plexus; those of the intestinal canal are the superior and inferior mesenteric and hypogastric plexuses; the extremity of the rectum is supplied by the inferior sacral nerves from the spinal cord.

THE LIVER.

The liver is a large conglomerate gland, and the largest organ in the body, weighing about four pounds, and measuring about twelve inches through its longest diameter. It occupies the right hypochondriac region, and extends across the epigastrium into the left hypochondriac, frequently reaching, by its left extremity, the upper end of the spleen. It is marked anteriorly by a deep notch, which divides it into two lobes. Above and behind it is in relation with the diaphragm, below with the stomach and ascending portion of the duodenum, transverse colon, right supra-renal capsule, and right kidney; its free anterior border corresponds with the lower margin of the ribs.

It is held in its place by five ligaments; the *longitudinal*, a fold of peritoneum extending through its notch; two *lateral*, formed by layers of peritoneum, which connect its lobes with the diaphragm; the *coronary*, formed by the separation of the two layers of the lateral; and the *round*, a fibrous cord resulting from the obliteration of the umbilical vein; this passes through a fissure in its under surface from the umbilicus to the inferior cava.

Its under surface is marked by five fissures; the *longitudinal*, the lower part of which contains the remains of the *ductus venosus*; the *transverse*, through which the hepatic artery, portal vein, and hepatic ducts enter the liver, the *fissure for the gall-bladder*, and the *fissure for the vena cava*.

These fissures divide the liver into five lobes; the *right*, five or six times larger than the left; the *left*, the *lobus quadratus*, on the under surface of the right lobe; the *lobus spigelii*, a triangular portion, also on the under surface of the right lobe; and the *lobus caudatus*, a small appendage of the former.

The *vessels* and *lymphatics* of the liver have been described; its *nerves* from the animal system proceed from the right phrenic and pneumogastric; those from the organic system are derived from the hepatic plexus.

Minute Anatomy of the Liver.—The liver is composed of lobules, a connecting medium called *Glisson's capsule*, of the ramifications of the *portal vein, hepatic duct, hepatic artery, hepatic veins, lymphatics*, and *nerves*, and is enclosed by the peritoneum and retained in position by its folds.

The *lobules* are small granular bodies, irregular in form, about the size of millet seeds, and, when divided longitudinally, have a foliated appearance. Each lobule is composed of a plexus of biliary ducts, of a venous plexus formed by branches of the portal vein, of a hepatic vein, and of minute arteries; nerves and absorbents are also supposed to enter into their formation, but have not been traced into them. To microscopic examination a lobule presents numerous minute bodies of a yellowish color and various forms, connected with each other by vessels; these minute bodies are the *acini* of Malpighi.

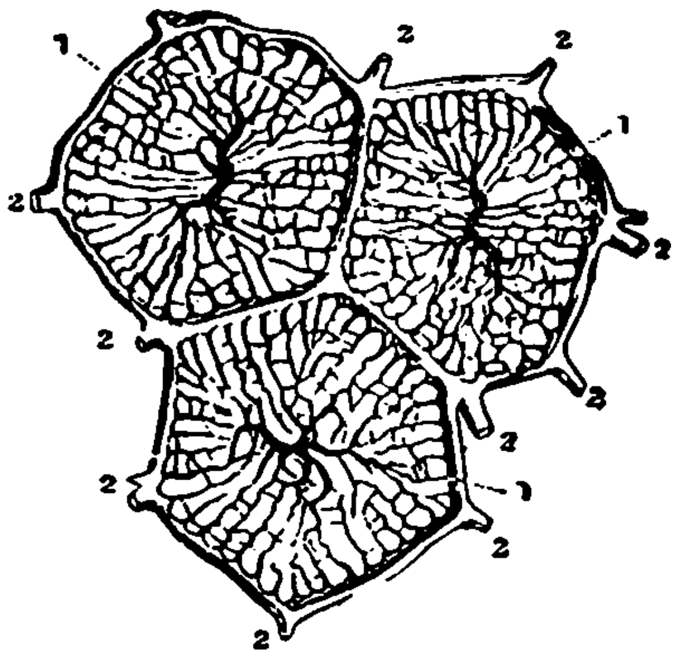
The branches of the *portal vein* are distributed through canals channeled in every part of the organ. This vein brings the returning blood from the chylopoietic viscera, and also conducts the venous blood from the ultimate ramifications of the hepatic artery; its branches in the canals are called *vaginal*, and form a venous *vaginal plexus;* these give off *interlobular branches*, and the latter enter the lobules and form *lobular venous plexuses;* from the blood circulating in these plexuses the bile is secreted.

The *bile* in the lobule is received by a network of minute ducts, the *lobular biliary plexus;* from the lobule it is conveyed into *interlobular ducts;* and these proceed into the biliary *vaginal plexus* of the portal canals, and thence into the excreting ducts, by which it is carried into the duodenum and gall-bladder, after being mingled in its course with the mucous secretion from the numberless muciparous follicles in the walls of the ducts.

The *hepatic artery* distributes branches through all the portal canals, gives off *vaginal branches*, which form a vaginal hepatic plexus, from which the *interlobular* branches arise, and these latter terminate ultimately in the lobular venous plexuses of the portal vein. The artery ramifies abundantly in the coats of the hepatic ducts, supplying materials for their mucous secretion, and for the nutrient vessels of the entire organ.

The *hepatic veins* commence in the centre of each lobule by minute radicles, which collect the impure blood from the lobular venous plexus, and convey it into the *interlobular veins;* these open into veins called *sublobular*, and the sublobular unite to form the large hepatic trunks by which the blood is conveyed into the vena cava.

Fig. 116.



LOBULES OF THE LIVER.

An important physiological deduction from the anatomical structure of the liver is, that bile is wholly secreted from venous blood, and not from a mixture of venous and arterial blood, as stated by Muller; and an equally important pathological inference is, that bile is wholly an excrementitious fluid, and not "auxiliary to digestion," as many physiologists suppose.

Fig. 116 is a horizontal section of three superficial lobules, showing the two principal systems of blood-vessels.

THE GALL-BLADDER.—The *gall-bladder* is a pyriform sac, which serves as a reservoir for the bile. It is situated on the under surface of the right lobe of the liver, and composed of serous, fibrous, and mucous coats. Its mucous coat is raised into minute rugæ, which form a spiral valve at the neck of the sac.

The *biliary ducts* are three: the *ductus communis choledochus*, which is the common excretory duct of the liver and gall-bladder, about three inches long, and about the size of a crow-quill, commences at the middle of the duodenum, and before reaching the liver divides into the *cystic*, which is about an inch in length, and enters the neck of the gall-bladder, and the *hepatic*, which continues onward to the transverse fissure, where it divides into two branches, which ramify through the portal canals to all parts of the liver.

THE PANCREAS.

The *pancrecs* (sweet-bread) is a long, flat, conglomerate gland, in structure and function analogous to the salivary glands. It is about six inches long, weighs about four ounces, situated transversely across the abdomen behind the stomach, opposite the first and second lumbar vertebræ. Its greater end, or head, is placed toward the right, surrounded by the curve of the duodenum; the lesser end extends to the left as far as the spleen. Upon the posterior part of its head is a lobular fold, called the *lesser pancreas.*

In *structure* the pancreas is composed of reddish-yellow polyhedral lobules, these consisting of smaller lobules, and these again composed of the ramifications of minute ducts, terminating in cæcal pouches. The *pancreatic duct* commences at the papillæ on the inner surface of the duodenum by a small dilatation common to it and the ductus communis choledochus, and passes obliquely through the middle of the gland, giving off numerous branches to be distributed through its substance. A smaller duct, the *ductus pancreaticus minus*, receives the secretion of the lesser pancreas; it generally opens into the principal duct near the duodenum, but sometimes passes into that intestine separately.

Its *arteries* are branches of the splenic, hepatic, and superior mesenteric; its *veins* open into the splenic; its *lymphatics* terminate in the lumbar glands; its *nerves* are filaments of the splenic plexus.

THE SPLEEN.

The spleen is an oblong flattened viscus, of a dark, bluish-red color, situated in the left hypochondrium. Its size and weight are variable; its texture is exceedingly spongy, vascular, and friable. Its internal surface is marked with several large irregular openings for the entrance and exit of vessels; this is the *hilus lienis.* A second spleen is sometimes found appended to one of the branches of the splenic artery, about the size of a hazel nut, and occasionally two and three of these bodies have been found.

The spleen is profusely supplied with blood; the *splenic artery* is very large in proportion to the bulk of the organ, and its branches are distributed to distinct sections, sparingly anastomosing with each other. The *veins*, by their numerous dilatations, form most of its bulk; their blood is poured into the splenic vein, which is one of the trunks that form the portal. The *lymphatics* are remarkable for their number and large size, and terminate in the lymphatic glands. Its *nerves* are the splenic plexus, derived from the solar.

The function of the spleen is unknown. Most physiologists have conjectured that it was in some way auxiliary to digestion; others, with more probability, have regarded it as a sort of brain-appendage to the organic nervous system. This hypothesis is strengthened by its peculiar structure, which has many points of resemblance both to secernent glands and the cerebro-spinal substance; and by the absence of an excretory duct.

THE SUPRA-RENAL CAPSULES.

The *supra-renal capsules* are two small, yellowish, flattened bodies, surmounting the kidneys, and inclining toward the vertebral column. The right is triangular in shape, the left semilunar; they are connected to the kidneys by the common cellular tissue and a fissure on the anterior surface divides each capsule into two lobes. Both capsules rest against the curve of the diaphragm on a level with the tenth dorsal vertebra. They are larger in the fœtus than in the adult, and are supposed to perform some function connected with embryonic life.

Their structure is composed of cortical and medullary substances. Their *arteries*, derived from the aorta, renal and phrenic arteries, are remarkable for the innumerable minute twigs into which they divide before entering the capsule. The *supra-renal vein*, whose large trunk in its centre gives the capsule the appearance of a central cavity, collects the blood from the medullary venous plexus, and receiving several branches which pierce the cortical layer, opens directly into the vena cava on the right side, and into the renal vein on the left. Their *lymphatics* are large and numerous, and terminate in lumbar glands. The *nerves* are derived from the phrenic plexus.

THE KIDNEYS.

The secreting organs of the urine are situated in the lumbar regions, behind the peritoneum, and on each side of the vertebral column, which their upper extremities approach. Each kidney is between four and five inches long, two and a half broad, about an inch thick, weighing from three to five ounces. The *right kidney* is somewhat lower than the left, from the position of the liver; the *left* is covered in front by the great end of the stomach and the spleen.

The structure of the kidney is dense and fragile, and when divided presents an external, vascular, or cortical, and an internal, tubular, or medullary substance. The *tubular* portion is formed of pale-reddish conical masses, and the *vascular* portion of blood-vessels and plexiform convolutions of uriniferous tubuli, which not only constitute the surface, but dip between the cones and surround them nearly to their apices.

The cones, or pyramids, are composed of minute straight tubuli uriniferi, of a diameter not exceeding that of a fine hair, which commence at the apices of the cones, and bifurcate from point to point toward the circumference of the kidney.

Fig 117.

SECTION OF THE KIDNEY.

Fig. 117 is a section of the kidney surmounted by the supra-renal capsule; the swellings on the surface mark its original constitution in distinct lobes 1. Supra-renal capsule. 2. Vascular portion. 3, 3. Tubular portion, consisting of cones. 4, 4. Two of the papillæ projecting into their corresponding calices. 5, 5, 5. The three infundibula; the middle 5 is situated in the mouth of a calyx. 6. Pelvis. 7. Ureter.

In the cortical portion are contained a multitude of very small, red, globular bodies, called *glomeruli*, or *corpora Malpighiana*, each of which is composed of a plexus of capillary vessels, and a coil of uriniferous tubule, both enclosed in a thin membranous capsule. The cones of the interior are invested by mucous membrane, which is continuous at their apices with the uriniferous tubuli, and is reflected from their sides so as to form around each a cup-like pouch, or *calyx*. The calices communicate with a common cavity of large size at each extremity and in the middle, and three cavities, called the *infundibula*, unite and form a membranous sac, which occupies the hilus renalis, the *pelvis* of the kidney.

The excretory duct of the kidney is called *ureter;* it is a membranous tube about as large as a goose-quill, and nearly eighteen inches long; it is situated behind the peritoneum, crossed by the spermatic vessels, and in its course downward crosses the common iliac artery and vein, and then the external iliac vessels; within the pelvis it crosses the umbilical artery and vas deferens in the male, and the upper part of the vagina in the female, and terminates upon the internal surface of the bladder. Sometimes there are two ureters to one kidney.

Mr. Bowman, who has investigated the intimate structure of the kidneys, thinks there are two distinct systems of capillary vessels, through both of which the blood passes in its course from the arteries into the veins, and that certain saline substances and morbid products, as sugar and albumen, which escape from the system through the urine, and also the principal constituents of urine, such as urea, lithic acid, etc., are, like the bile in the liver, derived from venous blood.

THE PELVIC VISCERA.

The cavity of the pelvis is the lower portion of the abdominal cavity; it is included within the bones of the pelvis, below the level of the linea-ilio-pectinea and the promontory of the sacrum. The male pelvic viscera are the urinary bladder, prostate gland, vesiculæ seminales, and rectum.

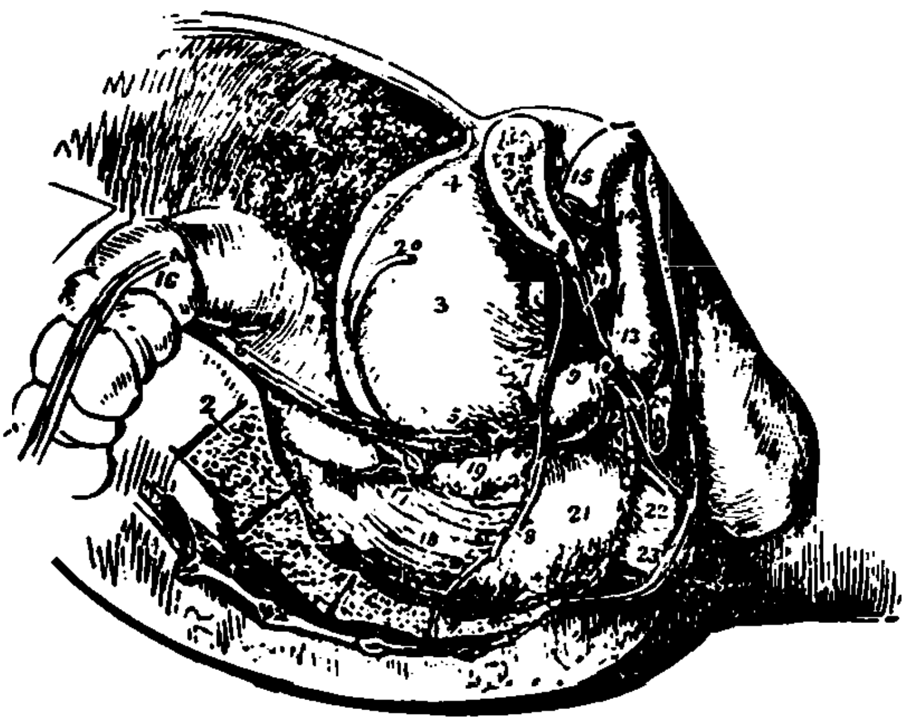
The *bladder* is an ovoid-oblong membranous sac, situated behind the ossa pubis and in front of the rectum. Its middle portion is called the *body;* its upper segment the *fundus;* its broad surface resting on the rectum, the *base;* and the narrow constricted portion against the prostate gland, the *neck.*

It is composed of *serous, muscular,* and *mucous* coats; the muscular coat is composed of longitudinal fibres externally, and an internal layer of transverse and oblique fibres, so arranged as to diminish the diameter of the viscus in all directions in the expulsion of its contents; a ring of elastic tissue surrounds the urethra within the prostate gland, to which the longitudinal fibres are attached, whose contraction enlarges the passage from the bladder into the urethra. Upon the internal surface of its base is a pale triangular plane, called *trigonum vesicale,* the most sensitive portion of the bladder, and occasioning great suffering when pressed upon by calculi. At the entrance of the urethra there is a slight elevation of the mucous membrane, called *uvula vesicæ.* It is retained in its place by seven *true ligaments;* two *anterior,* formed by the pelvic fascia; two *lateral,* formed by a reflection of the pelvic fascia and levatores ani muscles upon the sides of its base; two *umbilical,* the fibrous cords resulting from the obliteration of the umbilical arteries of the fœtus; the *urachus,* a small fibrous cord, formed by the obliteration of a tubular canal existing in embryo, attached to the apex of the bladder, and thence ascending to the umbilicus; and four *false ligaments,* which are folds of peritoneum, the two *lateral* corresponding with the passage of the vasa deferentia from the sides of the bladder to the internal abdominal rings, and the two *posterior* with the course of the umbilical arteries to its fundus.

The external surface of the bladder corresponding with the trigonum is triangular, and separated from the rectum merely by a thin layer of fibrous membrane, the *recto-vesical fascia.* It is through this space, bounded behind by the recto-vesical fold of peritoneum, and on each side by the vas deferens and vesicula seminalis, which converge almost to a point at the base of the prostate gland, that the opening is made in the recto-vesical operation for puncturing the bladder.

The *prostate gland* is situated in front of the neck of the bladder, and upon the rectum, through which it may be felt with the finger, surrounding the commencement of the urethra for a little more than an inch of its extent, in size and form resembling a Spanish chestnut. It consists of two lateral lobes, and a middle lobe or isthmus, and its structure is composed of ramified ducts, terminating in lobules of follicular pouches. Its secretion is poured into the prostatic portion of the urethra by fifteen or twenty excretory ducts.

Fig. 118.



VISCERA OF THE PELVIS.

Fig. 118 is a side view of viscera of the male pelvis. 1. Divided surface of the os pubis. 2. Divided surface of the sacrum. 3. Body of the bladder. 4. Its fundus; the urachus is seen passing upward from the apex. 5. Its base. 6. Ureter 7. Neck of the bladder. 8, 8. Pelvic fascia; the fibres above 7 are given off from the pelvic fascia, and represent the anterior ligaments of the bladder. 9. Prostate gland. 10. Membranous portion of the urethra, between the two layers of the deep perineal fascia. 11. The deep perineal fascia, formed of two layers. 12. One of Cowper's glands, between the layers and beneath the membranous portion of the urethra. 13. Bulb of the corpus spongiosum. 14. Body of the corpus spongiosum. 15. Right crus penis. 16. Upper part of the first portion of the rectum. 17. Recto-vesical fold of peritoneum. 18. Second portion of the rectum. 19. Right vesicula seminalis. 20. Vas deferens. 21. The rectum covered by the descending layer of the pelvic fascia, just as it is making its bend backward to constitute the third portion. 22. Part of the levator ani muscle investing the lower part of the rectum. 23. External sphincter ani. 24. Interval between the deep and superficial perineal fascia; they are seen to be continuous beneath the number.

The *vesiculæ seminales* are lobulated bodies, about two inches in length, situated on the under surface of the base of the bladder, and separated from the rectum only by the recto-vesical fascia. Each vesicula is formed by convolutions of a single tube, which gives off several irregular cæcal branches; it is enclosed in a dense fibrous membrane, derived from the pelvic fascia, and is constricted beneath the isthmus of the prostate gland into a small excretory duct. The *vas deferens* of the testis, somewhat enlarged and convoluted, lies along the inner border of each vesicula, and is included in its fibrous investment. It communicates with the duct of the vesicula, beneath the isthmus of the prostate, and forms the *ejaculatory duct*, which is about three fourths of an inch in length, and opens on the mucous membrane of the urethra.

The *penis* and *testes*, with their appendages, constitute the male organs of generation. The *penis* is divided into a head, the anterior extremity of which is the *glans*, a *root* which is strongly adherent to the pelvis, and an intervening *body*, consisting of two structures, called *corpus cavernosum* and *corpus spongiosum*. The integument of the penis is thin, and destitute of adipose matter. Surrounding the glans is a loose doubling, called the *prepuce;* this is connected to the orifice of the urethra by a process called *frænum;* the edge around the base of the glans is called *corona glandis;* the *glands of Tyson* are small papillary elevations around the base of the glans; their secretion is called *smegma;* the fascia is situated beneath the skin, and is but a modification of the superficial abdominal fascia; a portion connecting the penis with the pubis is called *ligamentum suspensorium*.

The largest part of its *body* is formed by the *corpus cavernosum*, which in shape resembles a double cylinder; these cylinders, separated and pointed at the root, are there called the *crura*, each *crus* being firmly attached to the ramus of the pubis and ischium. Externally this structure is covered by a thick fibro-elastic coat, and internally of erectile tissue. The partial separation of the two cylinders is called *septum pectiniforme*. The *corpus spongiosum* is situated along the under surface and in the inferior groove of the corpus cavernosum. Its posterior extremity is enlarged into the *bulb*, and its anterior is expanded into the *glans*. It is composed of erectile tissue, a peculiar cellulo-vascular structure entering largely into the composition of the organs of generation, and contains in its interior the spongy portion of the urethra.

The *urethra* is the urinary canal from the bladder through the penis. Its structure is membranous, composed of mucous and elastic-fibrous coats. Its diameter varies in different parts of its course, which is somewhat curved. The first portion is called the *prostatic urethra;* this is about an inch in length; on its lower surface is a longitudinal fold of mucous membrane, called *veru montanum*, or *caput gallinaginis;* on each side of this a depression called *prostatic sinus*, into which the prostatic ducts open; at the anterior extremity of the veru montanum are the openings of the ejaculatory ducts. The next portion is *membranous;* this is eight or ten lines in length, and very narrow, surrounded by loose tissue and a few muscular fibres. The rest is the *spongy* portion, six or seven inches in length; it is narrowest in the body of the organ; posteriorly it is dilated into the bulb, forming the *bulbous urethra*, and anteriorly in the glans it enlarges into the *fossa navicularis*. The external opening, *meatus urinarus*, is the most constricted portion of the canal, so that a catheter which will enter that opening will pass freely through the whole extent of a healthy urethra.

Cowper's glands are two small lobulated bodies, about the size of peas, situated beneath the membranous portion; their excretory ducts open into the bulbous portion. The whole internal surface of the spongy portion of the urethra is marked with *lacunæ*, or openings of mucous glands situated in the submucous cellular tissue. These openings are directed forward, and sometimes obstruct the point of a small catheter in its passage to the bladder.

The *testes* are glandular organs suspended from the abdomen by the spermatic cord, and enclosed in an integument called the scrotum. The *scrotum* is composed of a *tegumentary layer*, extremely thin, transparent, and corrugated, and beset with hairs having very prominent roots, and a proper covering called *dartos*, a fibro-muscular tissue, which sends inward a partition, *septum scroti*, which divides it into two cavities for the two testes.

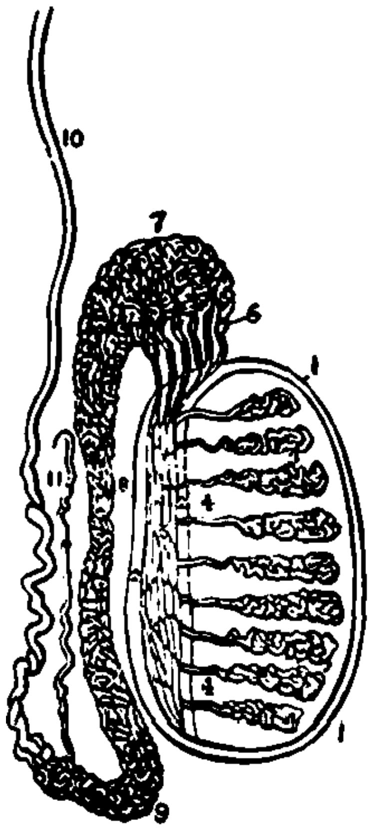
The *spermatic cord*, composed of arteries, veins, nerves, lymphatics, the excretory duct of the testicle, and investing tunics, is the medium of communication between the testes and interior of the abdomen. It commences at the internal abdominal ring, where the vessels composing it converge, and passes obliquely along the spermatic canal, escaping at the external abdominal ring, and descending through the scrotum to the posterior border of the testicle. The excretory duct of the testicle is called *vas deferens;* its coats are thick and tough, and it may be distinguished along the posterior border of the spermatic cord by the hard and cordy sensation it communicates to the fingers.

Each *testis* is an oblong rounded gland suspended in the cavity of the scrotum by the spermatic cord; its function is to secrete the seminal fluid. Encircling its posterior edges is a soft flattened body, called *epididymis;* it is formed by the convolutions of the excretory seminal ducts; its upper extremity is called *globus major*, and the lower *globus minor;* this extremity curves upward and becomes continuous with the vas deferens. The testis has three coverings, a serous coat called *tunica vaginalis;* a thick, middle, fibrous membrane, called *tunica albuginea*, which surrounds the testis, and is reflected into its interior, forming the *mediastinum testis*, from which numerous fibrous cords, *trabeculæ septula*, are given off; and an internal nutrient membrane called *tunica vasculosa*, which, analogous to the disposition of the pia mater in the brain, sends processes inward between the lobules of the organ.

The substance of the testis consists of numerous flattened lobules, with their bases toward the surface. Krause counted between four and five hundred of them. Each lobule is invested in a distinct sheath, formed of two layers, one from the tunica vasculosa, and the other from the tunica albuginea, and composed of several minute tubuli, *tubuli seminiferi*, exceedingly convoluted, frequently anastomosing near their extremities, and terminating in loops or cæcal ends of about $\frac{1}{170}$ of an inch in diameter. The tubuli seminiferi are of a bright yellow color, become less convoluted in the apices of the lobules, and terminate by forming from twenty to thirty small straight ducts of about twice the diameter of the tubuli seminifera; these ducts are the *vasa rectæ*.

Fig. 119 represents the minute structure of the testis. 1, 1. Tunica albuginea. 2, 2. Mediastinum testis. 3, 3. The lobuli. 4, 4. Vasa recta. 5. Rete testis. 6. Vasa efferentia; six of them only are shown in the diagram. 7. Cervi vasculosi, constituting the globus major of the epididymis. 8. Body of the epididymis. 9. Its globus minor. 10. Vas deferens. 11. Vasculum aberrans.

Fig. 119.



ANATOMY OF THE TESTIS.

The vasa recta enter the mediastinum, and terminate in from seven to thirteen smaller ducts, which pursue a waving course from below upward, through the fibrous tissue of the mediastinum, and communicate freely with each other, constituting the *rete testis*. The ducts of the rete testis terminate at the upper extremity of the mediastinum in small ducts called *vasa efferentia;* these vary in number from nine to thirty, and form, by their convolutions, numerous conical masses, the *coni vasculosi;* from the bases of these cones larger-sized tubes proceed, whose complex convolutions form the body of the epididymis.

THE FEMALE PELVIS.

The viscera of the female pelvis are the bladder, vagina, uterus and its appendages, the rectum, and some portion of the small intestines, which occupy the upper part of the cavity.

The *bladder* is situated behind the ossa pubis and in front of the uterus; it is broader than in the male, corresponding with the broader pelvis.

The *urethra* is about an inch and a half in length, and is lodged in the upper wall of the vagina, in its course downward and forward beneath the arch of the os pubis, to the meatus urinarius. It is surrounded by a proper coat of elastic tissue, to which the muscles of the

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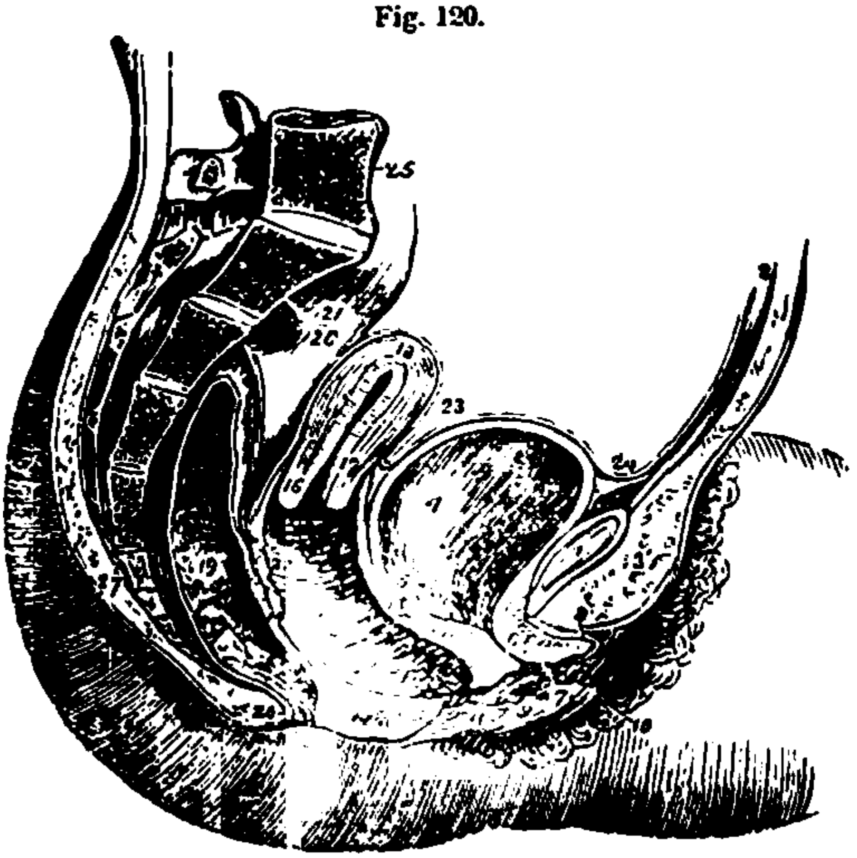
detrusor urinæ are attached, and to which the remarkable dilatability of the female urethra is owing.

Fig. 120.



VISCERA OF THE FEMALE PELVIS.

Fig. 120 is a side view of the viscera of the female pelvis. 1. Symphysis pubis, to the upper part of which the tendon of the rectus muscle is attached. 2. Abdominal parieties. 3. Collection of fat, forming the prominence of the mons Veneris. 4. Bladder. 5. Entrance of the left ureter. 6. Canal of the urethra, converted into a mere fissure by the contraction of its walls. 7. Meatus urinarius. 8. Clitoris, with its præputium, divided through the middle. 9. Left nympha. 10. Left labium majus. 11. Meatus of the vagina, narrowed by the contraction of its sphincter. 12, 22. Canal of the vagina, upon which the transverse rugæ are apparent. 13. The thick wall of separation between the vagina and rectum. 15. The perineum. 16. Os uteri. 17. Its cervix. 18. Its fundus; the cavitas uteri is seen along its centre. 19. Rectum, showing the disposition of its mucous membrane. 20. Anus. 21. Upper part of the rectum, invested by the peritoneum. 23. Utero-vesical fold of peritoneum; the recto-uterine fold is seen between the rectum and the posterior wall of the vagina. 24. The reflexion of the peritoneum, from the apex of the bladder upon the urachus to the internal surface of the abdominal parieties. 25. Last lumbar vertebra. 26. Sacrum. 27. Coccyx.

The *vagina* is a membranous canal leading from the vulva to the uterus; its structure is composed of *mucous*, *erectile*, and *contractile fibrous tissues*. The mucous membrane is marked by a number of transverse papillæ, or *rugæ*, and is covered by a thin cuticular epithelium, which is continued from the labia to the middle of the cervix uteri.

The *uterus* is a flattened, pear-shaped organ, occupying the upper part of the pelvic cavity between the bladder and rectum. Its *fundus* and *body* are enclosed in a duplicature of peritoneum, which forms a transverse septum between the bladder and rectum, the folds of which, on either side of the uterus, are its *broad ligaments*. Its lower portion is the *cervix;* around the circumference the upper end of the vagina is attached; its opening into the vagina is the *os uteri.* Its structure consists of an external *serous* coat, derived from the peritoneum, a middle *muscular* coat, and an internal coat of *mucous membrane.* The muscular coat gives it density and bulk, and in the unimpregnated state is exceedingly firm in texture, appearing to be composed of whitish fibres, inextricably interlaced and mingled with blood-vessels. During pregnancy the fibres become large and distinct, and disposed in two layers. The *superficial layer* consists of vertical fibres, some of which are longitudinal and others oblique. The *deep layer* consists of two hollow cones of circular fibres, having their apex at the openings of the Fallopian tubes, and intermingling by their bases on the body of the organ. Around the cervix they assume a circular form, and interlace at right angles.

Its *arteries* are the uterine from the internal iliac, and the spermatic from the aorta. Its *veins* are large, and in the unimpregnated state are called sinuses, being canals channeled through the substance of the organ, and lined by the mucous membrane. They terminate in the uterine plexuses on each side. The *lymphatics* terminate in the lumbar glands. The *nerves* are derived from the hypogastric, spermatic, and sacral plexuses. Dr. Robert Lee, after making the nervous structure of the uterus a subject of special investigation, concludes that "The human uterus possesses a great system of nerves, which enlarges with the coats, blood-vessels, and absorbents, during pregnancy, and which returns after parturition to its original condition before conception takes place."

The *appendages of the uterus* are the Fallopian tubes and ovaries, enclosed by the lateral duplicatures of the peritoneum, which constitute the broad ligaments.

The Fallopian tubes are the oviducts by which the impregnated ovum is conveyed to the uterus. Each tube is four or five inches in length; its canal is exceeding small; its opening into the uterus is called *ostium uterinum*, and that of its outer or free extremity, *ostium abdominale;* this end has a fringed-like appendage, called *fimbriata*, and is connected with the ovary by a short ligamentous cord, by which it is conducted to the surface of the ovary during sexual excitement. The coats of the tubes are *peritoneal*, *muscular*, and *mucous.*

The *ovaries* are oval, flattened, whitish bodies, situated in the posterior layer of peritoneum of the broad ligament, and connected to the upper angles of the uterus by a rounded cord, called the *ovarian ligament.* In structure each ovary is composed of cellulo-fibrous parenchyma or stroma, traversed by blood-vessels, and enclosed in a capsule consisting of vascular, fibrous, and serous layers In the cells of the stroma the small vesicles or ovisacs of the future ova, the *Graafian vesicles*, are developed. Each ovary contains about fifteen fully formed vesicles, although innumerable microscopic ovisacs exist in the parenchyma. A yellow spot or cicatrix, called *corpus luteum*, is found in one or both ovaries after conception. A *false corpus luteum* is sometimes met with in the ovaries of virgins; it is of a similar appearance, but smaller in size and without a central cavity.

The *external organs of generation* in the female are the mons Veneris, labia majora, labia minora, and clitoris; the internal being the vagina, uterus, ovaries, and Fallopian tubes, which have been described.

The *mons Veneris* is the prominent integument upon the front of the ossa pubis; its cellular tissue is loaded with adipose substance, and the surface covered with hair. The *labia majora* are longitudinal folds of adipose cellular tissue and integument, which form the common urino-sexual opening, or *vulva*. The *labia minora*, or *nymphæ*, are smaller folds, situated within the former. The *clitoris* is a small elongated body, situated in front of the ossa pubis, analogous to the corpus cavernosum of the penis, and, like it, arises by *crura* from the pelvis; its extremity is called its *glans*. The entrance of the vagina is about an inch behind the clitoris; it is closed in virgins by a partial membrane stretched across the opening; this is called the *hymen*; it is extremely variable in its form and appearance, and not unfrequently is entirely wanting. Sometimes it is imperforate, and occasionally it is so firm as to require a surgical trans-section. Frequently there is the appearance of a fringe of papillæ, *carunculæ myrtiformes*, around the opening of the vagina, which are the remains of a rudimentary or ruptured hymen. The *meatus urinarius* is situated behind the clitoris, and immediately in front of, and surrounded by, a tubercle at the upper angle of the vagina, and formed by the prominence of its upper wall.

THE MAMMARY GLANDS.

The *mammæ* exist in a rudimentary state in the male, and form a part of the reproductive system of the female. They are situated in the pectoral region, and only separated from the pectoralis major muscle by a thin fascia. The base of each mamma is somewhat elliptical; the anterior aspect is convex, having a central prominence of integument, called the *nipple*, surrounded by a colored areola. In structure it is a conglomerate gland, consisting of lobes held together by firm cellular tissue; the lobes are composed of lobules, and those of minute cæcal vesicles, which are the ultimate termination of the excretory ducts. The excretory ducts, *tubuli lactiferi*, are ten to fifteen in number, commencing by small openings at the apex of the nipple, and passing inward parallel with each other to the central part of the organ, where they form dilatations, *ampullæ*, and give off numerous branches to ramify through the gland to their ultimate termination in the minute lobules. The ducts and cæcal vesicles, in common with all others in the body, are lined by mucous membrane.

GENERAL ANATOMY OF THE FŒTUS.

The medium weight of a child of the full period is about seven pounds, and its length seventeen inches. The head is disproportionately large, and greatly lengthened from before backward, while the face is small. The chest is fully expanded, and the upper extremities well developed. The great size of the liver renders the upper part of the abdomen large and prominent; the lower part is small and conical, and the lower extremities very small comparatively.

The *osseous system* is to a great extent soft and cartilaginous. The bones of the head are separated by spaces where the ossification has not yet taken place, allowing them to move upon and even overlap each other.

The *muscular system* is well developed at birth, the muscles being generally large and fully formed. Their color is lighter, and their texture softer than in the adult. On the fibres of animal life the transverse striæ are not distinguishable until the sixth month of fœtal life.

The *vascular system* presents many peculiarities. The two auricles of the heart communicate by means of the *foramen ovale*. There is a communication between the pulmonary artery and descending aorta by means of a large trunk, the *ductus arteriosus*. The internal iliac arteries are continued to the placenta, by which the fœtal blood is returned to the placenta for revivification. There is also a communication between the umbilical vein and the inferior vena cava, the *ductus venosus*.

In the *nervous system* the brain is very soft, almost pulpy, but the nerves are firm and well developed.

The *eye* and *ear* of the organs of sense are large and fully developed, while the internal structure of the *nose* is very imperfectly developed.

The *lungs* are dense and solid in structure until inflated by the act of inspiration. The lung is proportionately large, and early developed, at first appearing like a simple vessel, but gradually becoming more complicated until perfected at birth. The two auricles communicate with each other until the moment of birth. There is also a communication between the pulmonary artery and aorta, called *ductus arteriosus*.

In the fœtal circulation the *pure* blood is brought from the placenta by the umbilical vein, which passes through the umbilicus and enters the liver, dividing these into numerous branches.

Of the abdominal viscera, the *liver* is first formed; the *stomach* and *spleen* are comparatively small, the *pancreas* large; the large intestines are filled with a greenish viscous secretion, called *meconium*.

NOTE.—The particular anatomy and physiology of the fœtus will be given in Part VIII.

PART II.

PHYSIOLOGY.

DEFINITIONS.—Physiology is the doctrine of the functions. It explains the actions and uses of the various organs and parts of the living body in its healthy or *normal* condition. Its *abnormal* or diseased states belong to the department of pathology. The functions have been divided into various classes, and each class admits of numerous subdivisions. The ancient physiologists divided them into *vital*, *animal*, and *natural*, corresponding to *nutritive*, *mental*, and *excretory* processes. Some modern authors have adopted Bichat's arrangement into *individual* and *social*, the former being subdivided into *animal* and *organic*. In general terms, *innervation*, *circulation*, and *respiration* are called *vital functions;* while these with *digestion*, *absorption*, *assimilation*. *secretion*, and *calorification*, are regarded as *nutritive functions; sensation*, *voice*, *muscular motion*, and *mental manifestation* constitute the *animal* or *relative functions;* and *generation* is the *reproductive function.*

CHAPTER I.

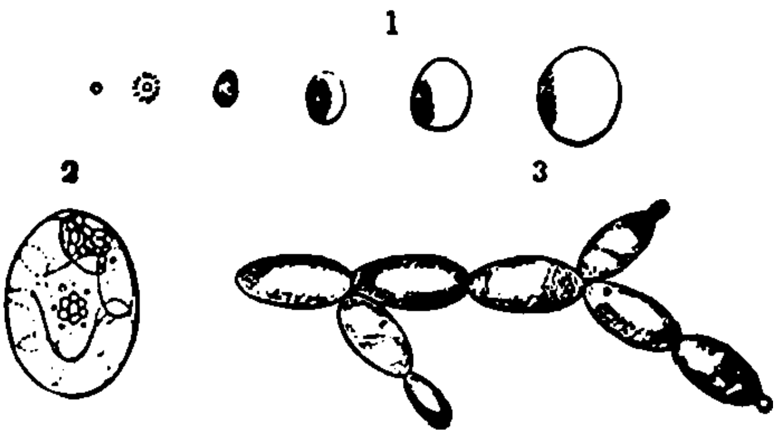
OF THE TISSUES.

GENERAL CHARACTERS OF THE TISSUES.—Though the bodily structures admit of many divisions, according to form, color, consistency, and arrangement, the phenomena of life may be more clearly presented by considering them in the relations of primary and secondary. The *primary* tissues are the *cellular* or *areolar*, *muscular*, and *nervous*. The vital property of the cellular substance is *elasticity*, of the muscular *contractility*, and of the nervous *sensibility*. Distinguished chemically, *gelatin* is the prevailing quality of the cellular tissue, *fibrin* of the muscular, and *albumen* of the nervous. The cellular structure supplies the body with materials of form, the muscular furnishes the agents of action, and the nervous provides the instruments of feeling. The secondary tissues are *membranes*, *ligaments*, *cartilages*, and a portion of the *bones*, *hair*, and *nails*, being various forms of cellular or gelatinous substance in different degrees of density.

The varied forms of all animal and even vegetable tissues are constituted of aggregations of two kinds of cells, variously modified. The cells are called *formative* and *secreting*; the only difference between them is, the former secretes a solid or semi-solid substance, which remains in the body with the debris of the cell for an appreciable time, and the latter secretes a fluid which escapes from the body with the remains of the cell which produced it. Each of these little cell-bodies has been compared to a laboratory, which receives from the surrounding matter the elements which it requires, and combines them so as to accomplish a desired result.

DEVELOPMENT OF CELLS.—A cell originates in a mass of soft or liquid matter which is formed of a combination of elements capable of being fitted into an organized structure. The matter is called *blastema*. In this blastema a minute point arises, which gradually increases in size, while a transparent wall springs up from one side of the point or granule, and continues to swell until the granule is seen to exist in and adhere to one side of the cell wall. Thus is formed the cell wall, with its fluid contents, and the granule or nucleus which, in a further stage of development, exhibits in its interior several new granules or nucleoli.

Fig. 121.



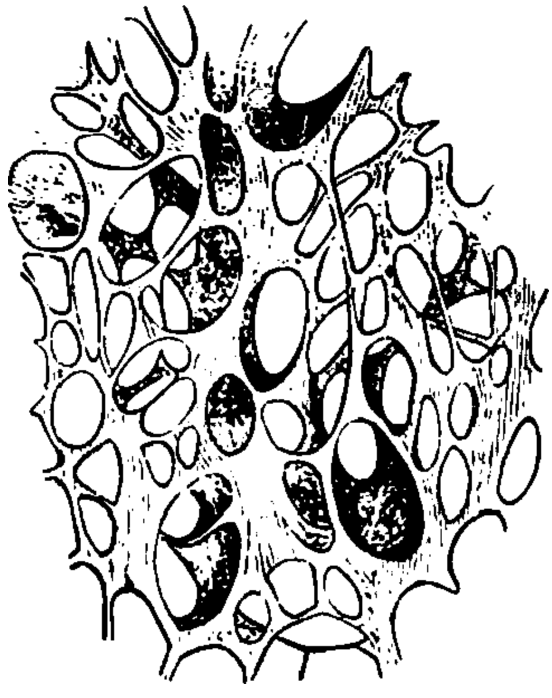
DEVELOPMENT OF CELLS.

The development and multiplication of cells are represented in fig 121. 1. Development of cell from the blastema. On the left is seen the corpuscle which becomes the nucleus; on the right the complete nucleated cell. 2. Development of new cells within the parent cell. 3. Development of new cells from the outer wall of pre-existing cells.

The cells undergo various transformations in the production of the different structures. They may lose their fluid contents, and their walls, by collapsing and adhering together, form simple, membranous, transparent disks. They also elongate, so as to form tubes or solid rods; in the former case they adhere by their ends to neighboring cells, and their cavities mutually open into each other, forming a vessel; in the latter case the contained fluid is lost, and a solid rod or fibre is the result. The cavities of cells may be obliterated by solid deposits within them, as in the formation of cartilage.

THE CELLULAR TISSUE.—The cellular or areolar tissue is the simplest form of animalized matter. It is flexible and adhesive, yet these properties seem to be included in the general term, elasticity. It pervades and connects together every part of the system, and being composed of membranous layers irregularly joined, so as to form numerous interstices of various capacities, air introduced under the skin may diffuse itself all over the surface of the body, a circumstance often resulting from wounds of the lungs.

Fig. 122.



AREOLAR TISSUE.

The cellular tissue is not composed of a congeries of distinct, isolated cells, but of cavities and interstices freely communicating with each other; hence the term *areolar* is generally applied to this structure by late authors. There are two kinds of this tissue, called *reticular* and *adipose*. The former is dispersed throughout the entire body, except the brain, the bones, and humors of the eye. It is scarcely perceptible in the tendons of muscles, but plentiful in their fleshy parts. The adipose portion is a connection of fibres running in various directions so as to form cavities, which have been called cells; into these cavities the fatty or oily matters are deposited. In some parts of the body it is merely a network of slender fibres, which give pliability and looseness. In other places it is more or less loaded with oil.

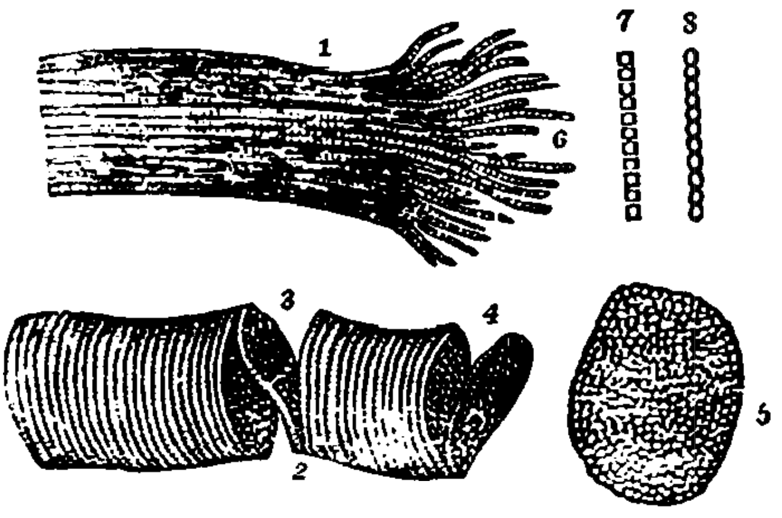
The uses of the areolar structure are, to give form and symmetrical smoothness to the body by filling up the interstices, defend the various organs and parts against pressure, connect different parts so as to admit of some degree of sliding motion between them, and serve as a bed for more tender organs, as the eye. It also relieves the body, to some extent, of the immediate bad effects of excessive alimentation, by affording a reservoir for surplus animal fat. It is a common error to suppose that persons who increase in bulk after having attained maturity of growth, acquire more *flesh*. They are merely burdened with a useless load which should have been expelled as waste matter. The areolar structure is very readily regenerated when destroyed.

THE MUSCULAR TISSUE.—The muscular or fibrinous tissue is of a higher grade of organization. Physiologists ascribe to it the vital properties of *contractility*, *irritability* or *excitability*, and *tonicity*; but to my mind, one term includes all the others. They are all merely expressions of the power of the muscular fibre to act, move, contract, upon the application of exciting causes. Muscles are said to be impressible to stimuli, and to contract when so impressed, by which motion or action is produced. The term contractility seems to imply impressibility—the susceptibility to be acted on and the action itself. Irritability and excitability are but different names for this susceptibility. Tonicity, by which physiologists mean the ability to maintain permanently a certain degree of contractility, is certainly nothing but a greater or less degree of contractile energy.

All the actions or motions of the various parts and organs are produced by the contraction or shortening of these muscular fibres, or rather, their alternate contraction and expansion.

Muscular contraction is accompanied with the production of *sound* and *heat*; the sound is probably owing to the movement of the adjacent fibres on each other, and the elevation of temperature is doubtless to be attributed to those chemical changes by which the disintegration and renewal of the tissue is effected.

Fig. 123.



MAGNIFIED FRAGMENTS OF MUSCULAR FIBRES.

In Fig. 123 are represented fragments of striped elementary fibres, and showing a cleavage in opposite directions. 1. Longitudinal cleavage. 2, 3, 4. Transverse cleavage forming disks. 5. A detached disk, showing the primitive particles, called sarcous elements. 7, 8. Separated fibrillæ, showing the beaded enlargements.

An ordinary muscle consists of bundles of fibres, arranged with great regularity in the direction of its action. Each individual fibre may be separated into fibrillæ by the splitting of its contents in a longitudina direction; these fibrillæ then present a banded appearance, caused by the arrangement of the contents of the tube.

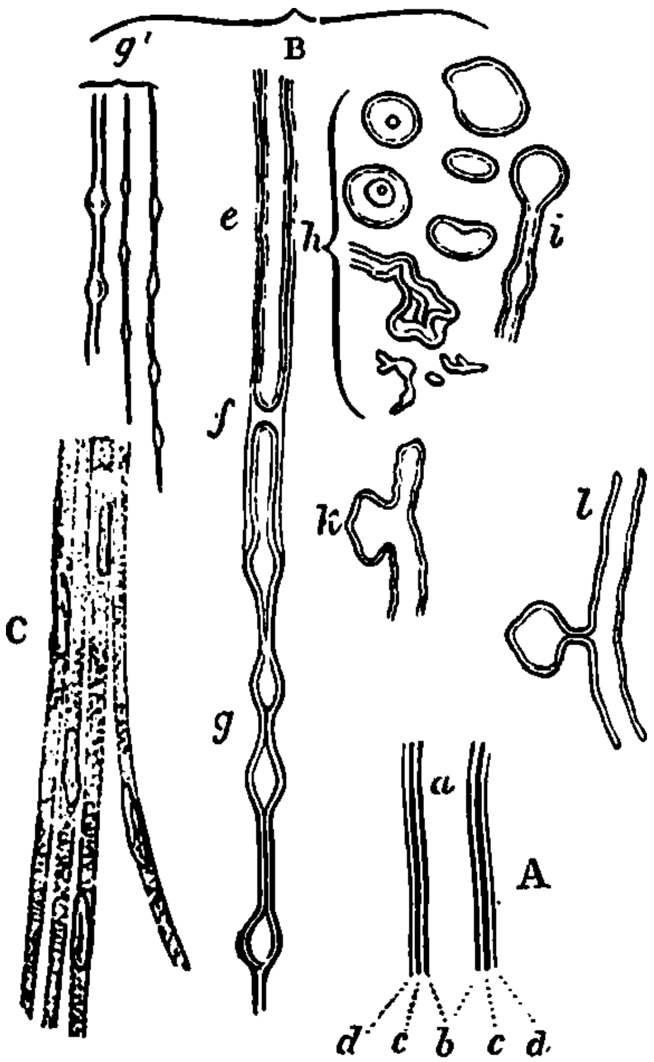
In structure muscular tissue is divided into *striated* (*striped*) and *non-striated* (*unstriped*)—the former being mainly appropriated to the voluntary functions, and the latter to the organic or involuntary. Functionally muscles are divided into *voluntary* and *involuntary*. The former contract in obedience to the will, and are the instruments by which the mind acts on external objects. Their fibres are arranged in parallel lines, and are connected together by areolar substance. Those of involuntary motion are more simple in their structure and arrangement than those under the influence of the will. Their fibres are disposed in layers, generally transverse or diagonal, with distinct parallel lines continually interlacing. In this way they form circular rings around the cavities of the circulating vessels, as the arteries, veins, absorbents, excretory ducts, and hollow viscera, as the stomach, bowels, uterus, and bladder, constituting one of their coats or coverings, which, by contracting, diminishes the calibre or cavity in length and diameter; and thus their contents are moved forward or expelled. The muscular tissue is not reproduced when once destroyed, but the loss is supplied by areolar substance, which is wholly insensible.

THE NERVOUS TISSUE.—The nervous is the highest order of organized matter. Though sensibility, or feeling, is its only property we can call vital, its immediate relation to mind causes it to manifest varied and wonderful powers. The nervous substance is the medium through which all impressions are received from the external world, and through which the mind conveys its mandates to the voluntary muscles. All motions, changes, or functional actions which are performed by the muscles, depend on the power, energy, or influence transmitted to the muscular tissue from the nerves.

The nervous structure is composed of a *white* or *fibrous* matter, which in the nervous trunks is tubular, with a secondary deposit within the cavity of the tube; and a *gray* or *vesicular* substance found in the ganglions. Wherever these two kinds of nervous matter are united together they constitute a *nervous centre*.

The ultimate nerve-fibre is tubular, consisting of an external thin and delicate membrane, which forms a sheath, and isolates the contained matter in its whole course from its central to its peripheral extremity. This has been called the *tubular membrane*, within which is contained a more opake substance, called the *white substance of Schwann;* and within this white substance is a transparent material, called the *axis cylinder.* The whole of this contained substance is very soft, and may be made to move along in the cavity of the tube.

Fig 124.



TUBULAR FIBRE OF SPINAL NERVE.

Fig. 124 is a diagram of tubular fibre of a spinal nerve. *a* Axis cylinder. *b.* Inner border of white substance. *c, c.* Outer border of white substance. *d, d.* Tubular membrane. B. Tubular fibres; *e,* in a natural state, showing the parts as in A. *f.* The white substance and axis cylinder interrupted by pressure, while the tubular membrane remains. *g.* The same with varicosities. *h.* Various appearances of the white substance and axis cylinder forced out of the tubular membrane by pressure. *i.* Broken end of tubular fibre, with the white substance closed over it. R. Lateral bulging of white substance and axis cylinder, from pressure. *l.* The same, more complete. *g.* Varicose fibres of various sizes, from the cerebellum. C. Gelatinous fibres from the solar plexus, treated with acetic acid, to exhibit their cell nuclei. B and C are magnified 320 diameters.

Physiologists are not agreed respecting the complete regeneration of nervous tissue after it has been once destroyed. Of its partial restoration there can be no doubt.

The nerve-fibres, which originate in the brain, and are distributed to the muscles, have no proper termination, but form *loops,* which either return into themselves or join others formed by the ultimate ramifications of the main trunks.

The *vesicular* matter, wherever found, is regarded as a *generator* of nervous influence; and the *white* or *tubular* as the *carrier* of that influence to the various parts of the system. The former portion is supplied with much the largest proportion of blood.

The general nervous system is susceptible of a division into five subordinate systems: 1. The nutritive system, or nerves of organic life. 2. The motory system, or nerves of voluntary motion. 3. The sentient system, or nerves of sensation. 4. The mental system, or brain. 5. The reflex system.

THE NUTRITIVE NERVOUS SYSTEM.—This system includes all the organic or involuntary nerves. In the order of development it precedes the others, as it relates to, and, in fact, presides over, all the processes of organic or vegetative life. All the functions belonging to the growth, development, and transformation of the bodily structures are controlled by these nerves. They have no sensibility of which the brain takes cognizance; yet they have an impressibility or a feeling of their own. To illustrate: the brain does not feel food in the stomach, nor blood in the heart, nor air in the lungs, nor bile in the liver, yet their presence is recognized or felt by the organic nerves. These nerves, too, have their little brains, or special centres, which serve to supply the nervo-electric influence to particular parts and organs, and connect the whole together in close sympathetic functional relations. The semilunar ganglion may be considered as the presiding centre, or great brain, and the other ganglia the central points, or little brains of the nutritive system.

In the lowest orders of animals the nutritive or organic system is concentered in a single straight nervous cord, which performs all the functions of those animals, as the brain, which belongs to a higher grade of being, does not exist. It is stated as a remarkable circumstance, that those animals which have no brain are also destitute of a spleen or melt. This fact strongly favors the hypothesis that the principal function of the spleen is to supply the organic nerves with an additional laboratory of their peculiar electrical or other power or influence. The organic nerves evidently derive their nourishment and support, as well as the principle or element by which they operate to control and regulate the organic functions, in a great measure directly from the arteries, for which purpose their filaments penetrate the arterial coats, and spread out on their internal surfaces. The superaddition of a brain in the higher animals seems to demand an additional source or organic nervous power, for the special purpose of its development and support. And for this purpose the spleen, by its large provision of arterial blood, and absence of an excretory duct, seems well adapted.

The organic nerves are connected with the cerebral by frequent anastomoses, which circumstance accounts for the reciprocal influence between mental impressions and bodily affections.

THE MOTORY NERVOUS SYSTEM.—All the nerves of voluntary motion originate from the brain and spinal marrow. In a perfectly healthy state of the whole organism, they are completely under the control of the will. In various spasmodic and convulsive diseases, this relation is for a time nearly or quite destroyed. The motor nerves are distributed to every muscular fibre in the body, and are the instruments through which the mental impulse is communicated to the muscles. All voluntary action is the motion produced by the contraction of the muscular fibres in obedience to the volition or decision of the mind, conveyed to the muscles by the motory system of nerves.

THE SENTIENT NERVOUS SYSTEM.—The nerves of sensation, like those of voluntary motion, are said to originate from the brain and spinal marrow. They are the instruments of communication from the external world to the brain, being the media of the external senses—seeing, hearing, tasting, smelling, and feeling. Thus the optic nerve conveys to the brain impressions of light; the auditory, of sound; the gustatory, of savors; the olfactory, of odors; and the nerves, of touch, distributed to all parts of the body which are endowed with sensibility, convey impressions of the chemical or mechanical properties of bodies, as heat, cold, form, size, density, pressure, etc.

Each nerve of a special sense is endowed with a modification of the general sense of feeling peculiar to and inherent in itself; for under no circumstances can the ear feel the impression of light, the eye of sound, or the skin of odors.

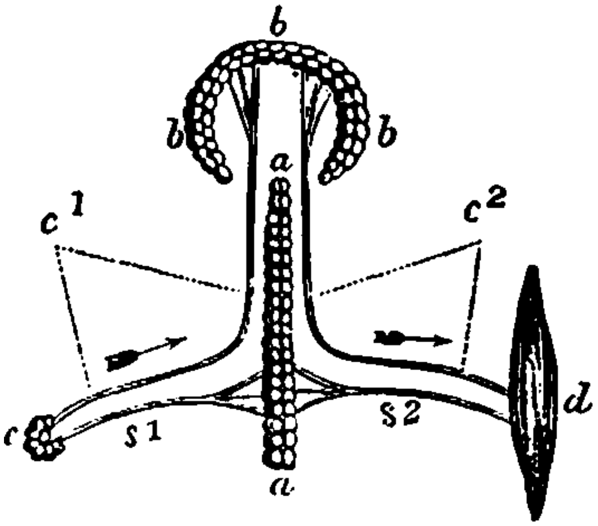
THE REFLEX NERVOUS SYSTEM.—The spinal cord is regarded as a conveyer of nervous influence to and from the brain, and also as an originator of nervous influence. When the spinal cord is divided or severely injured, the motor nerves given off *below* the injured point do not respond to the volition transmitted from the brain, while all the nerves *above* that point are under the influence of the brain. The impressions on the sensitive nerves are not propagated to the sensorium from below, but are from above the injured point.

The spinal cord is divided into two lateral halves, and each of these into an anterior, middle, and posterior column, corresponding probably to the sensory, motor, and organic nerves. The anterior root of the spinal nerves is the motor or *efferent* root, which conveys impressions *from* the brain; the posterior is the sensory or *afferent* root, which conveys impressions *to* the brain. A part of the fibres of both roots are unconnected with the brain, having their origin in the gray matter of the spinal cord. These fibres are supposed to form a distinct nervous circle, and they constitute the system to which those actions are due, called *reflex*. All spasmodic or convulsive movements of the body are considered examples of extreme reflex action; the producing causes of them may be seated in the spinal cord itself, then called *centric irritation*, or at a distance, the irritation of which is transmitted to the cord, called *concentric irritation*. *Reflex motions* are those muscular actions or contractions which take place in consequence of impressions conveyed *to* the spinal cord by the *afferent* nerves, and reflected *from* them by the *efferent* nerves.

A spinal nerve contains a bundle of *sensory* fibres passing upward *to* the brain; a *motor* set, conveying the influence of volition *from* the brain; an *excitor* set, or centripetal fibres, terminating in the true spinal cord, or ganglion, and conveying impressions *to* it; and a *motor* set, or centrifugal fibres, arising from the true spinal cord, and conveying the motor influence reflected from it to the muscles. The last two named sets of fibres, with the gray matter in the centre of the cord, constitute the reflex system.

Fig. 125 is a diagram of the origins and terminations of the different groups of nervous fibres. *a, a.* Vesicular substance of the spinal cord. *b, b.* Vesicular substance of the brain. *c.* Vesicular substance at the commencement of the afferent, which consists of *c* 1, the sensory nerve passing to the brain, and *s* 1, the spinal division, or excitor nerve, which terminates in the vesicular substance of the spinal cord. On the other side is the efferent or motor nerve, consisting of two divisions, *c* 2, the cerebral portion conveying voluntary motion, and *s* 2, the spinal division conveying reflex motion.

Fig. 125.



GROUPS OF NERVOUS FIBRES.

The medulla oblongata has the general properties of the spinal cord, and associates the cord and brain in functiona. qualities. Its power of reflexion is considered higher than that of any other part of the nervous system, irritation of it exciting convulsions in the whole trunk of the body. Respiration, deglutition, and those rhythmical actions of the respiratory system, laughing, yawning, sighing, etc., depend upon it. It is supposed also to be the seat, in whole or in part, of the power of voluntary motion.

The Mental Nervous System.—The surface of the brain is arranged in various convolutions, which constitute the phrenological organs of the prevailing system of mental philosophy. These convolutions bear a close relation to the general mental capacity, being more numerous and prominent in persons whose minds have been well-developed by exercise, while in those whose brains have been exercised but little they are much less complex, and in idiots exceedingly limited. The object of these convolutions is to afford an extensive surface for the gray or vesicular matter which generates the nervous power, and a more free communication between the blood-vessels on one side, which supply the materials of nervous influence, and the numerous fibres on the other side, which propagate their influence to the muscles.

The brain and spinal cord are divided by a mesial line into equal right and left halves or hemispheres; hence all the mental organs are double, as are also the sentient and motor nerves, which convey impressions to and from them.

All physiologists agree that the cerebrum is the seat of intelligence This part of the brain composes about six sevenths of the whole encephalon, and usually weighs from thirty-six to forty-six ounces. Phrenologians regard it as the seat of all the mental powers, except amativeness, whose organ is the cerebellum, which constitutes about one seventh part of the brain. It has been objected to the cerebellum being the organ of sexual impulse, that its development in the scale of animals bears no relation to the energy of the sexual propensity. But animals are created with reference to the circumstances in which they are to be placed; and, although size is a measure of power, other things being equal, there is, doubtless, as much in *quality* as in *bulk* of organization; and in those cases where the passion of amativeness has existed in connection with a partial or total absence of the organ—the force of habit, the exercise of the organ, or transmitted organic susceptibility, may explain the apparent exceptions to general experience.

That the cerebellum is also a generator of nervous influence to the muscles of locomotion, seems to be established from experiments on animals. When the organ was removed, although sensibility in any part was never destroyed, the animals lost the power of standing, walking, springing, flying, etc.

The whole brain, though the seat of sensibility, is itself wholly insensible. Any part of it may be cut, pricked, torn, or removed, without exciting pain.

Animals from whom the cerebrum was removed always lost the senses of sight, hearing, taste, and smell, and appeared as if in a deep sleep, without the power of dreaming; they could, however, be aroused to *unconscious* motions by irritations operating through the sense of feeling. These facts prove that it is not only the seat of most of the mental functions, but possesses the power of directing the mind to particular sensorial impressions.

PHILOSOPHY OF MIND.—The brain is the presiding centre of sensation, voluntary motion, the intellectua faculties, and the passions or propensities. The mind is the aggregate of all the functions of the brain. A mental power is the function of a particular organ or portion of the brain. All the mental powers may be distinguished into faculties and propensities.

The faculties together constitute the intellect. They are the powers concerned in thought the formation of ideas, the acquisition of knowledge, the thinking and knowing part of the mind. The faculties are divided into perceptive and reflective. The perceptives take cognizance of individual things and their mechanical properties. The reflectives arrange, compare, and analyze subjects, and trace out their relations of cause and effect. The perceptive faculties are the functions of the observing organs; the reflective faculties are the powers of the reasoning organs.

The propensities are the feeling organs; they are the impulses, emotions, or passions which impel to action. To gratify these feelings or propensities the intellectual faculties devise means, seek out objects, study methods. The external or special senses, seeing, hearing, smelling, tasting, and feeling, are the media through which the faculties operate in their natural or normal condition. But they are capable of acting independently of the external senses in certain abnormal states, as in somnambulism, dreaming, mesmerism, and clairvoyance. When the faculties have discerned the object, or ascertained the manner of satisfying the impulse or propensity, the will determines its instrumentalities—the bodily structures, to act in relation to its possession or enjoyment. The propensities which relate merely to individual preservation are called selfish, or self-relative; those which pertain to the family circle, domestic; those which connect us in mutual interests and sympathetic relations with our fellow-creatures, social; the higher plane of propensities, which relate to rules of action, conscience, and a Supreme Being, are termed moral qualities or sentiments; and those propensities most nearly allied in location and association with the faculties are called semi-intellectual.

Mind then appears to us as "duality in unity," consisting essentially of faculties and feelings—in other words, affections and thoughts. It is not difficult to imagine that the affectuous mind is the primitive mental property; first in order, highest or most interior in existence, and, to extend the idea poetically, more nearly

> "allied
> To angels on our better side."

All *true happiness* consists in *right feeling;* thinking is but a means to it. The healthful exercise of all the mental powers is the perfect condition of right feeling; and the normal play of all the bodily functions is indispensable to this healthful exercise of the mental powers. It is, therefore, literally true that health of body and health of mind is happiness.

The mind, however, must not be confounded with the soul. Mind may be defined as the manifestation of the soul or spirit through the material organism.

The Nervous Influence.—The essential nature of that power, principle, or influence, which endows the nervous tissue with its peculiar properties has always been a theme of interesting speculation. The most ancient doctrine was that of the circulation of a fluid through the tubes of the nervous fibres; but at length the tubes were found not to be hollow. The next theory was that of vibration: it was supposed that the nerves conveyed impressions from one extremity to the other by a vibratory motion analogous to a stringed instrument; but this doctrine was abandoned on discovering that the nerves, instead of being attached firmly at their extremities, are diffused into a soft, pulpy mass. The prevalent opinion now is, that the source of nervous power is some modification of electricity. The identity, however, of the nervous influence with electricity, galvanism, or magnetism, as manifested by any structure or material other than the nervous tissue, is positively disproved. It has been ascertained that if a ligature be placed upon a nerve, its power of conducting the true nervous or functional influence is lost, while its ability to transmit electrical currents remains.

In the present state of physiological science, therefore, we can only say that the nervous influence, the sensibility of the nervous tissue, the contractility of the muscular, and the elasticity of the areolar, are each vital properties peculiar to, and developed in, the organization of the structures to which they appertain; and there is not much probability that we shall ever arrive at any better explanation. What they are exactly and essentially we can no more demonstrate than we can the essential nature of oxygen, electricity, magnetism, or any other elementary substance or principle; nor would we be benefited if we could.

Rationale of Muscular Action.—The voluntary muscles are disposed in sets, which are said to antagonize each other; these sets are called flexors, extensors, adductors, abductors, etc., as they draw the part to which they are attached forward, backward, inward, outward, etc. Thus, where the flexors contract they close the fingers, draw up the arms, bend the legs, etc.; and the extensors, by contracting, open the fingers, extend the arm, straighten the leg, etc. The common opinion has long been, that when the nervous energy, or influence of the brain, is transmitted to one set of muscular fibres—the flexors, for example—they contract, while the other, or antagonizing muscles, remain passive, by which flexion is produced; and that when the nervous influence is directed to the opposing, or extensor muscles, these contract, and the flexors remain passive, by which means the contrary motion, extension, results.

But such cannot be the correct theory of muscular motion. Experiments seem to have demonstrated that when the nerves which supply either the flexor or extensor muscles are divided, neither will act or contract at all. From this it appears that neither set can act independently, and that the antagonizing muscles, as they are called, do really act in correspondence; the same nervous influence which produces contraction in one set, producing relaxation or expansion in the other. We must, then, regard muscular action, which is performed by the alternate contraction and expansion of the muscular fibres—analogous to electrical attraction and repulsion in inorganic matter—not as depending on two principles of influence, or on one principle alternately bestowed and withdrawn, but as resulting from two properties of one principle operating simultaneously.

The same law of motions appears to prevail with regard to the involuntary muscles; but their structure and arrangement are so different that its operation is more difficultly traced. Instead of running in straight lines, their fibres extend in parallel, transverse, diagonal, and circular directions, thereby embracing the part, organ, or vessel, so as to produce a complicated series of motions at the same time, as in the stomach, bowels, bladder, and uterus, where a kind of universal compression on the contents of their cavities results from the varied directions and motions of their fibres.

The strength and rapidity of muscular action are well illustrated in the feats performed by tumblers, jugglers, and dancers, and the articulations of spoken language. Some persons can pronounce 1500 letters in a minute, each requiring a separate contraction of muscular fibres, followed by a relaxation of equal length; so that each contraction must have occurred in one tenth of a second.

Mesmeric Phenomena.—Those manifestations of peculiar abnormal states and operations of the mental nervous system, known as dreams, somnambulism, second sight, mesmerism, clairvoyance, etc., deserve a passing notice. The sum total of these phenomena has been called mesmerism, pathetism, electrical psychology, or electro-biology, etc. The fact that the mind can and does take cognizance of things—sometimes real and sometimes imaginary—while in the state or condition termed mesmeric, which it cannot and does not in its ordinary state or condition, is unquestionable. The explanation is not so apparent.

It is a self-evident proposition that the human mind is created with constitutional relations to all objects in external nature—in the universe. All surrounding objects, without regard to direction or distance, may and do hold a specific relation to the mind, in other words, act upon, or impress, or hold communication with it. The special senses—seeing, hearing, tasting, smelling, and feeling—are the media of the correspondence between mind and surrounding objects, in the usual, ordinary, or normal state. But if the brain and nervous system are functionally exalted, rendered peculiarly impressible, while the special senses are in the ordinary functional condition, the mind will have a larger field of perceptions, a greater capacity to form ideas, whether correctly or incorrectly. If the brain and nervous system maintain, by any unusual internal or external exciting cause, the normally active condition, while the external or special senses are at rest—inactive or insusceptible—the same increased mental capacity to feel the impressions of distant objects, form ideas, etc., results. And if the brain and nervous system are under the abnormal influence which preternaturally augments their functions, while the external senses are not merely in a state of normal repose, but of profound and preternatural rest—abnormally insusceptible—then the objects at a very great distance, or in a direction which could not be seen, felt, heard, etc., in the normal state, or through the external senses, impress the mind, and are distinctly recognized. In this state, too, the mind takes greater or less cognizance of the thoughts of other minds with which it is brought into close sympathetic relations, and echoes very accurately the thoughts or opinions of such minds. In this way clairvoyants answer with surprising correctness many questions, their answers being simply the reflection of the minds, thoughts, or opinions of the operator, or manipulator, or of the person placed in communication.

But many times the attention of the mesmerizee or clairvoyant is directed to places, objects, and persons at great distances, hundreds or thousands of miles, when they discover and describe many things as they really exist, and others which have no reality at all. These phenomena prove that the mental field of vision may be vastly extended, but that its abnormal or preternatural state does not render its impressions reliable as exclusive sources of information; the ever-varying states of the nervous susceptibility may render the cognizance of objects in the abnormal state just as variable in regard to reality or fantasy.

Some persons have an organization peculiarly favorable to the manifestation of the phenomena in question, and others are capable of acquiring a great degree of mesmeric susceptibility, so much so as to pass into the clairvoyant state at will, and then survey with interior vision many things in heaven and earth as they really exist, or revel in dream-land, as imagination leads off in the mental operations.

The phenomena more strictly physiological, and those effects on the nervous influence which have been made available as remedial processes in disease, may all be accounted for on the principles of mental sympathy and electrical or magnetic innervation. A strongly magnetic, powerfully electric, or in other words, vigorously healthy person, may rapidly manufacture nervous influence, and readily impart it to another of more susceptible temperament, or in feeble health. The hand and fingers are exquisitely organized for receiving and transmitting a large amount of nervous influence, and gentle manipulations are the best ways of imparting it. The exercise of weak, torpid, and rigid muscles, by rubbing, kneading, thumping, etc., is remedial, or innervating, or magnetically medicinal, very much in the ratio of the capacity of the vital organism, and the development of the organic or nutritive nerves and ganglia of the operator.

Order of Structural Development.—From minute vesicles or cells, having as a nucleus a small round body of matter, surrounded by a granular fluid, and enclosed in a thin membrane, all the structures are developed. The ovum and the embryo are originally composed of such nucleated cells. Some cells are independent of and isolated from each other, as the corpuscles of the blood, chyle, and lymph; others cohere by their surfaces and borders, as in the epidermis, or scarf-skin; others are connected by an intermediate substance, as bone and cartilage; and others are united in rows, forming hollow tubes, capillary vessels, and the tubuli of nerves and muscles.

The first distinct structure developed in the human body is that of the nerves of organic life. The necessity of this is apparent, as they constitute the presiding centre and controlling instruments over all the functions of nutrition and growth. They form not only a general centre to the whole organic system, but by means of their ganglia supply each particular part, organ, and function with a special presiding centre. These ganglia appear like mere enlargements of the nervous cord, and are numerously distributed throughout the body, according to the importance and complexity of the functions to which they specially appertain. They serve undoubtedly to collect, direct, modify, regulate, and adapt the nervous influence to the functional condition of the various organs, and constitute, in one sense, so many points of polarity to its attractive and repellent properties.

Next in order, as second in functional importance, the heart and muscular system are produced, followed by blood-vessels gradually extending and enlarging till the vascular system is completed. The nutritive or organic nerves intimately accompany the arteries from their ganglia, and send off branches to aid in the development and preside over the nourishment of particular organs, to which they hold the same relation that the brain does to the voluntary muscles. The ganglia which form the subordinate centres to the alimentary canal are the first ones produced from the increasing development of the organic nerves. Soon on each side of the central mass of the nutritive nervous substance numerous ganglia, or *little brains*, arise, in the shape of two connected nervous cords, and eventually form, on each side of the spinal column, a series of ganglia extending the whole length of the spine. These ganglia send out branches of nerves to the several special centres, to unite them in associated action; to the muscles, and to those branches of the other ganglia which are sent to the viscera, and contribute to the development of the spine, trunk, and extremities.

The great centre of the organic system, the semilunar ganglion, consists of the two semicircular bodies behind the pit of the stomach; they are closely connected by branches passing from one to the other, which form the solar plexus. To this general centre the numerous special centres are united by nervous cords and plexuses. Death takes place if the functions of this system of nerves be suspended but for a moment.

With the increasing formation of the ganglionic centre the alimentary organs are developed; the stomach, intestines, pancreas, etc., followed by the excretory organs, the liver, kidneys, and skin. Lastly are developed the lungs, spleen, brain, and spinal marrow, the membranes, bones, ligaments, and cartilages, terminating in the hair, nails, and epidermis.

CHAPTER II.

OF THE SPECIAL SENSES.

SENSATION is the recognition by the mind of an impression. That part of the brain, or rather quality, which perceives impressions is often called the *sensorium*. Sensations are distinguished into *external* and *internal*. External sensations arise from impressions made upon the outer surface of the body, as the eye, nose, mouth, ear, and skin, which are the organs of the external or special senses. Internal sensations have their causes within the body, and arise from functional conditions, as hunger, thirst, suffocation. An active capillary circulation is essential to the normal sensibility of a part. If the blood is excluded from the capillary vessels by severe cold, the sensibility is deadened; and if the vessels are over-distended, as in inflammation, the sensibility becomes painful. General sensibility is distributed over the entire body, enabling us to feel those impressions of surrounding objects which produce the various modifications of pain and pleasure. Special sensibility pertains to those organs which connect the mind with the physical world, and by which the mind is educated. The nerves of special sensation have no general sensibility except what is derived from nerves of general sensibility distributed to them.

SENSE OF TOUCH.—The nerves of feeling are the posterior roots of the spinal nerves, and some fibres of the fifth and eighth pairs of cerebral nerves. They are distributed to the papillæ of the skin, which are small elevations enclosing loops of blood-vessels and branches of sensory nerves, situated on the external surface of the cutis vera.

Fig. 126.

CUTANEOUS PAPILLÆ.

Fig. 126 is a representation of the papillæ of the palm of the hand, the cuticle being removed.

When a body to be touched comes in contact with the sensory surface, the only idea communicated to the mind is that of resistance. The degree of resistance affords a knowledge of the hardness or softness of the body. When the body touched and the sensory surface are moved upon each other, a motion is conceived of extension or space, roughness, smoothness, and other mechanical properties.

The knowledge of *form* and *weight* some late physiologists have been unable to account for by the ordinary sense of touch, and have got out of the difficulty by supposing a sixth sense, which they call the *muscular sense*, to exist for that particular purpose. The sense of *temperature* has also been attributed to a distinct set of nerves, because the recognition of it occurred without the actual contact of the hot or cold body with the sensory surface. I do not see that either supposition makes the matter any clearer. Form and weight are but degrees of extension and resistance, and temperature, whether its essential nature is caloric, light, or electricity, is but the perception of rays or particles coming in contact with the sensory surface, and expanding or contracting, that is to say, *moving* the contractile tissues so as to *impress* the nervous papillæ.

The sense of touch is developed in different parts in proportion to the supply of sensory nerves. In man the acuteness of the sense varies in different regions of the body. The lips, tip of the tongue, and inside of the last joints of the fingers are exquisitely sensitive, in consequence of the nerves being very numerous and superficially distributed. The epidermis is also very thin in those parts, and the innumerable lines and furrows afford the papillæ a greater degree of isolation. The development of the sense corresponds with the number and extent of these lines and furrows. The sense of touch, like all the special senses, may be educated to a surprising degree of acuteness and accuracy, as with the blind, who have been taught to read and even distinguish colors by it.

Sense of Taste.—The various papillæ on the surface of the tongue, when excited by contact with savory substances become turgid and erect, so as to produce considerable roughness of the organ. Some of the papillæ, the filiform particularly, are supposed to be concerned in the common sensibility or feeling of the tongue, and the remainder are regarded as exclusively pertaining to the sense of taste.

Solubility of the matter brought in contact with the tongue is a necessary condition of taste. The sense may also be excited by mechanical or chemical irritation of the nerves. A smart blow by the finger, or a galvanic shock, will often excite the taste, which is then sometimes acid and sometimes alkaline. As sapid substances impress the olfactory as well as the gustatory nerves, the sense of taste is generally materially diminished when the nose is obstructed.

Taste, like all the special senses, is highly educable, but in civilized life is generally deeply depraved and perverted. Its object in the animal economy is to direct us in the selection of alimentary substances, and assists us in judging of their adaptation to the wants of the nutritive apparatus. The ability to appreciate and enjoy the gustatory property of *natural* and *healthful* food is exactly proportioned to the integrity of the sense; and those persons who cannot realize any agreeable savor in any article of nutriment until the papillæ of the tongue are stung into action by salt, pepper, mustard, vinegar, or other pungents, know but little of the bountiful and luxurious repast nature has provided for her unsophisticated children, or of the real pleasures of eating. Like the drunkard, who swallows the burning poison of alcohol not for the mere pleasure of drinking, but to drown or appease a maddening and insatiable craving, the epicure or riotous liver eats not to enjoy or live, so much as to silence the goadings of a morbid appetite.

SENSE OF SMELL.—Olfaction enables us to distinguish flavor, and thereby judge of the odorous particles floating in the atmosphere. Its use is to co-operate with taste in determining the qualities of food, and protect the respiratory passages by detecting injurious effluvia or other deleterious matters. Its seat is the mucous membrane of the nose, though the whole of the mucous surface is not endowed with the sense of smell. The upper portion of the membrane, expanded over the superior and part of the middle spongy bones, is the olfactory region, to which the olfactory nerve is distributed. Sneezing, which is called a reflex action, is supposed to depend on the fifth pair of nerves, from which is derived the general sensibility of the mucous membrane.

The conditions requisite for the perfect exercise of this sense are, integrity of the nervous apparatus, and a normal degree of special sensibility. The odorous particles must also be soluble. Colds, inflammation of the mucous surface, strong irritants and narcotics, as cephalic or tobacco snuff, always weaken or paralyze, and sometimes utterly destroy all perception of odors. Smelling-bottles of ammonia and camphor, and all strong and pungent perfumery, not only injure the sense, but injuriously affect the whole brain through the medium of this sense.

SENSE OF HEARING.—No part of the human organization exhibits a greater complexity of structure than the hearing apparatus. Nor will it excite wonder that it is so, when we consider how extensively human beings are related to the external world and to each other, in their duties, their interests, and their pleasures, by this function. The *external ear* is fashioned into various elevations, depressions, and curvatures, peculiarly fitted to catch the sonorous waves from all directions. The *external meatus* conveys them, strengthened by reflection from the walls of the canal, and modified by the resonance of the mass it encloses, to the *membrana tympani*. This membrane is not essential to sound, for its perforation or destruction is not followed by a loss of the sense; but it serves to modify the sonorous vibrations which are to be communicated to the chain of bones, in such a manner as to be thrown into reciprocal vibration, though it cannot reciprocate any sound lower than its own fundamental note.

The *chain of bones*, moved by their muscles, conducts the vibrations across the tympanum to the *internal ear*. The *tensor tympani*, in the function of hearing, performs an office analogous to that of the iris in seeing. Its contraction draws down the handle of the malleus, rendering the membrana tympani tense. When very tense it cannot reciprocate *low* sounds, and by *very loud* sounds it may be excited to reflection, in which state the membrane is too tense to reciprocate them. Its natural condition is rather lax, the state in which it can reciprocate the greatest variety of sounds. The tensor tympani muscle contracts more powerfully as the sound is louder, as the iris does upon the application of the stimulus of light.

The *tympanum* isolates the chain of bones, and allows free motion to the membrane at each of its extremities, while its contained air reverberates the sound, which is still further strengthened and modified by reflection from the neighboring walls, cells, spaces, and cavities, particularly by the reflection from the membrane of the *fenestra ovalis* and *fenestra rotunda*. The *Eustachian tube* serves principally to maintain an equilibrium between the external air and that enclosed in the tympanum, by which undue tension of the membrana tympani is prevented.

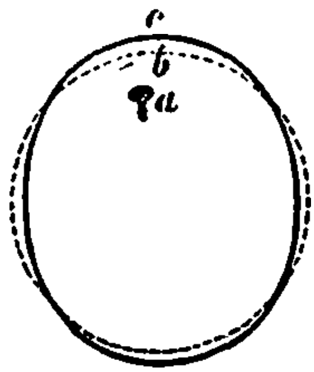
The uses of the different parts of the labyrinth are not well understood. It is supposed that the *semicircular canals* regulate the perception of the *direction* of sounds, while the *cochlea* determines the *pitch* of the notes. The *fluid* contained in the *membranous portion* of the labyrinth, and the ear-stones, *otoconïtes*, which float in it, doubtless increase the impression on the sentient nerves by being thrown into vibratory motions, while this part of the labyrinth itself affords a more extended surface for the expansion of the auditory nerve.

Philosophy of Sound.—The whole complex structure of the auditory apparatus has reference to two principles: the propagation of sonorous vibrations, and their multiplication by resonance. In some of the lower animals the perception of sound takes place by means of a very simple contrivance, consisting essentially of a sac containing a fluid, and having a nerve spread out upon it; the membrana tympani, ossicula, cochlea, and semicircular canals being absent.

Sounds are said to be propagated by *reciprocation*, by *resonance*, and by *conduction*. An example of the first method is found in two strings of equal tension, placed side by side; if the one be thrown into vibration, the other will reciprocate by making corresponding vibrations. Resonance occurs when a sounding body is placed in connection with any other, of which one or more parts may be thrown into reciprocal vibrations, although the tone of the whole be different, or if the medium be incapable of producing any tone at all. Thus, if a tuning-fork, while vibrating, be placed in contact with a sounding-board, the latter will divide itself, as it were, into a number of parts, each of which will reciprocate the original sound so as greatly to increase its intensity. Sounds of conduction are propagated through all bodies, solids being better conductors than fluids, and fluids more conductive than gases. If the ear be placed at one extremity of a log or a long board, and the other end be struck, the sound will extend along or through the whole length of the material, and be perceived by the organ.

A more definite idea of sound may be obtained from the familiar illustration of the common church bell.

Fig. 127.



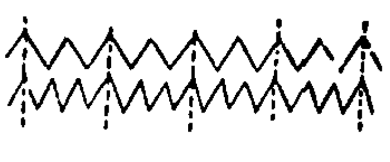
When the tongue, *a*, strikes the side at *b*, it springs out to *c*, changing entirely the form of the bell, which is represented by the dotted line. When the bell springs back to its original form, its sides retract and expand in an opposite direction, as a vibrating string rebounds beyond its centre, or starting point; and so alternately, making a succession of sonorous waves of air, as a stone thrown into a pool causes circular rings to expand in all directions. When these movements of the air become sensible to the ear, we have the perception of sound.

The primitive sounds of the musical scale are derived from the different forces or kinds of vibration. Thus, when a bell is struck, the first full, loud sound is the fundamental or key note. When the force of the blow is partially spent, there is a different degree of motion, producing a different force of atmospheric vibration, and occasioning a modified perception of sound; and when the vibrations have decreased still further in intensity, a third primitive sound is recognized.

A musical *chord* is the combined sound of several sounds produced simultaneously. When the effort is pleasant to the ear, these chords are called *concords*; and when unpleasant, *discords*. The most pleasing concords are produced when the greatest number of vibrations in a given time occur together; and the most disagreeable discords, when the fewest vibrations take place simultaneously.

A good idea of concord may be gathered from the following illustration:

Fig. 128.

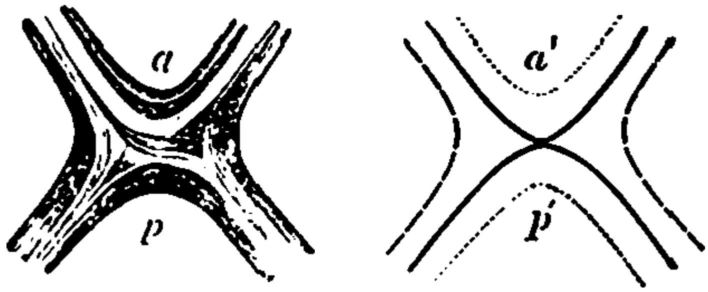


On counting the waved lines, it will be found that every third vibration of the sound represented by the upper line, and every second vibration of the sound represented by the under line, come together, the conjunction being denoted by the dotted cross-lines According to the greater or less frequency of these coincident vibrations, are the sounds concordant or discordant. The most agreeable concord is, of course, that where every vibration of one sound and every other vibration of another sound come together.

THE SENSE OF SIGHT.—Vision makes us acquainted with the existence of light, by which medium the mind recognizes the form, size, color, position, etc., of bodies that transmit or reflect it.

The roots of the optic nerves unite, before entering the orbits, into intimate junctions, called *chiasms*, from these chiasms they diverge and enter the orbit through the optic foramina, part of the fibres of each passing to the opposite eye, a part being connecting or commisural, and the remainder passing to the eye of the same side. This arrangement seems to associate the two eyes in a single act of vision, although most physiologists regard the single vision with two eyes as a result of the rays of light from a luminous object falling upon parts of the retinæ accustomed to act together.

Fig. 129.



OPTIC CHIASM.

Fig. 129 is a representation of the course of the fibres of the optic nerve in the chiasm. *a.* Anterior fibres, commisural between the two retinæ. *p.* Posterior fibres, commisural between the thalami, or origin of the optic nerves. *a' p.'* Diagram of the preceding.

The essential parts of the eye are, the expansion of the optic nerve, called *retina*, which *feels* the impressions of light, and the *transparent refracting media*, or humors of the eye, which transmit the light so as to bring it to a focus upon the retina. The *sclerotic* forms a firm support to the globe, and is opake, except in front, where it becomes transparent for the admission of the rays of light, and is called *cornea*. The dark pigment called *choroid*, between the sclerotic and retina, absorbs the rays of light after they have impressed the retina. The choroid becomes gradually lighter in many people as they advance in life, and in the Albino it is entirely wanting. The *iris* is a vertical curtain-like process of the choroid, hanging across the cavity of the aqueous humor, and its central perforation is the *pupil*. The contraction and relaxation of the circular fibres surrounding the orifice of the pupil, as the rays of light are stronger or weaker, regulate the impression on the nervous expansion. When the iris becomes insensible or weakened, the pupil remains permanently dilated and vision dull, as in affections of the optic nerve, compression of the brain, etc. The iris is also weakened and the pupil dilated by being continued too long in dark or deeply shaded situations. The pure narcotics, belladona, henbane, etc., cause a dilatation of the pupil by paralyzing the nervous influence. Under exposure to very strong light, and in acute inflammatory affections of the brain, the pupil is remarkably contracted; and also during the stage of excitement, when the brain is laboring under the influence of the stimulating narcotics, as opium, camphor, and alcohol.

The adaptation of the eye to distances is a phenomenon not yet very well explained. Some physiologists consider it as entirely the result of habit or education, while others suppose the perception of a distinct image, whether the object be far or near, is owing to an altered position of the crystalline lens by muscular agency—an opinion strengthened by the fact, that the adjusting power of the eye is impaired or lost by the extraction of the lens, or by paralyzing the muscles of the ciliary processes and iris with belladona.

The question has been much discussed, why objects appear erect to us, when it is known that the rays of light from the opposite points of a luminous object cross one another by the successive refractions they experience, and thus make the image on the retina actually inverted? But no satisfactory solution has yet been offered, and many regard the phenomenon as the result of education and experience.

CHAPTER III.

OF VOICE AND SPEECH.

Voice is formed in the larynx, and is produced by the simple expulsion of air from the lungs, when the vocal ligaments or cords are held in a certain degree of tension. Nearly all animals possess the power of making voice-sounds. Singing, crying, and yelling are examples. *Speech* is the modification of voice-sounds in the cavity of the mouth, constituting articulation. The articulating organs are the tongue, palate, lips, and teeth. The fauces and cavities of the nose modify and intensify both voice and articulate sounds by affording a resonant surface. Speech in perfection is a faculty peculiarly human, although many animals—the parrot and jackdaw, for examples—are capable of uttering words and sentences very distinctly.

All the *vowels* are voice-sounds, being made without any change in the shape or position of the vocal organs during their continuance. *Short* vowel sounds are distinguished from those termed *long*, *broad*, *grave*, and *close*, by the impossibility of prolonging them for any appreciable length of time. The others can be prolonged as long as expiration can be maintained. The *consonants* are articulate sounds, formed by interruptions in the vowel sounds produced by changes in the position of the vocal organs.

The English language may be reduced by analysis to forty-four rudimental sounds, or elements, sixteen of which are vowels and twenty-eight consonants. The vowel elements are: the *long*, *short*, *broad*, and *grave* sounds of *a*, as in *ail*, *at*, *all*, *ah*; the *long* and *short* sounds of *e*, as in *ease*, *end*; the *long* and *short* sounds of *i*, as in *isle*, *ill*; the *long*, *short*, and *close* sounds of *o*, as in *old*, *on*, *move*; the *long*, *short*, and *broad* sounds of *u*, as in *turn*, *tub*, *full*; and the *double vowel* sounds of *oi* or *oy*, in *oil*, *coy*, and *ou* or *ow*, in *our*, *how*.

Diphthongs are two vowel sounds in one syllable; the only ones in our language are long *i*, as in *mile*, and long *u*, as in *lure*, and the sounds of *oi* or *oy*, and *ou* or *ow*. Triphthongs have no existence. They are said to be the union of *three* vowel sounds in one syllable: but though these vowels are often *written* in one syllable, one or more of them is always silent in the pronunciation, as in ad*ieu*, which is pronounced as if written ad*u*.

The consonant elements are: the *name* sound of *b*, as in *bite*; the *soft* or *hissing* sound of *c*, or name sound of *s*, as in *cent*; the *hard* sound of *c*, or name sound of *k*, as in *came*; the *name* sound of *z*, as in *suffice*; the sound of *sh*, as in *ocean*; the *name* sound of *d*, as in *dust*; the *name* sound of *t*, as in *correct*; the *name* sound of *f*, as in *brief*; the *name* sound of *v*, as in *of*; the *soft* sound of *g*, or name sound of *j*, as in *germ*; the *hard* or guttural sound of *g*, as in *gull*; the sound of *g* represented by *zh*, as in *rouge*; the *aspirate* or name sound of *h*, as in *hale*; the name sound of *l*, as in *late*; the *name* sound of *m*, as in *man*; the *name* sound of *n*, as in *nun*; the sound of *n* represented by *ng*, as in *link*; the *name* sound of *p*, as in *page*; the *smooth* sound of *r*, as in *far*; the *trilled* sound of *r*, as in *rough*; the *name* sound of *w*, as in *wool*; the sound of *x*, represented by *ks*, as in *flax*; the sound of *x*, represented by *gz*, as in *exist*; the sound of *y*, represented by *ye*, as in *youth*; the *aspirate* sound of *th*, as in *thin*; the *vocal* sound of *th*, as in *this*; the sound of *wh*, as in *whale*; and the sound of *ch*, as in *church*.

In a strictly philosophically written language, each distinct elementary sound should be represented by a distinct character, making as many letters as there are vocal and articulate elements. But in the English language there are only twenty-six letters to nearly twice as many sounds; and while some of the letters represent but one elementary sound, others, as *a* and *c*, represent four. The phonographic reform, therefore, is clearly founded in nature and in physiology.

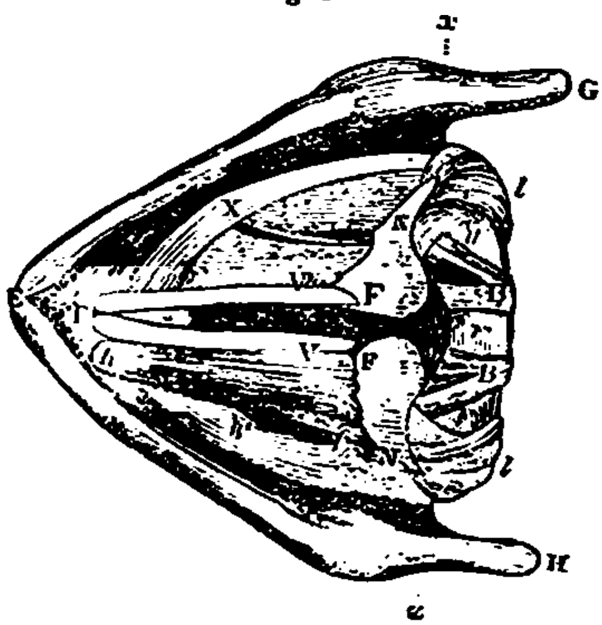
The vocal apparatus has been compared to various musical instruments, in which strings, tubes, and reeds are the agencies in the production of sound, as the violin, flute, and clarionet. The analogy is not very close in relation to either separately, but the vocal machinery combines many properties of them all.

The lower vocal cords are mainly concerned in the production of sound; if the upper cords are removed voice continues, but is rendered feeble; if the lower are destroyed, it is entirely lost.

The *tones* of voice depend on the varying tension of the vocal cords. In the production of tones, the ligaments of opposite sides are brought into approaching parallelism with each other by the approximation of the points of the arytenoid cartilages; in the intervals they are again separated, and the opening between them, *rima glottidis*, assumes the form of the letter V.

Fig. 130 exhibits the vocal ligaments as seen superiorly. G, E, H. Thyroid cartilage. N, F. Arytenoid cartilages. S, V, S, V. Vocal cords or ligaments. N, X. Crico-arytenoideus lateralis. V. k, f. Right thyro-arytenoideus. N, l, N, l. Crico-arytenoidei postici. B. B. Crico-arytenoid ligament.

Fig. 130.



LARYNX FROM ABOVE.

The muscles which stretch or relax the vocal ligaments are alone concerned in the voice. The muscles which open and close the glottis regulate the amount of the air inspired and expired, and belong to respiration. These muscles are the seat of spasmodic affections producing suffocation.

The *pitch* of the tones is regulated by the tension of the vocal cords. Its *volume* or *intensity* depends on the capacity of the lungs, length of the trachea, and the force with which the air is expelled, and the flexibility of the vocal cords. In the male the vocal cords are longer than in the female, in the proportion of three to two, which renders the male voice usually an octave lower

The natural compass of voice in most persons is two octaves, or twenty-four semitones. Singers are capable of producing ten distinct intervals between each semitone, making in all 240 intervals, requiring as many different states of tension of the vocal cords, all of which are producible at pleasure, and without a greater variation of the length of the cords than one fifth of an inch. One of the most wonderful phenomena of vitality is the facility with which the will determines the exact degree of tension necessary to produce a given note, when the mind has formed a distinct conception of the tone required.

A musical note is a prolonged vowel sound, and may be regarded as the natural language of emotion, or the expression of the affectuous mind. Speech is the natural expression of ideas or thoughts. These two kinds of natural language are intimately associated in the human being, so that there is music in *well-spoken* thoughts.

Ventriloquism is simply the power of imitating the voices of others, the cries of animals, and the sounds of inanimate matter so closely as to produce a complete vocal illusion, making them seem to come from any distance or direction, or through any kind of media. Those who have this imitative power well developed, must possess an extraordinary flexibility of the whole vocal apparatus.

CHAPTER IV.

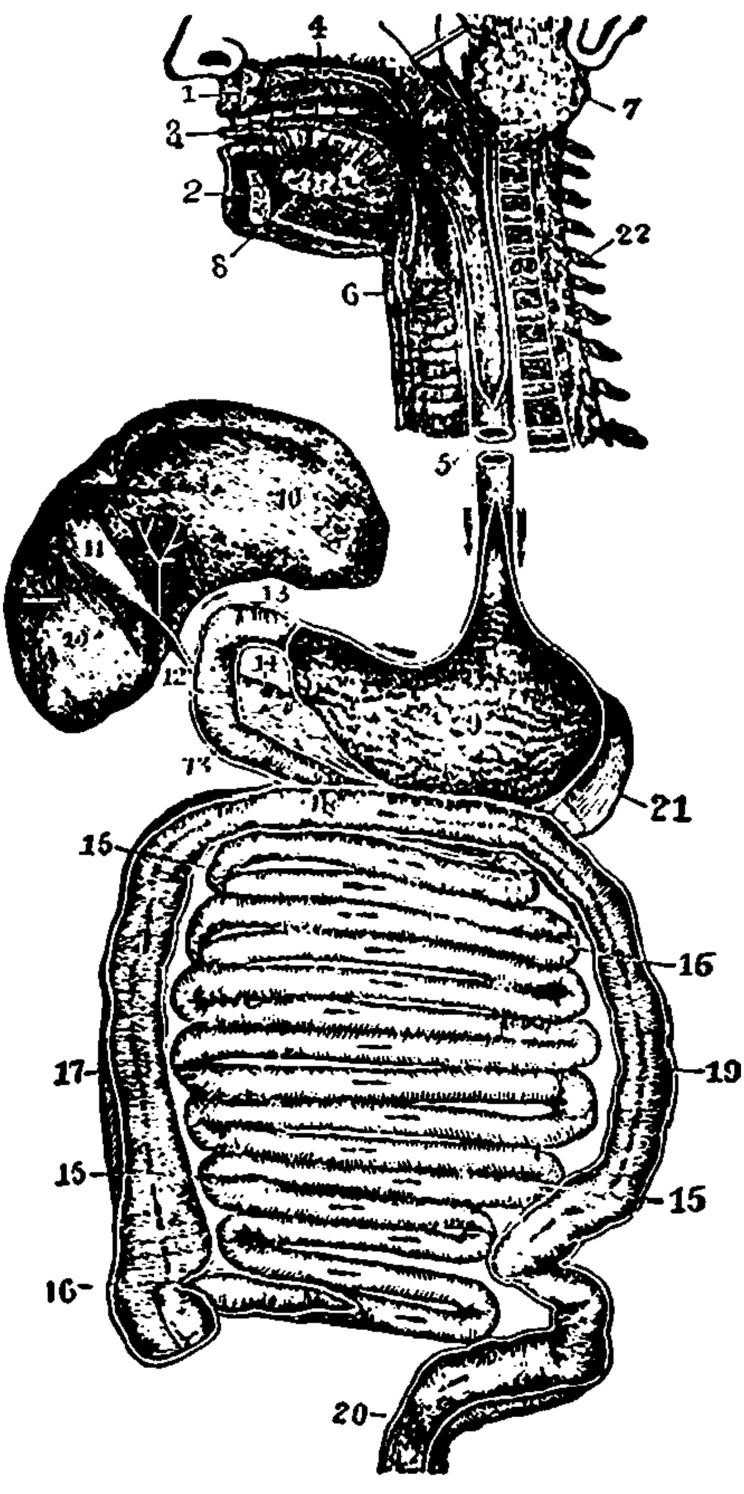
OF THE INDIVIDUAL FUNCTIONS.

THOSE functions which relate exclusively to the growth, development, and preservation of the individual organism are, digestion, circulation, respiration, absorption, nutrition, secretion, and calorification. Some physiologists regard *innervation*, or the production of nervous influence, and that property of the tissues called *endosmose* and *exosmose*, by which fluids and gases are interchanged through the structures, as distinct functions.

I think, however, the term function is not properly applied to those properties or processes of the organism. Innervation literally means the *existence* of nervous power; its production must depend on the other functions. Endosmosis and exosmosis are rather mechanical than vital processes, as they take place in unorganized as well as organized structures.

Fig. 131 is an ideal representation of the organs of digestion, opened nearly the whole length. 1. Upper jaw. 2. Lower jaw. 3. Tongue. 4. Roof of the mouth. 5. Œsophagus. 6. Trachea. 7 and 8. The parotid and sublinguinal glands—two of the salivary glands. 9. Stomach. 10, 10. Liver. 11. Gall-cyst. 12. The duct conveying the bile to the duodenum (13, 13). 14. Pancreas. 15, 15, 15, 15. Small intestine. 16. Opening of the small into the large intestine. 17, 18, 19, 20. Large intestine. 21. Spleen. 22. Upper part of the spinal column.

Fig 131.



THE DIGESTIVE SYSTEM.

Digestion.—The first of the organic functions is the conversion of alimentary matter into chyle, which in its turn is converted into blood. The first process of the digestive function is *mastication*, by which the food is divided into fine particles by the cutting and grinding action of the teeth. The presence of aliment and the act of mastication excite the function of the salivary glands to secrete the solvent fluid called *saliva*, which is intimately mingled with the particles of alimentary matter, completing the process of *insalivation*. The alimentary substances, comminuted and softened are then conveyed into the stomach by the act of swallowing, called *deglutition*. The presence of food in the stomach excites the flow of *gastric juice*, which is secreted from its mucous membrane. The vessels of the stomach then receive a greater supply of blood, and there is a slight increase of temperature. The solvent property of the gastric juice was generally conjectured, but sometimes denied, until clearly demonstrated by the experiments of Dr. Beaumont, in 1833. In consequence of a gun-shot wound in the person of Alexis St. Martin healing in such a manner as to leave an artificial opening into the stomach, Dr. Beaumont was enabled to introduce various aliments directly into the stomach, and ascertain the chemical or solvent property of the gastric juice.

The gastric juice usually manifests an acid reaction to chemical tests, but chemists do not agree very well as to its actual chemical properties. According to the analysis of Professor Dunglison, it contains free muriatic and acetic acids, phosphates and muriates of potassa, soda, magnesia, and lime. Blondlot imputes its acidity to super-phosphate of lime, while Professor Thornton and MM. Bernard and Barseswil attribute it to the presence of lactic acid; an acid which Liebig positively denies the existence of in a healthy stomach. These diversities in the results of analyses are probably due, in some measure, to the different methods of conducting them, in part to the different proportions or kinds of saline, alkaline, and earthy matters taken into the system with the food and drink, and in some degree to differences in the qualities or kinds of the aliments themselves.

The active principle of the gastric juice is called *pepsine;* its action is analogous to that of a *ferment*, which has the power of exciting chemical changes in the particles of other substances without undergoing decomposition itself. The quantity of gastric juice secreted is regulated by the *wants* of the system, and not by the quantity of food taken. Hence all excess of ingestion is a source of injurious irritation.

Chymification is that part of the digestive process in which the nutritious portion of the aliment is reduced to a pultaceous, homogeneous mass, called *chyme.* In addition to the solvent action of the gastric juice, chymification is aided materially by the contraction of the muscular coat of the stomach, whose fibres are so arranged as to diminish its diameter in all directions, and keep the food in constant motion until it is thoroughly permeated by the gastric juice, the pyloric orifice of the stomach being closed at the same time by the circular fibres acting there as a sphincter.

As fast as the alimentary mass becomes chymified, it is passed along into the duodenum. The most innutritious particles of the ingesta are not rendered chymous, but are reduced to a condition enabling them to pass through the alimentary canal with facility, to be expelled as excrementitious matter. Hence the fallacy of the doctrine lately advanced by Dr. Edward Johnson in his works on Hydropathy, and by some other European authors, that the fœces were *wholly* a secretion, an error which must have originated from observations made on persons whose diet consisted almost wholly of animal and concentrated vegetable food.

In the duodenum the alimentary substance receives the *pancreatic juice* from the pancreas, and is there also mixed with the *bile* from the liver. The pancreatic juice is analogous in qualities to the saliva, and assists further to attenuate and resolve the particles of chyme into the condition best adapted for conversion into chyle.

Various opinions are entertained concerning the nature and uses of the bile. Some physiologists regard it as in part a vital secretion, and in some way auxiliary to digestion. The common notion that it is found in the stomach in a healthy state is erroneous. The stomach cannot endure and will not tolerate it. When accidentally forced there by reversed peristaltic action, the operation of emetics, or other morbid conditions, it produces violent tremblings, spasms, and vomitings, and sometimes convulsions. Others regard the bile as a mere chemical agent in separating the chyle, or nutritious part of the aliment, from the general mass of chyme; and others still look upon it as wholly an effete or excrementitious matter.

The fact that the bile is secreted from venous or impure blood, with which the liver is supplied, unlike any other organ in the body, seems to indicate that the office of the liver is to filter some of the accumulated impurities from the blood, before it returns to the heart, and the analyses of the bile pretty conclusively show that the liver is the depurating organ for certain combinations of effete carbon and hydrogen. Foreign substances have actually been found in the liver very soon after their reception into the stomach; substances which can never be found in the general circulation; a circumstance strongly corroborative of the opinion that the bile is, at least primarily, an excrementitious fluid. It may be, however, secondarily subservient to the economy of the digestive function, by mixing with the innutritious portion of the aliment, and lucubrating its passage, and by mingling with the oily matters, and favoring their solution by resolving them into a saponaceous mass; and also by its alkaline properties, neutralizing any surplus acid matter.

Fluids taken into the stomach are mostly absorbed from it without passing into the intestinal tube. When digestible solid and liquid aliments are taken into the stomach together, the aqueous portion is absorbed before the digestion of the solid matter commences; but indigestible substances must either be violently expelled by vomiting or purging, or more quietly thrown off by the excretories. When, therefore, their impression on the stomach is not strong enough to produce violent resistance, or the organic instincts are palsied in a measure by habit, they must necessarily be absorbed, and pass unchanged into the circulation. This is the case with metallic, mineral, and many earthy, alkaline, and saline matters, with all medical drugs, with alcohol in all its forms, tobacco, and with many articles employed as seasonings or condiments.

Chylification does not take place in the duodenum, for chyle itself is never found there. A still further process is required to elaborate a fluid which is to replenish the blood and supply all the structures. Another change is therefore effected by the *lacteal absorbent vessels.* The lacteals, or chyle-ducts, do not take up or absorb chyle from the alimentary tube, but *form* or manufacture it from the chymous mass; nor does the functional action of these vessels perfect or complete the process of chylification. The finishing elaboration takes place in the *mesenteric glands,* numerously distributed along the course of the lacteals, and formed by their enlargement and convolutions. On receiving the final action of the mesenteric glands, the chyle, fitted for nutrition, passes into the thoracic duct, and thence into the general mass of blood.

The innutritious portion of the food, mingled with and lucubrated by excrementitious matters in the form of bile, and such fœcal matters as are secreted by the mucous surface of the intestinal canal, are carried off by the peristaltic action of the bowels. The peristaltic motion of the whole alimentary canal is produced by the regular, gradual contraction of the circular muscular fibres from above downward, which motion is assisted and invigorated by the general compression on the whole surface of the abdomen produced by the free and energetic action of the external abdominal muscles.

Vomiting is effected by the reversed action of the muscular fibres, aided by the sympathetic and powerful contraction of the abdominal muscles.

Hunger and *thirst*, the sensations of which are referred to the stomach and throat, are indications of the wants of the general system. The rather ancient doctrines that hunger was produced by gastric juice in the stomach, and thirst by a dry condition of the mucous surface of the fauces, are clearly erroneous. Both sensations are organic instincts which communicate the need of the body for solid and liquid aliment to the common sensorium.

Circulation.—The circulating system comprises the *heart* as its grand central organ; the *arteries,* which convey the blood to all parts of the body; the *capillaries,* which connect the arteries and veins; and the *veins,* which return the blood to the heart.

Commencing at the central point, the blood is received from all parts of the *venous system* into the *right auricle* of the heart; the auricle contracts, and the blood is forced into the *right ventricle;* the right ventricle, contracting, sends it into the *pulmonary artery;* this artery divides into branches, which are ramified through the substance of the *lungs*, and bring the blood in contact with their innumerable air cells, where it throws off its surplus carbon, and probably receives oxygen or electricity, becomes changed from dark or venous to fluid or arterial, and is returned through the *pulmonary veins* to the *left auricle* of the heart; from the left auricle it passes into the *left ventricle*, and from thence it passes through the *arteries* to all parts of the body; the valves of the veins and of the different cavities of the heart preventing the current from receding.

The whole quantity of blood is estimated at about one fifth of the entire weight of the body, which is thirty pounds in a person weighing 150 pounds. The cavities of the heart hold about two ounces, three fourths of which is discharged at each contraction, and, counting seventy pulsations in each minute, a little more than six pounds of blood will pass through it in this time, or nearly 10,000 pounds in twenty-four hours. The whole quantity of blood probably passes through the heart once in four or five minutes.

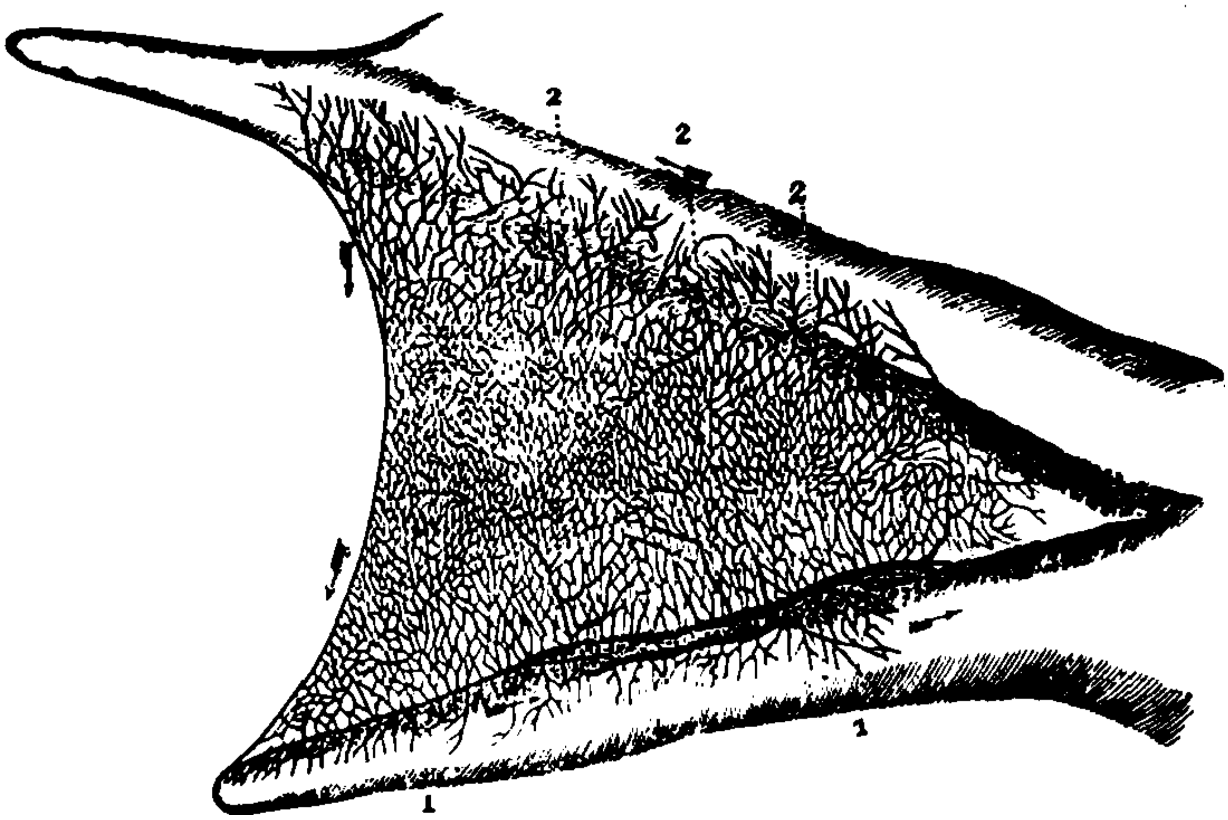
The *frequency* of the heart's contractions—in other words, the beats of the pulse—gradually diminish from the commencement to the end of life. Immediately after birth the pulsations are 100 to 130; in middle life, 65 to 75; and in old age, 65 to 50.

The two auricles of the heart contract simultaneously, as also do the two ventricles, the auricles and ventricles alternating with each other. The contraction of each cavity is called its *systole;* the relaxation which follows, its *diastole.* The systole of the ventricles corresponds with the projection of blood into the arteries, causing the *pulse.* The apex of the heart, being near the walls of the chest, in the neighborhood of the fifth and sixth ribs of the left side, communicates, by the motions of the organ, a decided shock or jarring sensation, which is called the *impulse* of the heart.

The *sounds* produced by the heart's action can be readily detected. By placing the ear on the front part of the chest, two sounds will be distinctly heard, following each other in rapid succession at each beat of the heart. These sounds are alternated with short intervals of repose. The first sound is the longest, and corresponds with the systole of the ventricles, the pulse in the arteries, and the impulse against the walls of the chest; the second, which is but half as long, corresponds with the diastole of the ventricles. The first sound is dull and prolonged; the second is short and sharp. The first sound is produced by the rush of blood through the comparatively narrow outlets of the aorta and pulmonary artery, and its passage over the rough internal surface of the heart, aided by the muscular contraction of the ventricles and the heart's impulse. The second sound is evidently occasioned by the sudden shutting down of the semilunar valves at the orifices of the aorta and pulmonary artery.

The *capillary vessels* are a network of extremely minute vessels intermediate between the arteries and veins. This structure exists in all organic textures. The size of the capillaries is proportioned to that of the red particles of the blood, their diameters varying from $\frac{1}{1000}$ to $\frac{1}{5000}$ of an inch. They are not a distinct system terminating in open mouths, but merely fine tubes by which the arteries are continued into the veins.

Fig. 132.



CAPILLARY SYSTEM.

Fig. 132 represents the anastomoses of the blood-vessels, which form the capillaries, as seen in the web of a frog's foot by the aid of the microscope. 1, 1. The veins. 2, 2, 2. The arteries.

In the capillary vessels all the organic functions take place. Their circulation is to a great degree independent of the heart's action, and is, no doubt, influenced and regulated by the organic nerves, which preside over the functional process, and distribute the blood to the various parts and organs, according to the necessities of the vital economy. The sum of the diameters of all the capillary vessels greatly exceeds that of the arteries and veins, which enables the blood in them to move slowly, and even sometimes take a retrograde direction to some extent, circumstances favorable to the perfect nutrition of the structures, the separation of worn-out material, and the consolidation of new.

In its passage through the capillary vessels the blood loses the vivifying properties and fluid color it received in the lungs, and becomes dark, impure, and charged with effete matter, resulting from the disintegration of the tissues. All the excrementitious or waste matters not collected into the excretory apparatuses of the several depurating organs, are carried along by the capillaries into the veins, to be purified in passing through the liver and lungs.

Respiration.—Respiration is the function by which the blood is aerated or purified. It consists of the alternate inspiration and expiration of atmospheric air. The process of breathing has a two-fold relation to the animal economy. 1. The lungs, as depurating organs, eliminate from the blood a large proportion of the impurities and waste matters which it acquires in the capillaries, particularly its excess of carbon. 2. The lungs, as auxiliary nutritive organs, *digest* the inspired air, and separate, or rather *form* from it a principle convertible into the substance of the blood. Doubtless, too, they receive and transmit to the nervous system, through the medium of the blood, a constantly replenishing stream of that electric, magnetic, or other vital property on which the nervous influence depends.

The air which we ordinarily breathe, uniformly consists of about twenty-two parts of oxygen, seventy-seven of nitrogen, and one of carbonic acid gas, in one hundred. Other gaseous matters frequently exist, to a greater or less extent, in the atmosphere, from local causes, not as constituents, but as accidental admixtures, if we except ammonia, a compound of nitrogen and carbon, which appears to be ordinarily present in the proportion of one fourth of a grain to about 20,800 cubic feet. The constituent proportions of the atmosphere are found not to vary perceptibly in different latitudes, nor in low or mountainous regions.

The air expired from the lungs is found to have lost about sixteen parts of its oxygen, and gained about fourteen per cent. of carbon. As carbonic acid contains precisely its own volume of oxygen, fourteen of the sixteen parts of oxygen lost in the lungs *may be* employed in converting the effete carbon into carbonic acid gas, in which state it is expelled, and the remaining two parts of oxygen *may* serve as nutrient material. But as carbonic acid is found to exist already formed in the veins, and as animals placed in hydrogen or nitrogen still continue to evolve carbonic acid, it appears clear enough that the greater part, if not all, of the carbonic acid gas expelled from the lungs is *formed in the tissues*, thus leaving the greater part or all of the oxygen absorbed from the inspired air to be used for other purposes than "burning up the carbon" in the lungs. This decarbonization and oxygenation of the blood changes it from a dark purple to a bright florid color. The oxygenation of the blood does not consist of the circulation of oxygen in the blood *as oxygen*, but is rather a process of aeriform digestion, by which oxygen is converted into electricity, analogous to the process of alimentary digestion, by which food is converted into chyle.

The nitrogen, which forms so large a proportion of the air we breathe, is sometimes increased, sometimes diminished, and at other times unchanged in quantity by respiration, which seems to prove that its absorption in or expulsion from the lungs depends on the wants of the organic economy, and probably is regulated by the sufficient, excessive, or deficient supply of the nitrogenous principle of the food.

The precise chemical process by which the change of the color of the blood is effected in the lungs, is still an unsolved problem. It has generally been imputed to the presence of iron. Liebig supposes iron to exist in the form of a carbonate of the protoxide in venous blood; and that in the lungs the carbonic acid is given off, leaving the protoxide, which, by union with half an equivalent of oxygen, is converted into the peroxide, and that this peroxide changes the venous blood into arterial. Liebig's theory, however ingenious it may be, has been disproved by Mulder, who has shown that the color is retained when all the iron is removed.

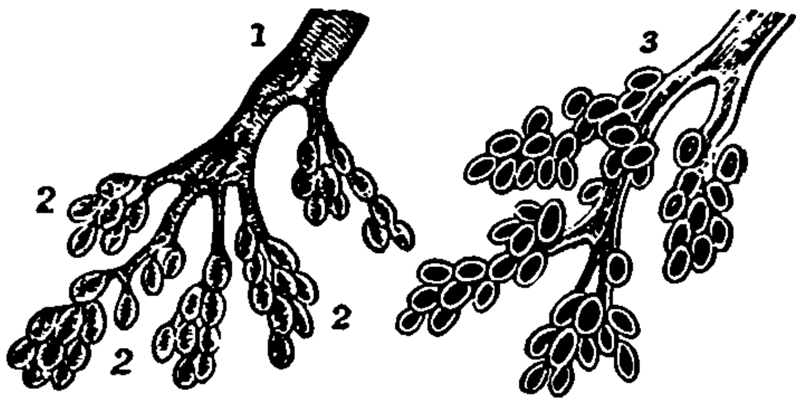
Respiration occurs in aquatic animals which do not breathe air. In them the respiratory organs are membranes prolonged externally into tufts or fringes, called *gills*, each one of which is supplied with arteries and veins, during the circulation of blood through which aeration is effected.

In air-breathing animals the membranous or aerating surface is reflected internally, forming passages or chambers in which the air is received, and on which the capillary vessels are distributed. Insects have a series of tubes ramifying through the whole body, and carrying air to every part.

In the human lungs the sides or walls of the air cells are formed of a thin transparent membrane, and the capillary vessels are placed between the walls of two adjacent cells, so as to be exposed to the action of the air on both sides. The number of the air cells of the whole lungs is immense. M. Rochoux has estimated them at six hundred millions.

Fig. 133 represents the bronchial tube, and its division into air cells, as much magnified. 1. A bronchial tube. 2, 2, 2. Air cells, or vesicles. 3. A bronchial tube and vesicles laid open.

Fig. 133.



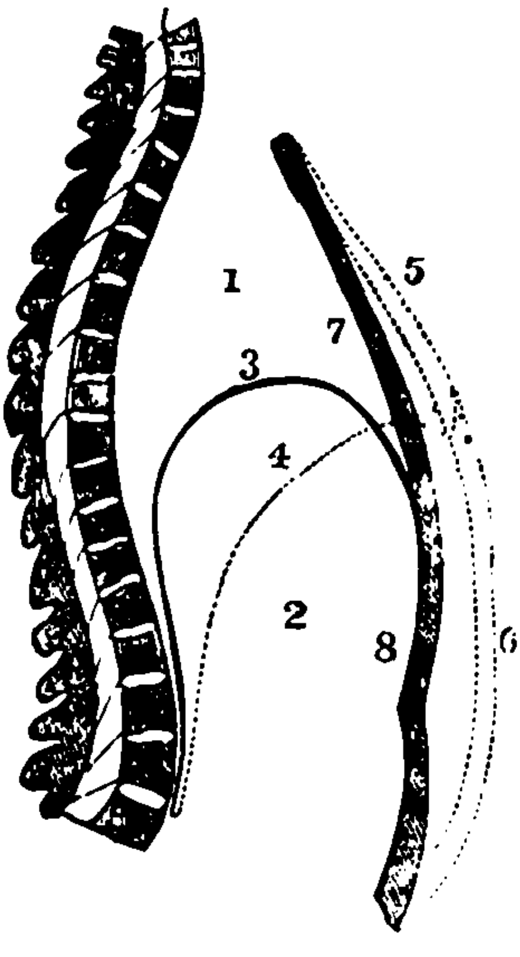
BRONCHIAL TUBE AND AIR-VESICLES.

The capacity of the lungs varies greatly in different individuals. M. Bourgery concludes from his inquiries that the development of the air cells continues up to the age of thirty, at which time the respiratory capacity is greatest. According to the experiments of Mr. Coathupe, about 266½ cubic feet of air pass through the lungs of a middle-sized man in twenty-four hours. At the average number of sixteen inspirations per minute, the amount of air received at each inspiration would be twenty cubic inches. Mr Hutchinson judges the capacity of the lungs by "the quantity of air which an individual can force out of the chest by the greatest voluntary expiration after the greatest voluntary inspiration." Dr. Southwood Smith, from a series of experiments, estimates the volume of air received at an ordinary inspiration at one pint, the volume ordinarily present in the lungs at about twelve pints, and the volume expelled at an ordinary expiration at a little less than a pint. He also concludes that in the mutual action which takes place between the air and blood, the air loses thirty-seven ounces of oxygen and the blood fourteen ounces of carbon every twenty-four hours. The lightness of the lungs depends on the residuary air they contain, and when the lungs have been once inflated by a full inspiration, no force or mechanical power can again dislodge the air sufficiently to make them sink in water. It is this residuary air which supports life a few minutes in cases of suffocation, immersion, etc.

The movements of the respiratory apparatus are partly voluntary, for the purposes of being subservient to voice and speech, and partly involuntary, for the purposes of aeration. The lungs themselves are entirely passive in respiration. When the walls of the chest are drawn asunder, and the thorax dilated, the external air rushes in to the air cells, distending them in proportion to the dilatation of the thorax, and keeping the surface of the lungs all the while accurately in contact with the walls of the chest in all their movements. But if air be admitted into the cavity of the pleura outside of the lungs, as by a penetrating wound of the thorax, the lungs cannot be fully distended by inspiration, but will remain partially collapsed, although the thorax expands, because the pressure of air from without the air cells balances that within.

The diaphragm, by extending the ribs, and pressing down the abdominal viscera, is the principal agent in inspiration; in a deep inspiration the intercostal muscles assist in the expansion of the chest by spreading the ribs, aided also, to some extent, by the muscles of the thorax generally. Expiration is mainly accomplished by the abdominal muscles, whose contraction draws down the ribs and compresses the viscera up against the relaxed diaphragm, thus diminishing the cavity of the thorax from below.

Fig. 134.



ACTION OF THE DIAPHRAGM.

Fig. 134 is a side view of the chest and abdomen in respiration. 1. Cavity of the chest. 2. Cavity of the abdomen. 3. Line of direction for the diaphragm when relaxed in expiration. 4. Line of direction when contracted in inspiration. 5, 6. Position of the front walls of the chest and abdomen in inspiration. 7, 8. Their position in expiration.

The connection of the respiratory function with sensibility, or the sense of feeling, is an interesting and as yet almost unoccupied field of inquiry. According to the experience of drowning persons—those who have remained from one to several minutes under water without breathing, and afterward been resuscitated—there is no pain after the complete suspension of respiration. Although intellectual consciousness remains, and mental conceptions are greatly exalted and intensified, all sensations of mere bodily suffering are absent. The anesthetic effects of ether and chloroform appear to bear a close relation to the extent to which the breathing is suspended. A complete unconsciousness to pain is attended with an extremely feeble and sometimes almost imperceptible respiration.

Absorption.—The absorbent system proper comprises two sets of vessels, with their glandular enlargements and convolutions—the *lac-*

teals and the *lymphatics*. The lacteals convey *nutritive* or new matter into the mass of blood, to replenish the tissues; the lymphatics take up and return to the blood the surplus nutrient materials, and also old or waste particles, in order that they may be used in the secretions, or got rid of at the excretory outlets. The function of the lacteals is called *external absorption*, or the absorption of *composition*; that of the lymphatics is called *internal absorption*, or the absorption of *decomposition*. *External* absorption also includes the absorption which takes place from the surface of the body and mucous membrane of the respiratory passages, as well as that performed by the proper lacteal vessels from the mucous surface of the alimentary canal. *Internal* absorption, sometimes called *interstitial*, also comprehends that which takes place from the component tissues of the organs, and the interior of short sacs, as well as that performed in the capillary vessels.

The veins belonging to the *external* division also act the part of absorbent vessels, but in a very different manner from the lacteals or lymphatics; these vessels exercise a selecting and transmuting power over the elements subjected to their action; hence the chyle and lymph are always found to possess nearly the same general properties. On the contrary, the veins imbibe and carry along unaltered all fluids or substances possessing the proper degree of tenuity to move in the current of circulation. It is well known that many poisons, alcohol, tobacco, the virus of venomous reptiles, etc., exert a much more deleterious effect when injected into the areolar tissue under the skin, than when taken into the stomach. In the former case they pass directly, unchanged, into the circulation; in the latter event they are modified, and more or less decomposed by the action of the absorbent vessels before entering the general system.

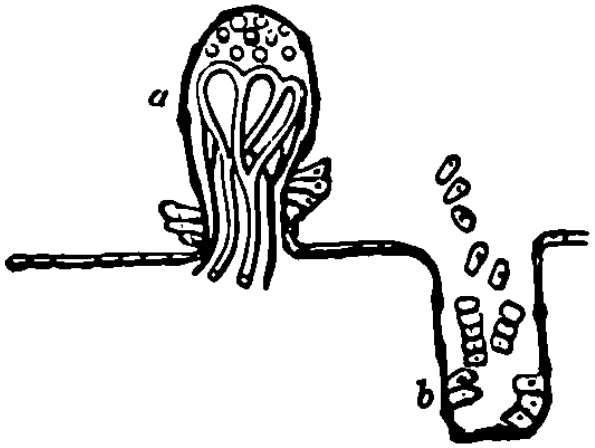
Fig. 135.

LACTEAL ORIGIN.

Alimentary absorption is effected mostly in the small intestines. The lacteals commence by *villi* in the mucous surface, each tube beginning in a single villus by a *closed* extremity; the trunk arising from each villus is formed by the confluence of a number of smaller branches, which anastomose freely with each other in the form of *loops*, as in fig. 135, never commencing in open extremities.

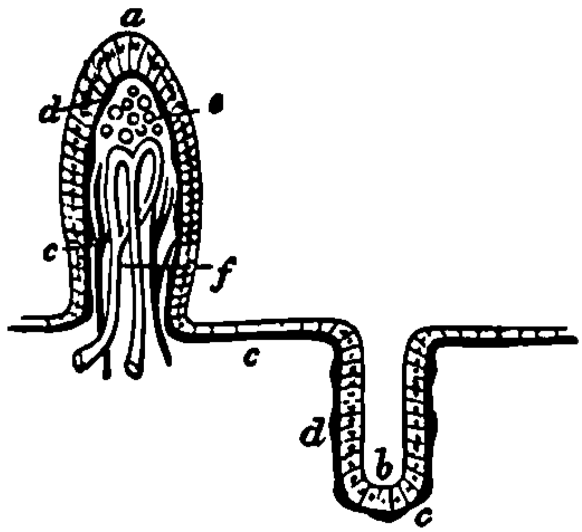
These loops are embedded in a mass of cells at the extremity of each villus; these cells exercise the selecting or transmuting power over the nutritive elements; when full their contents are yielded to the absorbent vessels, either by a process of deliquescence or bursting, their place being supplied by fresh cells, and so the process is continued till the nutritive material is exhausted; after which the villi, previously turgid, becomes flaccid, and the epithelium, which was removed during the process of absorption, is renewed; the lacteal vessels then become the interstitial absorbent vessels of the intestinal canal and act the part of *lymphatics*.

Fig. 136.



CHYLIFICATION.

Fig. 137.



LYMPHATIC ABSORPTION.

Fig. 136 is a diagram of the mucous membrane during digestion and the preparation of chyle. *a*. A villus, turgid and erect; its protective epithelium cast off from its free extremity; its absorbent vessels, lacteals, and blood-vessels turgid. *b*. A follicle discharging its epithelial cells.

Fig. 137 is a representation of the same mucous membrane when chylification is not going on. *a*. Protective epithelium of a villus. *b*. Secreting epithelium of a follicle. *c*, *c*, *c*. Primary membrane, with its germinal spots, or nuclei, *d*, *d*. *e*. Germs of absorbent vesicles. *f*. Vessels and lacteals of villus.

The *chyle* in the lacteals is almost invariably of the same chemical composition, however diversified the character of the food from which it is formed. It is not, however, always of the same *vital* quality; for that which is made of animal food, when taken from the body, undergoes putrefaction much sooner—in three or four days—while that which is selected from vegetable food resists decomposition out of the living organs for several weeks. Its milky color depends on the presence of minute corpuscles, called *chyle globules*. Usually it contains fatty, albuminous, fibrinous, and saline matters, in varying quantities, according to the ingesta.

The *lymphatics* exhibit no essential anatomical difference in origin, structure, or arrangement from the lacteals. They are distributed throughout almost every part of the body, and very numerously upon the skin.

The *lymph*, an almost colorless fluid, which the lymphatics convey to the thoracic duct, very closely resembles the chyle, the main difference consisting in the color of the latter. Its *source* is a matter of conjecture. Dr. Carpenter supposes the matters absorbed by the lymphatics to consist of the residual fluid, which, having escaped from the blood-vessels into the tissues for their nutrition, is now returned to the former. Probably they also contain a portion of the decayed and worn-out particles of the structures. The lymph, like the chyle, contains peculiar self-coagulating corpuscles, and both fluids contain the same ingredients, though in different proportions, for the organic elements are much more abundant in the chyle.

The *glandular* laboratories, through which the lacteals pass, are the ganglia of the mesentery; and those of the lymph-vessels are the lymphatic glands. In these ganglia both fluids are doubtless still further changed, elaborated, and fitted for circulation, nutrition, or expulsion. That these ganglia exercise a supervisory function over the economy of nutrition, acting as sentinels to prevent the introduction of an enemy into the vital domain, is evinced by the fact that when any foreign, injurious, or poisonous element gains admission into the absorbent vessels, whose presence in the general circulation would be immediately dangerous to life, these glands, in the language of some physiologists, "take on inflammation" to arrest its progress. In less ambiguous phrase, the glandular follicles contract their diameters, obstruct the passage, attract an additional supply of blood, and thus hold the aggressor in check until the reinforcement of vital power can so change, modify, or destroy the invading foe, that its elements may pass along with impunity or with greatly diminished danger to the organism.

The *extremities of the veins* are the principal absorbents for taking up the really effete and decomposed matters of the decaying tissues, as well as the accidental impurities of the body; although the lymphatics sometimes take up excrementitious matters, as bile, pus, venereal and other virus brought in contact with them.

Absorption from the skin has been called *accidental*, because the fluids pass in by simple imbibition. The rapidity of this absorption is mainly influenced by the condition of the blood-vessels, being most active when they are most empty, and least so when they are full. When the epidermis is removed, as by a blister, the external integument absorbs with great rapidity. Frequent bathing, followed by friction, increases its absorbing powers.

Absorption by imbibition is effected by both veins and lymphatics. In the mucous membrane of the lungs and stomach, the thin fluids are taken up by the veins, and it may be stated as a general law of the absorbent system, that wherever a thin fluid is placed in contact with an extended surface, it will be taken up by those vessels which present the largest surface and the thinnest walls. It is difficult, however, to explain the absorption of fluids from serous cavities on the principle of imbibition alone.

Probably the most clear and correct general view of the function of absorption may be presented in the following summary: The venous extremities, acting as absorbent vessels, take up the greater portion of useless, injurious, or worn-out matters; the lymphatic vessels return the unused or surplus recrementitious matters, and also serve as auxiliary vessels, or special provisions to guard against obstructions when the functions of the veins are overtasked or imperfectly performed. The elements of the blood in the capillary system are exhaled through the coats of the vessels, and there undergo certain chemico-vital changes. Such elements as are needed to repair the waste, and build up the structures of the body, are assimilated and become a component part of the body; other elements are separated, and so re-combined as to form the secretions, and waste particles are carried back into the circulation to be changed or thrown off.

If the processes of alimentation and exhalation overdo those of absorption and depuration, accumulation takes place in the cellular membrane or serous cavities, of adipose or watery matter, and obstruction exists in the form of corpulency or dropsy. Hence obesity is as truly an abnormal or diseased state as dropsy.

Nutrition.— Nutrition, more properly termed assimilation, is the actual accretion of the alimentary matter to the organism—the completion of the class of nutritive functions. The food, masticated and insalivated in the mouth, acted upon by the gastric juice in the stomach, and the pancreatic juice in the duodenum, still further elaborated in its passage through the lacteals and mesenteric glands, and finally oxygenated in the lungs, is not yet fitted for nutrition. The nutrient process is not accomplished until the alimentary matter is subjected to the finishing action of the capillary vessels. It is here converted into the congenial elements of the several structures, becoming a component part of their substance.

Though the arterial blood supplies the nutrient material to every part and structure of the body, yet this blood does not contain all the proximate elements of the body *as such*. For example, gelatin, which enters so largely into the composition of the animal structures, is never found in the blood in the state of gelatin. This shows again the power of the living organism not only to decompose and recompose the elements of sustenance, but even to transmute one substance, which chemistry regards as a simple element, into another.

The processes by which the various changes of matter take place in the capillary system have been the subject of much chemical research and speculation in modern times. But here, as in all cases where the operations of a living principle are approached, chemistry is and must of necessity be at fault. Chemistry may reduce and refine, divide and subdivide all the forms of organic matter to their ultimate elements, or to a certain set of ultimate results or substances, by a process of *destructive* analysis. It may readily *destroy the evidence* of the life principle, but the chemist's skill can never recombine the elements so as to restore or reproduce the manifestation of vitality. All attempts, therefore, to explain the phenomena of life by the demonstration of chemical problems, are to be regarded only in the sense of analogies. Experiments have shown that saline ingredients, dissolved in water may be decomposed by an electric stream. If a solution of salts be placed in a glass tube having a membranous covering at its extremities, an electric current will not only separate their constituent elements, but deposit some of them on the *outside* of the membrane. Reasoning analogically, we may suppose that the organic nerves transmit the electric principle, which, like the continuous operation of a galvanic battery, separates the materials of the blood into their simplest forms, enabling the play of organic affinities to attach each particle of matter to a congenial particle, and thus replenish or augment the structures. Each atom of matter is evidently *polarized*, that is, possessed of points or properties of attraction and repulsion toward all surrounding atoms, which enable it to assume determinate relations of aggregation or separation toward all other atoms of the same or of different matter.

To this view, that the organic nerves are *necessary* to the nutritive process, it may be objected that nutrition is just as perfect in vegetables, which have nothing analogous to a nervous system. But animal nutrition, unlike vegetable, requires sensation, locomotion, and mind to appreciate, move after, and judge of the materials of nutrition; and the office of a distinct nutritive nervous structure is to associate the operations of mind and the special senses with the voluntary muscles, as well as to energize the involuntary muscles, in the performance of this function. Were animals, like vegetables, "fixed to one peculiar spot," and their only functional economy "to draw nutrition, propagate, and rot," there would be no necessity for either a motory, or sensory, or mental nervous system.

Mere increase of bulk is not nutrition. Morbid depositions of matter which is not assimilated may take place, as in tubercles, wens, encysted dropsy, etc., and the *embonpoint* of persons who are called "high livers," though indicative of excessive alimentation, denotes *defective* rather than excessive nutrition. When the whole body is loaded with fatty accumulations, assimilation is never as perfect, nor the structures as firm, round, and elastic, nor the body as powerful and enduring, nor as capable of sustaining depletion and prolonged fasting, as in a moderately lean condition of the system.

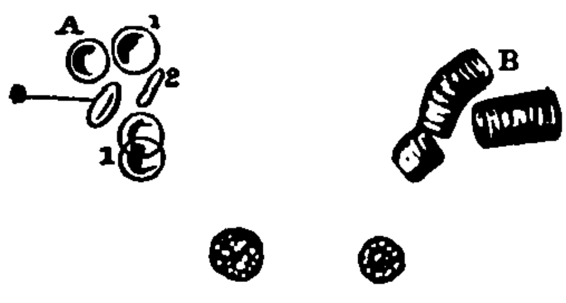
In those abnormal growths called *hypertrophy*, there is an actual increase of substance identical with the hypertrophied tissue or organ; while in the opposite state, *atrophy*, there is an absolute deficiency of assimilated matter. In the former case the nourishment of the structure is greater than the waste; in the latter the waste is greater than the replacement.

Cancerous and *fungous* growths proceed by a similar process of cell-development to that of the original structures, but from some disturbing cause, the nutrient particles are arranged according to a new and abnormal scale of chemical affinities.

Many speculations have been indulged respecting the time in which the whole body is renewed, the extremes of the calculations having generally been *four* and *seven years*. The period must vary greatly, according to habits of life, amount of exertion, kind of food, etc. Probably many bodies are renewed in a much less time than four years.

The coagulation of blood out of the body affords a good illustration of the law by which the primary atoms are arranged in the building up of the tissues, as represented in the cut.

Fig. 138.



CORPUSCULES OF THE BLOOD.

In Fig. 138, A represents the blood-corpuscles as seen on their flat surface and edge. B. Congeries of blood-corpuscles in columns. In coagulating, the corpuscles apply themselves to each other, so as to resemble piles of money.

Though the blood is the immediate source of all nutrition, many structures, as the tendons and ligaments, do not receive *red* blood. The coloring matter which surrounds the corpuscles, therefore, is not essential to the nutritive quality of blood. Many fishes, reptiles, and insects have no red blood. Dr. Carpenter has made the following convenient table, showing the distribution of the constituents of human blood in living and in dead bodies.

Living Blood.	Fibrin, Albumen, Salts,	In solution, forming Liquor Sanguinis.
	Corpuscles,	—Suspended in Liquor Sanguinis.
Dead Blood.	Fibrin, Corpuscles,	Crassamentum, or clot.
	Albumen, Salts,	In solution, forming serum.

SECRETION.—Secretion literally means *separation;* but the process by which a new substance is produced by a re-arrangement of the elementary matters contained in the blood is one of *formation.* Secretion, therefore, is not the separation but the *production* of a proximate element from the blood. Each organ or structure secretes or forms its own peculiar fluid, serving some special purpose in the animal economy. The mucus and serous fluids poured out on the surfaces of mucous and serous membranes, are regarded as *exhalations*, mere exudations by the process of exosmose, rather than secretions.

All the cavities of the body which open externally, as those of the nose, mouth, alimentary canal, trachea, bladder, and uterus, are lined with a *mucous* membrane, which secretes or exhales a bland, slimy fluid, called *mucus.* This mucus serves to moisten and lubricate their surfaces, facilitate the passage of crude matters, and protect them against the action of acrid and irritating agents.

All the internal surfaces of cavities not opening externally, as those of the abdomen, chest, heart, brain, and joints, are lined with a *serous* membrane, from which secretes or exhales a thin watery fluid, called *serum*, whose office is to facilitate the motions of their surfaces.

Some of the secretions are wholly *recrementitious*, being for the use of the animal economy, as the saliva, chyle, gastric juice, and synovia; others are wholly *excrementitious*, being mere waste material, as sweat, urine, bile, and fœces. Some of the excrementitious secretions are made subservient to organic purposes, as the bile and ear-wax; and some of the organs secrete a nutrient and expel an effete material at the same time, as the lungs and skin.

Fig. 139.

GLANDULAR SECRETION.

There are three forms of secreting organs. The simplest form is that of the animal membrane, which is abundantly supplied with blood-vessels, and covered with an epithelium, as the serous and synovial membranes; the next form is the inversion or depression of the membrane, constituting the *follicle;* and the last is the *gland*, an aggregation of follicles.

Fig. 139 represents the follicles, multiplied and clustered together upon efferent ducts common to several of them, the duct converging to form the main excretory duct, the whole constituting a secreting gland.

The important agents in secretion, as well as in nutrition, are *cells*, which are developed upon the lining membrane of the follicles and tubes, and which elaborate the matter of secretion from the blood, and pour it into the excretory duct. The cells, as in the case of nutrition, are constantly being cast off and reproduced.

The follicular secretions are divided into the *mucous* and *cutaneous*. Of the former character are the ordinary follicles of mucous membranes, and the numerous glandulæ of the intestinal canal; the simple and the compound *gastric follicles* of the stomach, which secrete the *gastric juice;* the *glands of Brunner* in the duodenum; the *glands of Peyer* in the jejunum and ilium, which are supposed to secrete the putrescent elements of the fæces; the *follicles of Lieberkühn*, distributed through the whole intestines, but especially numerous in the small intestines, and which secrete a thick, tenacious mucus; the *large follicles* in the cæcum and rectum, producing slight elevations on their surfaces; the *glands of Duvergny* and *Nabothi*, in the vagina and cervix of the uterus in the female; and the *glands of Cowper* and the *prostate*, in the male, The *tonsils* also are considered as a collection of lubricating mucous follicles.

The cutaneous division includes the *meibomian follicles*, which are seated in the tarsal cartilages. and secretes the gummy fluid that lubricates the edges of the eyelids; the *ceruminous*, which secretes the thick resinous substance called *ear-wax;* the *sebaceous*, which pour out an *adipose matter* upon the skin; and the *sudoriferous*, which secrete the proper *perspirable matter.*

The sweat glands have been estimated by Mr. E. Wilson at about *seven millions.* As their secretion is usually evaporated as fast as formed, most of the perspirable matter passes off in the form of *insensible* perspiration. Perspiration is *sensible* only when excessive, or when it accumulates upon the skin by a moist state of the atmosphere. In the armpit is a peculiar description of glandules, called *odoriferous* or *miliary*, which secrete an odorous matter characteristic of that part of the body. This odorous principle is said to differ in animals sufficiently to afford a test by which their blood can be distinguished. A few months ago I had a patient under treatment in whom the odor from the axillary glands was so strong and fetid as to make his presence disagreeable, especially in a warm room. It has been alleged that the blood of the female can be distinguished from that of the male by the peculiar odor from this source; an opinion which I am inclined to think has more fancy than fact about it.

The *glandular secretions* are the *lachrymal*, or *tears*, from the lachrymal gland, which lubricates and cleanses the conjunctiva; the *salivary*, formed by the *parotid*, *submaxillary*, *sublingual*, and *pancreatic glands;* the *bile*, found in the *liver;* the *urine*, found in the *kidneys;* the *spermatic* secretion of the *testes*, and the *mammary* secretion of the *breasts*. The milk is more affected by the food and drink of the mother than any other secretion, and also by strong passions or emotions of the mind. Instances have been known in which a single violent fit of passion, or other paroxysm of excitement, has so changed the quality of the milk as to destroy the life of the nursing child in an hour.

The *spleen*, *supra-renal capsules*, *thymus* and *thyroid glands*, have been called *vascular glands*, or *glandiform ganglia*, although they form or secrete no peculiar fluid, and have no excretory duct. Physiologists generally regard them as reservoirs for an excess of blood in neighboring organs, the spleen being the diverticulum for the stomach and liver, or the portal circulation; the thymus to the lungs in fœtal life, the thyroid to the brain, and the supra-renal capsules to the kidneys.

THE EXCRETORY ORGANS.—Those organs which perform the *excretory* part of the secretory function are the *lungs*, *skin*, *liver*, *bowels*, and *kidneys*. All the excretory organs are capable of vicarious function, doing the work of each other to a great extent, though the lungs and liver, skin and kidneys, most intimately reciprocate in functional duty. The lungs and liver are the special depurating organs for the surplus carbon and hydrogen; the skin and kidneys for the nitrogenous products of decomposition; and the bowels throw off the more complex proximate elements of waste matters and fœcal secretions.

The depurating as well as nutrient function of the *lungs* has already been considered.

The *skin* is not only a cleansing organ, but, like the lungs, a breathing organ; for it really absorbs oxygen, and throws off carbonic acid gas. Next to the lungs the skin is the most extensive as well as important detergent structure of the body. The amount of solid matter eliminated from the body through this emunctory is, on the average, about 100 grains per day. The amount of fluid thrown off is more variable, depending on external temperature, quantity of drink, activity of the kidneys, etc. The estimates of the transpiration from the cutaneous and pulmonary surface in twenty-four hours are from 1¾ lb. to 5 lbs., nearly three fourths of this amount passing from the skin.

The *liver* secretes the matter of bile from the venous blood. The object of the biliary secretion evidently is to eliminate certain impurities from the body in the form of compounds of carbon, hydrogen, and nitrogen, and also to deterge the blood of a portion of any excess of alkali that may be absorbed by the venous extremities.

Liebig has fabricated a singularly inconsistent hypothesis, which has satisfied himself and all others who are satisfied to echo his arguments without taking the trouble to examine them, that the bile is a nutritive product, and that, consequently, whatever will tend to the formation of bile, or any of the proximate elements usually found in bile, is a useful and nutritive substance. Liebig reasons in this wise. The bile is composed of several certain proximate elements. One of these is called *taurine*. This taurine is the only compound or proximate element found in the bile which contains *nitrogen*. Now *theine* and *caffeine*, the active principles of tea and coffee, are found, on chemical analysis, also to contain a very small quantity of nitrogen; *ergo*, tea and coffee, though injurious stimulants to the nerves, may be useful to the liver by furnishing the nitrogenous element of the taurine of the bile! Such reasoning is extremely absurd, and the error is a most palpable one. It consists in mistaking a waste material for an aliment; a depurating process for a nutritive one. As well might one mistake putrid flesh for wholesome food, because it contains carburetted hydrogen, which is also found in the fæces, or excrementitious matters of the bowels.

The *kidneys* eliminate from the system a large proportion of effete saline, alkaline, and earthy particles, and the greatest portion of the surplus nitrogen. The average amount of urine excreted in twenty-four hours has been estimated at from thirty to forty ounces. Of course it depends greatly on the activity of the skin, amount of fluid taken into the stomach, moist or dry, hot or cold state of the atmosphere, etc. The amount of solid organic matter expelled daily by this emunctory has a close relation to the activity and corresponding waste of the muscular tissue, and this is determined with considerable accuracy by the amount of *urea* in the urine; a test, however, of no practical value in treating diseases.

The "brick dust" sediment, "chalky deposits," and "albuminous" appearance of urine, are dependent to a very great extent on the character and purity of the food and drink. The long-continued employment of what are very absurdly called "medicated waters," containing carbonates of lime, soda, iron, and magnesia, chloride of soda, sulphates of lime and magnesia, muriate of lime, sulphur, sulphuretted hydrogen, iodine, hydriodates of soda and potash, etc., as well as all very hard and impure water, is a common cause of gravel, stone, calculous concretions, etc., and a prolific source of diseases of the kidneys and bladder.

The total suspension of the urinary secretion is attended with rapidly fatal results, the patient manifesting symptoms like those produced by narcotic poisons.

The *bowels* are the emunctories for such innutritious portions of the food as do not pass into the circulation, and are not taken up by the lymphatics or venous extremities, and carried to other depurating organs; and also such waste and worn out particles as are secreted in the form of fœces. The quantity and character of the dejections depend much on the nature of the ingesta. As the contents of the alimentary canal pass along, their fluid portion is gradually withdrawn, and they acquire a firmer consistence; they also become more fœcal in character as the putrescent elements of the blood are secreted by the various glandules along the intestinal tract.

Calorification.—Many speculations have been indulged by chemists and physiologists, in relation to the production of animal heat. Since the publication of Liebig's elaborate work on Organic Chemistry, the notion has become generally prevalent among the scientific circles, and from them it has been promulgated among the non-scientific people, that the production of animal heat is a mere chemical process, the lungs serving as a stove or fire-place, and the carbonaceous substances of the food serving as fuel "to be burned in the lungs." According to this theory, fatty substances, animal oils, and other matters containing a large proportion of carbon, are not only useful but absolutely necessary to keep up the requisite degree of animal temperature. The position seems to me as almost self-evidently absurd, and it has certainly led many persons into the most egregious blunders practically, and at the expense, too, of their own common sense and common observation.

All the organic functions of the body—the vital processes—are in one sense chemical. They are not, however, such chemical decompositions and re-combinations as are performed in a chemical laboratory. They are not such as the chemist can ever demonstrate or imitate. They not only change the relative proportion of elementary matters, but absolutely transmute elements into each other, reduce several of what we call elements to one, and separate one into several. All the chemico-vital processes—respiration, digestion, circulation, secretion, etc.—are attended with the elimination of heat; in other words, latent caloric becomes sensible by these changes of matter. But all the organs, by virtue of their own specially presiding centres of nervous influence, are, to some extent, self-regulating in their temperature, while the entire body possesses a general self-regulating power. The principal organ whose function serves as a universal regulator and equalizer of animal temperature, is the skin. When in vigorous and healthy condition it throws off the surplus heat, or retains the deficient, according to the necessities of the organism. There is no need of a fire and boilers to warm up the blood, as the water is heated by the machinery of a steam-engine, and for this simple reason I think nature has not provided them.

The error lies here. Liebig and his followers have mistaken an excrementitious or cleansing process for a nutritive or supplying one. They have misconceived the function by which the body rids itself of waste matters, and called it a useful and indispensable condition of vitality. They have supposed the chemical process by which nature throws off the effete carbon through the lungs to be a method of furnishing animal heat. This, I think, can easily be made manifest.

According to the theory of animal heat I am controverting, fat, suet, tallow, lard, marrow, grease, butter, blubber, and fixed oils, should constitute healthful food; and such is, indeed, the conclusion of Liebig's followers. But the common experience of all mankind is against it. Common observation says that these articles, though to some extent sufferable, are not strictly wholesome; and further, medical men generally disallow these articles to their patients when they are very much reduced with disease, at the same that the animal temperature is very low, and requires such food, if ever. Again, corpulent persons, who are surcharged with carbon, do not bear cold better than lean persons, who have little; in fact they are, other circumstances being equal, more sensitive to it.

But if fats and oils are useful as fuel for the pulmonary warming-pan, because of their larger proportion of carbon, alcohol would be useful in the same way, on exactly the same principle. Accordingly, strange as it may seem, we find Pereira, in his able *chemical* work on

Food and Diet, adopting alcohol as an alimentary principle! Alcohol an aliment, a food, a nutritive material! Can any thing be more ridiculous?

Now alcohol contains more carbon than most kinds of animal or vegetable food, except animal oils or fats; and, in the chemical theory we are considering, ought to be just as useful as an "element of respiration;" and so by a single vagary of modern science we are thrown back to the errors of four thousand years ago. Pereira says: "Alcohol, therefore, is a *fuel* in the animal economy, and by its oxidation in the lungs, must evolve caloric, and *serve* to support the temperature of the body." Now let us hear his argument: "Alcohol is an element of respiration. Common experience favors this view. Coachmen and others take it in cold weather to keep them warm, and it is familiarly used to prevent what is commonly called 'catching cold.' In cases of extreme suffering and exhaustion from excessive exertion and privation of food, the cautious and moderate *dietetical* use of spirit has on many occasions, proved invaluable. In Captain Bligh's account of the sufferings of himself and companions, in consequence of the mutiny of the crew of the Bounty (in the South Seas, in 1787–9), he observes: 'The little rum we had was of great service; when our nights were particularly distressing, I generally served a teaspoonful or two to each person, and it was joyful tidings when they heard of my intentions.'"

Here the *pernicious* effects of a positive *poison* are mistaken for the *useful* results of natural *aliment!* As long ago as 1787, the opinion was generally entertained that "a little rum" was a sort of elixir vitæ, warming the body when cold, cooling it when hot, drying it when wet, and wetting it when dry, as well as sustaining it when famished, and regulating it when full. More enlightened observation has discarded these absurdities, and it is to be regretted that they should be revived again by medical philosophers.

Though Pereira asserts and tries to prove the utility of alcohol in the animal economy, he allows it is injurious at the same time, thus involving his theory in still greater confusion. He says: "Though alcohol evolves heat in burning [in the lungs], it is an obnoxious fuel." Does not this admission prove that the heat evolved by the use of alcohol is simply the result of the effort of the organism to get rid of it? This would be the heat of fever or inflammation; a heat much more calculated to wear out and prematurely exhaust the animal economy than to support it. And this view, I venture to say, is confirmed by all human experience.

Moreover, against Pereira's far-brought testimony in favor of the dietetic use of rum, we can quote any amount of controverting evidence. Liebig himself admits that "the development of heat in the body, after the use of wine, increases without the manifestation of a corresponding amount of mechanical force. A moderate quantity of wine in women and children unaccustomed to its use, produces a diminution of the force necessary for voluntary motions. *Weariness, feebleness in the limbs,* and *drowsiness,* plainly show that the force available for mechanical purposes, in other words, the change of matter, has been diminished." Rev. Mr. Scoresby testified before a committee of the British House of Commons, in 1834: "My principal experience has been in severely cold climates, and there it is observable that there is a very pernicious effect in the reaction after the use of ardent spirits. In the case of a storm, or other sudden difficulty, I should most decidedly prefer the *water-drinkers* to those who were under the influence of *any stimulant.*" Sir John Ross testifies that: "Having in the Arctic regions, in his own person, experienced the beneficial effects of abstaining wholly from spirituous drinks, he proposed to his men that they should try the same experiment, which was done with the most gratifying results. When men under hard and steady labor are given their usual allowance of grog, they become languid and faint, losing their strength in reality, while they attribute that to the continuance of their fatiguing exertions. He who will make the corresponding experiments on two equal boat's crews, running in a heavy sea, will soon be convinced that the water-drinkers will far outdo the others." Dr. Rush says: "The temporary warmth produced by spiritous liquors is always succeeded by increased chilliness, rendering the body still more liable to be affected and injured by cold." These authorities could be extended, but we have already enough for our purpose. All the facts we can find which bear at all on this subject, go to prove most indubitably that alcohol is in every sense exactly the opposite of an "element of respiration." It is indeed a "fuel in the animal economy," in the same sense in which any accidental combustible substance creates a flame which burns our dwelling-house to the ground.

The whole argument, *pro* and *con,* will apply equally to animal fats and oils, with this qualification. Greasy matters, though composed mostly of waste, useless, and excrementitious materials, which have accumulated in the cellular repository, because the process of alimentation was increased beyond that of elimination, are not strictly poisonous. They contain doubtless a very small quantity, yet very impure quality, of substances convertible into nutriment. But, as food, they are to be regarded as next to venous blood in grossness and impurity.

They contain about eighty per cent. of carbon; hence, when freely taken into the system, the lungs, as the principal excretory organ for effete carbon, has an additional duty to perform in throwing it off. This increased labor is, as a matter of course, attended with an increased temperature of the body, simply because there is a greater amount of matter than is natural or necessary to be disposed of. But this, as in the case of alcohol, is an extraneous, useless, exhausting labor, which wears out the machinery of life with inordinate rapidity. If the excessive quantity of carbon is constantly supplied in the diet, the organism must prematurely wear out, or break down with disordered action. If fatty matters are only occasionally eaten, the temporary increase of temperature will be followed by depression and debility, precisely as with alcohol, though much less in degree. The lungs, however, do not "burn up"—oxidate—all the surplus carbon of grease, oils, gravies, etc., for we see in most persons addicted to their free use, pimples, blotches, eruptions, swellings, boils, and cancerous ulcerations, with evidences of bad blood, torpid brains, and glandular obstructions, clearly traceable to this habit, and curable by its discontinuance. The principal injurious effect, therefore, of animal oils and fats is not from their large quantity of carbon, but from their intrinsically impure character. In all pure, healthful, and natural alimentary substances, the system can appropriate what carbon it requires, and dispose of the remainder without injury, obstruction, or excitement, be the quantity contained in the alimentary article more or less. All the grains, esculent roots, and fruits, as well as the flesh-meat of animals, contain exactly the right proportions of carbon in their composition for perfect nutrition, respiration, and animal heat, however much their respective quantities of carbon may vary. They are also universally allowed to be "easily digestible," and innocuous to the stomach in all normal conditions of the digestive powers. Not so with greasy matters.

Pereira himself says, directly in the face of his argument in favor of the use of grease for the benefit of the lungs: "*Fixed oil or fat* is more difficult of digestion, and more obnoxious to the stomach, than any other alimentary principle." Can any body tell why an alimentary article which is so necessary to the ungs should be so obnoxious to the stomach, unless nature has made a very great blunder? The whole theory of a respiratory alimentary principle seems to me preposterous in the extreme.

It is further urged, in favor of this wild conclusion from a false starting point, that people in very cold climates, the Esquimaux, for example, consume immense quantities of blubber oil, tallow candles when they can get them, fatty matters of all kinds that they are able to procure, as well as enormous quantities of flesh or fish, as they can catch it; and simply because they do these things, and live in a cold climate where they can get little else, the inference is drawn that it is necessary they should so eat to get carbon in the body, to be "burned in the lungs" to support the animal temperature. It is very true that a cold, rigorous climate enables the digestive organs to bear what would destroy life very soon in a warm climate. It is also true that these blubber-oil eaters, and all the tribes of men whose dietetic habits are similar, are a very inferior race, and in them nothing is developed scarcely, save the mere animal nature; hence their stomachs have all the nervous power almost of their whole constitutions. More than this, their animal nature is itself actually inferior in muscular power to that of those tribes and races of men whose general regimen is comparatively free from fats and animal oils.

From all the arguments and facts I am able to gather, the conclusion is unavoidable, that this notion of pouring carbon into the stomach to support respiration and manufacture animal heat, is just as absurd as the common fallacy of heating, peppering, and stimulating the stomach with spices, pills, and spirits, to aid digestion. Moreover, the theory of the combustion of carbon in the lungs sufficiently to heat up the body is positively disproved by the fact that most of the carbonic acid expelled from the lungs is really formed in the tissues distant from the lungs.

There is no doubt that the oxygenation of the tissues throughout the system, and the combination of oxygen with carbon, are sources of animal heat, in common with all the organic functions and chemical changes which take place in the body. All the conditions requisite to the due regulation of the animal temperature are good digestion, free respiration, vigorous circulation, proper assimilation, and perfect depuration, in two words—*good health.*

The ordinary temperature of the human body ranges from 98° to 100° Fahr., varying but very few degrees above or below when the surrounding atmosphere is greatly elevated or depressed, nor under the most violent fevers or extreme states of debility and emaciation. That *cutaneous respiration* is subservient to the maintenance of the equal temperature of the body, is evident from the fact that if the hair of animals be shaved off, and the bare skin covered with varnish, the temperature instantly falls.

ENDOSMOSE AND EXOSMOSE.—Dutrochet discovered and Liebig has demonstrated certain facts in relation to the interchange of dissimilar fluids in different parts of the animal structures, which facts together have been called the laws of *endosmosis* and *exosmosis*. According to a principle of these laws, whenever any animal membrane has one of its surfaces in contact with a different fluid, an interchange takes place; a part of the fluid on the outside passes to the inner surface, while a portion of the fluid on the inside passes through and mixes with that on the outer surface, the interchange continuing until both fluids become similar. The term endosmose means *imbibition*, and is applied to the current passing from without to within; exosmose means *transudation*, and is applied to the passage of the fluid from within to without.

If a solution of any salt, or of sugar, is poured into a glass tube closed below by a piece of bladder, the particles of the solution permeate the pores of the bladder, but do not pass through it. If the tube thus filled is placed in a vessel containing distilled water, the fluid gradually rises within the tube, and sometimes to the extent of several inches, while at the same time it is found that a portion of the solution has passed from the interior of the tube to the water external to it.

It is said that in order to have these phenomena manifest, the fluids must be of *different densities*, and that there must also be an *affinity* between the membrane and the fluid, or no current will take place. *Gases*, as well as fluids, are diffused among each other, even through the compound textures.

These properties of the tissues, which are also possessed by some inorganic substances, as thin plates of slate or of baked clay, are extremely important in relation to the treatment of diseases, especially in cleansing the body from drug-medicines and other impurities, circumstances which will be noticed more particularly in the therapeutic department of this work.

NOTE.—The REPRODUCTIVE function will be considered in PART VIII.

CHAPTER V.

OF TEMPERAMENTS.

TEMPERAMENTS are peculiarities of organization. Marked differences in individuals, occasioned by the disproportionate development of some one or more of the systems or tissues, have been noticed since the earliest times. Galen distinguished these differences into the *sanguine*, *phlegmatic*, *lymphatic*, and *melancholic* temperaments, a distinction based on the supposed preponderance of some one of the four elements—air, water, fire, and earth. Various divisions of the temperaments have been proposed by modern physiologists. Dr. Caldwell bases the three principal temperaments on the three principal cavities of the body; the *cerebral* or *mental* temperament, existing when the *cranium* is most capacious, the *sanguine* when the *chest* is large, and the *lymphatic* when the *abdomen* predominates.

The temperaments usually recognized, and which are as satisfactory as any other classification for practical purposes, are the *nervous*, *sanguine*, *bilious*, and *lymphatic*. The nervous and sanguine are the *irritable* or *active* temperaments; the bilious and lymphatic are the *inirritable* or *torpid* temperaments. The former dispose to more rapid motion and greater activity, with less power of endurance; the latter are less easily excited to action, but more powerful and enduring. The former enjoy or suffer with the greatest intensity; the latter are incapable of the same extremes of feeling. When all the systems and parts of the body are equally developed, the temperament is called *balanced*.

Fig. 140.

NERVOUS TEMPERAMENT

Fig. 141.

SANGUINE TEMPERAMENT.

THE NERVOUS TEMPERAMENT.—This temperament is dependent on a large development of the brain and nervous system, and when strong or pure, is marked by angular points in the body and sharpness of features, large head, small bones and muscles, and generally delicate features, as represented in fig. 140.

THE SANGUINE TEMPERAMENT.—The sanguine, or *arterial* tem perament of some authors, depends on a large development of the circulating system, more especially the lungs and arteries. Its signs are broad shoulders, an animated, lively countenance, florid complexion, blue eyes, sandy, yellowish, or brown hair, and a smooth, harmonious combination of the general form and features, as seen in fig. 141.

Fig. 142.

BILIOUS TEMPERAMENT.

Fig. 143.

LYMPHATIC TEMPERAMENT.

BILIOUS TEMPERAMENT.—The bilious, sometimes called *nervous* temperament, is produced by the structural preponderance of the bones, muscles, and veins. It is known by large, full muscles, prominent, swelling veins, dark hair and eyes, dark, brown, or yellow complexion, as in fig. 142.

LYMPHATIC TEMPERAMENT.—The lymphatic, or *digestive* temperament, is occasioned by the large development of the abdominal viscera, particularly the digestive organs. It is denoted by a general rotundity or fullness of the body, dull, pale appearance of the skin, and a disposition somewhat inclining to indolence. It is represented in fig. 143.

The several temperaments are combined in all conceivable proportions, but are seldom so perfectly balanced that one or two will not prevail over the others, and give a manifest direction to the individual character. Black hair and eyes, red cheeks, and a yellowish neck, indicate an equal combination of the sanguine and bilious; sharp features red cheeks, thin flesh, light hair, and blue eyes, indicate a balance between the sanguine and nervous; sharp features, with a lean body and a dark complexion, indicate a balance between the nervous and bilious; and heavy, round form and features, with a dark complexion, denote a combination nearly equal between the bilious and lymphatic.

CHAPTER VI.

RACES OF MEN.

THE division of the human family into races or classes, each distinguished by certain striking peculiarities in the shape of the head, and in the structure, color, and arrangement of the skin, hair, and eyes, though strictly belonging to the science of ethnology, is a subject constantly becoming more interesting to the physiologist, from its intimate connection with the development of men, and the improvement and advancement of humanity.

A classification of mankind into leading classes must of course involve distinctions purely arbitrary; for the races may be distinguished into two or twenty, or any number between, as the marks of difference are more or less prominent.

The division of Blumenbach, who makes five principal races, is as useful and satisfactory as any other can be. These are named the *Caucasian*, *Mongolian*, *Ethiopic*, *American*, and *Malay*.

Fig. 144.

CAUCASIAN RACE.

THE CAUCASIAN RACE.—The Caucasian race is remarkable for the highest physiological development, personal symmetry and beauty, and intellectual attainments. The chief families of this race are the *Caucasians proper*, and the *Germanic*, *Celtic*, *Arabian*, *Libyan*, *Nilotic*, and *Hindostanic* branches.

In this race the skin is generally fair, the hair fine and long, and of various colors, the skull large, rounded, and oval, and the forehead broad or prominent, large and elevated.

The face is relatively small and well-proportioned, the nose arched, the chin full, and the teeth vertical.

In this variety or race of men we find the farthest remove from the animal in brain, features, and hair, with a superiority of intellectual and moral power, love of the arts, science, and poetry. The progress of the human family seems to be made wholly through this race.

Fig. 145.

MONGOLIAN RACE.

THE MONGOLIAN RACE.—The Mongolian variety includes the *Mongol Tartars, Turks*, and the *Chinese* and *Polar* tribes, which inhabit a vast extent of the earth's surface, and constitute about half of the population of the globe. In physiological characteristics the Mongolians manifest considerable variety. The hair is black, long, and straight, the beard scanty, the skin commonly of an olive tint, the eyes black, the nose broad and short, the cheek-bones broad and flat, the skull oblong, but flattened so as to give it a square appearance, and the forehead low.

In moral development this race is decidedly inferior; their intellectual powers are more imitative than inventive, and they possess but little strength and originality of mind.

THE ETHIOPIC RACE.—The *Negroes of Central Africa*, the *Caffres* and *Hottentots of South Africa*, the *Natives of Australia*, and the *Islanders of the Indian Archipelago and the Pacific Ocean*, constitute the principal families of the Ethiopic or black race.

Fig. 146.

ETHIOPIC OR BLACK RACE.

The black variety of mankind have complexions of jetty hue, black, woolly hair, eyes large, black, and prominent, nose broad and flat, thick lips, and wide mouth. The head is long from the ears back, and narrow; the forehead is low, narrow, and retreating; the cheek-bones prominent, the jaws and teeth projecting, and the chin small. A long, protruding heel, and a flat shin-bone, often distinguish this variety.

In disposition they are easy, indolent, cheerful, fond of sensual pleasure, and lovers of children, fond of gaudy show, but very improvident. In intellect the race varies much, but the majority of its tribes are low in this respect. There are, however, many instances in which individuals of this race have exhibited respect able talent.

THE AMERICAN RACE.—The *Indian tribes*, or "*Red men*," who once occupied originally nearly the whole of *North* and *South America*, south of the sixtieth degree of north latitude, constitute this variety.

Fig. 147.

AMERICAN RACE.

The people of this race vary considerably in complexion, but are mostly of a reddish-brown color. The hair is long, straight, and black, the beard deficient, the eyes black and deep set, brows prominent, forehead receding, prominent aquiline nose, high cheek-bones, small skull, rising high at the crown, and the back part flat, large mouth, hard, rough features, with fine, straight, symmetrical frames. They are averse to cultivation, and slow in acquiring knowledge, sedate, proud, restless, sly, revengeful, fond of war, and wholly destitute of maritime adventure, and are rapidly disappearing from the earth before the all-conquering march of the Caucasian.

THE MALAY RACE.—This variety of the human family inhabit *Borneo*, *Java*, the *Phillipine Islands*, *New Zealand*, the *Polynesian Islands*, and a part of *Madagascar*.

Fig. 148.

MALAY RACE

The Malays have tawny or dark brown skins, coarse, black hair, large mouth, broad, short noses, seeming as if broken at the root, projecting upper jaws, and protruding teeth. The forehead is broad and low, the crown of the head high. The moral character of the Malays is of an inferior order. They are active, ingenious, and fond of maritime pursuits, and exhibit considerable intellectual capacity. Yet this race is constantly giving way before European civilization, and has already disappeared from New Holland and Van Diemen's Land

If the opinion is correct that the stronger race continually overgrows all the rest, and gradually obliterates them from the earth, the Caucasians are surely destined eventually to "possess the land." The history of the whole human race thus far indicates that such is the order of nature.

ORIGIN OF THE RACES.—Whether the various races of men have each had separate origins, or whether they are descendants of a common pair, modified by habits of life, climate, and external conditions, my limits will not permit me to discuss. Dr. Pritchard, after a labored investigation, came to the conclusion of the original *unity* of the races of the human family. Other authors have examined the subject apparently as critically, and settled down upon the opinion of the original *diversity* of the races.

Dr. Carpenter remarks: "It is a question of great scientific interest, as well as one that considerably affects the mode in which we treat the races that differ from our own, whether they are all of *one* species, that is, descended from the *same* or from *similar* parentage, or whether they are to be regarded as *distinct species*, the first parents of the several races having had the same differences among themselves as those now exhibited by their descendants."

No doubt the question of the natural inferiority of a race or tribe of the family of mankind really *does* affect the manner in which they are dealt with by their superiors, and materially modifies the state of their consciences in relation to the use or abuse of the weaker by the stronger, still this might makes no right, nor does this question furnish any reason why the more powerful race should maltreat the more feeble. I admit that the process of extermination is going on, according to the irreversible laws of nature, from the highest human being to the lowest animal. I believe that the stronger animals will exterminate the weaker, that man will eventually run out of existence the stronger animals, and that the superior tribe of the human family will finally obliterate all traces of the existence of all the others; still I cannot see in the operations of this law any reason for oppressing, or even for not striving for the development of all men, yes, of all animals, according to their capacities and conditions. So long as inferior men *do* exist, our duty to them is plain enough. No one pretends that we, the stronger, have any right to rid the earth of their presence by violence, or in any other way except that "ordained by Heaven." So far as Nature is concerned, she will see that her laws on the subject are faithfully executed, without our special interference. As far as the feebler races are capable of development and improvement, they are entitled to the same consideration as those who are more highly endowed in organization.

THEORY OF POPULATION.—Philosophers have not yet been able to agree upon any satisfactory theory of population. Mr. Malthus has contended that population has a tendency to increase faster than the means of subsistence, unless some extraordinary counteracting causes be interposed. On this assumption, "war, pestilence. and famine," may be hailed as special Godsends to keep the race down to the level of the means of subsistence; but it places the Creator in an attitude from which our reason revolts. Mr. Doubleday, on the other hand, has lately met the positions of Mr. Malthus with an opposite theory. He has undertaken to show that poverty is the principal cause of a rapid increase, and that a good degree of the comforts of life "deadens the principle of increase." He sustains the first clause of his proposition by adverting to the fact that poor folks have the most children, and the latter part by quoting the well-known historical data, that wealthy and luxurious families frequently run out, as have done wealthy and luxurious nations. The doctrines of both of these gentlemen are too narrow and superficial.

Great wealth and extreme poverty are equally in violation of the "natural constitution of man." That God who fashioned the earth, made it capable of yielding sustenance enough for all the beings created in His own image. If men have got at variance with themselves, and warred upon each other; if some have usurped too much of the domain of our common mother, Earth, and others have not where to lay their heads; if men have deranged their proper social relations, perverted the laws of their own organization, and entailed upon themselves and society innumerable *permitted* evils, let us pause long before we charge all these results to special providences or natural tendencies.

The actual productiveness of the earth is incredible to those who have never examined the subject. Under the best systems of agriculture and dietetics, Ireland, where now eight millions of human beings starve, could healthfully sustain one hundred millions, and the soil of the United States is capable of producing more than food enough for all the inhabitants now existing on the globe.

PART III.

HYGIENE.

THE hygienic agencies—absurdly called "non-naturals" in medical books—comprise the whole and ample materia medica of the true hydropath. They are *air*, *light*, *water*, *food*, *temperature*, *exercise*, *sleep*, *clothing*, and the *passions*. These agencies, variously modified and intensified, I believe, are capable of producing all the really remedial effects in all diseases which the whole pharmacopœia of allopathy, with its thousand drugs and destructives, can produce, and without any of the evil or injurious results always attendant upon the operation of the latter; while to sustain the vital machinery in its most vigorous and enduring condition, in other words, to preserve health, we have but to employ or apply them according to established and invariable laws.

In claiming for those agencies by which every part and organ of every living animal and vegetable in existence is nourished, built up, sustained, and finally changed and decomposed, by which the integrity of every structure and function is maintained during life, and resolved into its primitive elements and conditions on the cessation of the life-principle, a complete and perfect materia medica, I mean as far as regards functional derangement, which, indeed, constitutes ninety-nine-hundredths of the diseases of society. Mechanical injuries, displacements of parts, organic lesions, etc., coming appropriately under the management of the surgeon, may and often do require mechanical agencies of some sort.

I am aware that few practicing hydropaths take this *ultra* ground. Some of them administer anodynes occasionally; some bleed now and then; some call in the aid of blue pill and cathartic potions under particular circumstances; others give a little brandy on emergencies, on the absurd notion of "keeping up the vital powers till *nature has time to rally;*" and others deal out "a little homeopathy" ever and anon. I am most thoroughly convinced that all of these "auxiliaries" are unnecessary; most of them much worse than useless. Their apparent necessity, I contend, has its source in the *ignorance* of the practitioner. He does not fully understand the philosophy of vitality, the intrinsic character of disease, nor the scope and power of these hygienic agencies, if he regards them as at fault or insufficient. I grant that occasional dosing may be the best some hydropaths can do. I consider him justifiable in acting according to his understanding. It may happen, too, that he has not all the appliances of hydropathy at command, or the patient will not submit to them. Under such circumstances I do not say that it is not expedient to give drugs. But I do maintain that a full knowledge of all the remedial resources of hygiene, with the possession of all the means afforded by such knowledge, enables the hydropath to dispense with drug medication entirely.

I have known and carefully noted the particulars of many cases where the professed hydropath has resorted to drugging, or bleeding, or external irritants, and in every such case there was manifest ignorance or error in the management of water, diet, exercise, sleep, temperature, or of the voluntary habits, or in relation to some other hygienic agent or condition. I have known some patients, while under judicious water-treatment, in their impatience to force nature a little faster than she was willing to go of her own accord, dose themselves now and then with stimulants, bitters, herb teas, nervines, or laxatives, and whatever seeming advantage immediately resulted, I have always found, as far as I have been able to "compare notes," that those who did nothing of the kind, other circumstances being equal, would get the best health in the end.

CHAPTER I.

OF AIR.

Vital Property of Air.—The physiology of the respiratory function explains the relation of an abundant supply of pure fresh air to the maintenance of health and the attainment of longevity. Fresh air in the lungs is so immediately essential to life that most animals, in less than one minute, when deprived of it, suffocate, become unconscious, and appear to be dead, real death occurring in a few minutes if air is not supplied.

Oxygen, which has been called "vital air," is undoubtedly the vivifying principle of the atmosphere. Carbon, nitrogen, and hydrogen are generally considered *poisonous* in relation to the lungs, but they are rather negative than positive agents, being merely incapable of supporting respiration. When persons or animals are confined in a close room, they continue to breathe until the oxygen of the enclosed air is exhausted, when death inevitably results. The flame of a lamp or candle will also expire when the oxygen is consumed, this gas being as essential to combustion as to respiration. In dry wells, deep vaults, and other situations where carbonic acid gas, or other irrespirable airs, are liable to accumulate, the introduction of a lighted taper is an important precaution. If the flame be extinguished, it would be dangerous to life to enter, for breathing cannot take place where combustion ceases. Carbonic acid gas, being heavier than common atmospheric air, settles to the bottom of a pit or room, while nitrogen and hydrogen, being lighter ascend to the top; therefore in a room vitiated by a large collection of persons, or from want of ventilation, the purest air is found in the middle of the apartment. A dog has been suffocated by carbonic acid gas in a room where a man, standing erect, felt no inconvenience.

Quantity of Respired Air.—Physiologists reckon that an adequate supply of air for an ordinary man to breathe each minute is from seven to ten cubic feet. A hundred persons confined in a room thirty feet in length, breadth, and height, containing nearly 30,000 cubic feet, would render the whole air unfit for respiration in about five hours. Imperfect ventilation, therefore, in crowded assemblies, churches, school-rooms, theatres, factories, and workshops, especially in the evening, when many lamps or gas-burners are employed, is a common source of debility and disease. An ordinary gas-burner consumes as much oxygen as four adult persons; but the loss of oxygen is not alone the cause of injury resulting from large gatherings of people in ill-ventilated places, for the irrespirable air thrown out from the lungs is rendered still more noxious by the exhalations from the skin.

The artificial habit of lessening the breathing capacity by means of stays, corsets, and tight dresses, is now happily passing away, although the wasp-like waists which deform so many of the gentler sex still *adorn* the "fashion plates" of the magazines, and caricature the female form in most of the fashionable shop-windows. Could the women of America—I say nothing of *ladies*—fully appreciate the importance of dress as connected with respiration, and the relation of this function to their own health and happiness and the welfare of their offspring, the monthly importation of Parisian cuts, turns, twists, fits and misfits, would soon be substituted by "short dresses," *loose* as well as short, or something in the way of clothing that would emancipate the lungs

Fig. 149.

NATURAL WAIST.

from oppression "most foul, strange, and unnatural." A reform in female dress would not only set free the breathing apparatus, but would confer an incalculable benefit on the human race in another respect. It would enable the wealthy classes to devote more attention to more useful subjects, and think less of the frivolities of ever-changing and never satisfying fashions; and diminish the demand upon the kind of work—sewing by day and by night—which is now ruining the constitutions of thousands of poor and industrious females, and sending them rapidly to premature graves.

Fig. 149 is a representation of the female chest in the natural state, unconstrained in the least by the clothing. The person who fails to discover the ease, grace, beauty, and symmetry of the figure as contrasted with that of a modern belle, must have a taste as artificial as any mantua-maker could desire. It is perfectly certain that, just to the extent that any female diminishes the circumference of the body around the lungs, just in that ratio will she lessen the number of her days, provided she does not die of violence or disease, which is a hazard she must also encounter.

Fig. 150.

UNNATURAL WAIST.

Observe the stiff, constrained, uncomfortable, and uncomely appearance of a fashionable lady (fig. 150). It is really painful to look upon such a self-constituted burlesque on humanity.

If there are any young ladies whose excess of approbativeness induces them to strain, and labor, and suffer, to produce "small tapering waists," so as to look "delicately fashionable," or "fashionably delicate," for the purpose of attracting the admiration of the other sex, let me assure them that they are destined to a sad failure. Notice they may, indeed, obtain, but admiration in that way, never. I have never heard a young man speak of the habit except in terms of ridicule; and I have never heard any man speak of it except in language of reprobation for its manifestly injurious consequences, and contempt for its ridiculous appearance.

The contrast appears still stronger when the diminutive circle of the waist which beautifies the belle is placed by the side of the broad, expanded chest, which renders the woman vigorous and healthy, and consequently a help *meet* for man—fig. 151. Such was the model of female beauty ere sacreligious hands had marred its fair proportions, and wherever, among the inhabitants of all parts of the earth, we find long-lived mothers and grandmothers, we are sure to find full, round chests and capacious lungs.

Fig. 151.

VENUS DE MEDICIS.

Purity of Respired Air.—Equal in importance with the quantity of the air we breathe is its purity. It is melancholy to reflect on the hard necessity which compels multitudes to live, or rather stay, in the sweltering garrets and infectious cellars of cities, or on the cupidity of landlords who provide such tenements, or on that dereliction of duty in municipal authorities which permits their existence. Much of the evil, however, *may* have its source in ignorance.

Few sanatory circumstances are less regarded than those nuisances which fill the air with noxious effluvia. I know of no reason why Boston and Philadelphia should be more healthy than New York unless it is because the air of Boston is not continually filled with the poison of *tobacco smoke*, and the Philadelphians have little or no *under ground population*. In every hygienic aspect, New York is the favored locality. It is true New York suffers a large influx of foreigners, the fatality among whom considerably swells its bill of mortality. But this alone, viewed in connection with its superior advantage in position, does not account for the difference, for according to the statistics of the present year, the mortality of New York is twenty-five per cent. greater than that of Philadelphia, and twelve and a half per cent. greater than that of Boston; equal, in fact, to New Orleans and other southern cities usually regarded as sickly.

Nearly all cities—New York especially—are full of air-infecting nuisances, not as generally diffused as tobacco smoke, but as intensely poisonous in certain localities, as distilleries, cow stables, swill-milk factories, hog-pens, soap factories, slaughter-houses, bone-boiling establishments, tallow-melting places, graveyards, etc., from which are constantly emanating streams of contagion and death. I do not believe there is a single city on earth, certainly not in the United States. where the people would endure or tolerate these pestilences, were they fully enlightened on the subject.

It is utterly impossible for the lungs to be fully expanded in a very impure atmosphere, because the air-passages, irritated by the extraneous particles, spasmodically contract to keep them out. The consequence of this is, those persons who reside permanently in an atmosphere charged with foreign ingredients or miasms, find their lungs continually contracting, unless this tendency is counteracted by a constant vocal or muscular exercise calculated to invigorate the whole respiratory apparatus and expand the chest.

Change of Air.—The remarkable benefits frequently experienced when the inhabitants of crowded, dusty cities rusticate in the country for a few days, or when invalids exercise themselves in traveling, and amuse themselves with a variety of new scenery, has caused some physiologists, who have a reputation for considerable intelligence, to imagine that the advantage was in the *change* itself more than in the better quality of the country air. It is quite a prevalent notion that human beings require changes of food, drink, and air, merely as changes. Such notions have no foundation in philosophy. If the food, or drink, or air, or all, is physiologically the *best*, it can never be improved by any change during the whole period of life; but if in any respect it is imperfect, a change to a better quality would be beneficial. Dr. Dunglison, who is a standard author in the profession on hygienic matters, thinks there is so much virtue in "modifications of different atmospheric influences," that a change from a *better* to a *worse* air is better than no change at all. His language is (Elements of Hygiene, page 125): "The change from a better to a worse air has even been found serviceable. In Edinburgh, the inhabitants of the most airy parts of the New Town frequently send their children, when laboring under hooping-cough, to the Cowgate, a filthy street, which runs at right angles under one of the largest thoroughfares in the Old Town, and in which, at a certain hour of the night, the inhabitants eject all the offensive accumulations from their houses, to be washed away by the water of the reservoirs, let on for the purpose." It is passing strange that any medical man of the present day, of high rank and acknowledged authority in his profession, should be so blinded by false theories as to commend a custom so abominable, simply because some ignorant persons were foolish enough to practice it!

Positions and Habits affecting Respiration.—Sedentary habits, unless frequently alternated with vigorous and prolonged exercise, weaken the abdominal muscles, and thereby lessen the activity of the breathing process.

Intense mental application, if long-continued, powerfully diminishes the respiratory function. No person in deep thought, with the brain laboring at its utmost capacity, breathes deep and free; hence editors, particularly those who are closely confined to their sanctums, are proverbially short-lived. Many of them are worked to death in five or six years, who, had they attended properly to their respiratory functions, both pulmonary and cutaneous, could have held out, under the same amount of labor, three or four times as long. All very studious persons, especially those given to abstruse investigations—the exercise of the reflective intellect—should never fail to exercise the whole body daily, and the arms, shoulders, and abdominal muscles several times a day. Riding on horseback, climbing mountains, running up and down stairs, dancing the tight rope, swinging on the hand ladder, throwing the dumb bells or grace hoops, playing ball, bowling, sawing wood, planing boards, etc., are examples of appropriate exercises. Rotary motions, with both arms extended, making the hands simultaneously describe as large a circle as possible, striking the elbows or backs of the hands together behind the back, or attempting so to do, are excellent exercises when the person is stoop-shouldered, and the chest contracted from malformation or by artificial means.

All crooked or constrained bodily positions affect respiration injuriously. Reading, writing, sitting, standing, speaking, or laboring, with the trunk of the body bent forward, is extremely hurtful, by overstretching the muscles of the back, compressing the lungs, and pushing downward and backward the stomach, bowels, and abdominal muscles. In all mechanical or manual labor occupations, the body should always be bent, or *lean*, on the hip joints; the trunk should always be kept "as straight as an Indian."

Catching Cold.—The general misapprehension in regard to the theory of "catching cold," frequently produces the very evil that is most feared. More colds are taken in overheated than in too cold places, and still more are owing to vitiated air. "Backwoodsmen," who sleep all winter long in shanties through which the snow-flakes pass freely, are seldom troubled with what are called "colds and coughs." Too close confinement to hot air in ill-ventilated rooms renders the body preternaturally susceptible to atmospheric changes. Infants and young children are generally badly managed in this respect in this country. They are often made sickly, puny, peevish, and effeminate, by keeping the doors and windows too close, and the sufferer too much in doors, as though the breath of heaven was unfriendly to human life.

Purifying the Air.—There is one method of purifying the air which is accessible to all persons in all places. In sleeping and other apartments, where thorough ventilation is impossible, the air may be rapidly changed and materially freshened by opening all the doors and windows, and then swinging one door violently forward and backward. It is a good, indeed a necessary practice in the cases of invalids who occupy close and secluded rooms, and who are unable to walk out.

Sleeping Rooms.—Sleeping rooms are generally miserably ventilated. Air of a pure quality, and abundant in quantity, is much more important during our sleeping than in our waking hours; but the common habits of the people are to provide large, spacious eating and sitting rooms, and small, close sleeping apartments. No one should sleep in a room, in summer or in winter, with all the windows and doors tightly closed. Windows can at all times be opened more or less at the bottom or top, or the door placed a little ajar, so as to permit the ingress of fresh air, without admitting any injurious current. I have known invalids with bronchitis, consumption, and other diseases, in this city of a thousand intelligent physicians, suffer horribly, by being confined in a close, sultry room, in a hot July day, *per advice of the doctor!*

Bed-curtains are rather worse than a useless appendage. If used at all, they should never be drawn tightly around the bed. The head should never be raised very high during sleep, as that position oppresses the lungs; nor should the sleeper incline toward the face, with the shoulders thrown forward. A late supper, by filling the stomach, prevents, in the horizontal posture, the descent of the diaphragm, hinders free breathing, and induces congestion of the brain, dreaming, nightmare, etc.

Stoves and Fireplaces.—Grates and fireplaces secure a much better ventilation than stoves of any description. Stoves are regarded by some as constituting "the great nuisance of America;" and there is no question that, as usually managed, they do actually vitiate all the air of the room. Air-tight stoves require the most careful attention to ventilation, and indeed no stove should be used in any place where there is not resource or provision for the free admission of external air.

Lamps, Candles, Gas-Burners, etc.—As all the means by which a room is lighted in the evening are so many methods of consuming the oxygen, and rendering the air irrespirable, it is well to bear in mind that the amount of ventilation must have a due relation to the number of lights employed. In small rooms, and in sleeping rooms where a lamp is kept burning through the night, and in rooms occupied by invalids, attention to this circumstance is especially important. In this connection I will allude to another very common source of vitiated air—*smoky lamps.* It may astonish those who have never seen this evil, to be told that persons can have their organs of sense so dulled and torpified as to sit a whole evening in a room with two or three oil lamps, each sending up a column of black smoke, and filling the room with a rank, suffocating odor, and yet not appear to be the least offended or incommoded. Yet such things are not uncommon in our cities; and many who work evenings by the light of smoky lamps, often get weak eyes as well as impure blood as the result.

Public Conveyances.—It may be traveling a little out of the record, for me to speak of the bad air of steamboats, railroad cars, stages, omnibuses, and other conveyances; but being a constant sufferer from this source, I may perhaps be justifiable in glancing at it. especially as it is a public evil as well as a private grievance. It would seem at first thought that any method of passing through the air at the rate of fifteen or twenty miles an hour, ought to secure the passenger fresh air in abundance. The theory is beautiful, but it fails in practice. Wherever we go, the tobacco-nuisance follows us. We feel its narcotic miasm rank in every street of the city, and if we go into the country it goes with us. To be sure, "No smoking abaft the wheels," is conspicuously displayed on the Sound and River steamers; "No smoking inside the cars," is said or intended on the cars; while on the numerous ferry-boats conveying constant streams of people to and from the great emporium, it is gently intimated, "*Gentlemen* are particularly requested not to smoke on *this side* of the boat;" still it always happens that the evidence of smoking pervades every part of the boat or car. Those who stand outside of the not-to-be-smoked-in apartment, around the gangways, on the platform, and at either end, contrive in some way or other to make the whole company smell the weed, whether they will or no. And in the stages and omnibuses no one thinks of smoking inside without permission, but the driver, and one or two puffers on his seat, can easily give the passengers a "comfortable smoke," particularly uncomfortable to some if the wind be against them.

There is yet another evil which ought to be remedied. There is usually in omnibuses, stages, and railroad cars, a few persons who canot, or think they cannot, bear fresh air, when the weather is cool or damp. To suit their whim, all the windows are closed, and the company perhaps for an hour or two sit inhaling over and over again the confined air, all the while becoming more vitiated. The rules of ventilation apply to all rooms and apartments alike, whether in dwelling-houses or traveling vehicles

CHAPTER II

OF LIGHT.

Relation of Light to Organization.—The hygienic importance of light is not sufficiently understood by the people, nor its remedial influence sufficiently regarded by physicians. Whether it be a distinct imponderable entity, a property of electricity, or something else, it would be idle here to speculate; but it is certain that the light which this earth derives from the sun and the fixed stars, has a powerfully modifying influence on all the functions of its animal and vegetable kingdoms.

Some plants thrive best when exposed to strong sunlight, others in a moderate light, and others when considerably shaded, yet all of them, without exception, require a good degree of the influence of light to become hardy, firm, and vigorous. Those which grow in deeply-shaded situations or dark cellars are comparatively colorless, slender, and friable. Light is the cause of color in all bodies; it is entirely reflected by white surfaces, and completely absorbed by black.

Many insects and fishes while living are constantly luminous, in consequence of the rays of light being constantly emitted from various points of their bodies; the fire-fly emits its sparks from two oval spots at the side of the thorax; in the glow-worm a phosphorescent brilliancy issues from its abdominal rings; luminous insects are supposed to absorb light during the day, like the Bononian stone, and impart it in the evening.

Physiological Influences of Light.—Plants absorb carbon, and give out oxygen or vital air in the light; but during the night this process is reversed, so that they absorb oxygen, and give out carbon; hence it is injurious and even dangerous to sleep at night in a situation which is closely surrounded with dense foliage, and not well ventilated.

The nutritive process is materially checked in all vegetables and animals when deprived of light for a considerable time; in this case vegetables are said to become *etiolated*, a condition analogous to that called *anæmia*, or *hypæmia*, in man—a state of debility, bloodlessness, and inanition. In some of the lower animals the process of metamorphosis is arrested by deprivation of the solar influence. The tadpole, for example, instead of developing into the frog, either continues to grow as a tadpole, or degenerates into some kind of monstrosity; and the specimens of human monstrosities, developed abnormally, in consequence of the absence of a due degree of "Heaven's first-born," are neither few nor far between in the underground tenements of large cities.

The operation of light on the animal organism has always been recognized as urging to exercise, and increasing the activity of both the bodily and mental powers; while its absence or privation disposes to indolence and obesity. Animals are more readily fattened when kept in obscurity, because the diminished activity of the depurating functions favors the accumulation of adipose matter. Poultry are often confined in dark places to augment their store of oil; and the heads of geese and turkeys are sometimes covered by a hood, or their eyes put out, in order to procure from them fat and greasy livers, as choice morsels for depraved epicures.

Almost the entire population of our large cities, who occupy back-rooms and rear buildings where the sun never shines, and cellars and vaults below the level of the ground on the shaded side of narrow streets, is more or less diseased. Of those who do not die of acute diseases, a majority exhibit unmistakable marks of imperfect development and deficient vitality; and, in fact, as with animals and vegetables in like circumstances, often run into deformities and monstrosities, not more reproachful, however, to those parents who propagate under such disadvantages, than disgraceful to that city, state, or national government which either *compels* or *permits* any class of its citizens to live in such abodes.

These facts show us that light, and an abundant supply of it, is indispensable to a due development of all organized bodies.

Therapeutic Considerations.—Medical men have always noticed that diseases of all kinds, from the most trifling toothache, quinsy, or rheumatism, to the severest attack of fever, scrofula, or consumption, are much less manageable in low, dark apartments. And it is notorious that, during the prevalence of epidemics, as the cholera, the shaded side of a narrow street invariably exhibits the greatest ratio of fatal cases

"The observations of Dr. Edwards, on the influence of light in promoting the perfect development of animals, led him to conclude that in climates where nudity is not incompatible with health, exposure of the whole surface of the body to light is favorable to the regular conformation of the body; and he, therefore, has suggested insolation in the open air as a means calculated to restore healthy conformation to children affected with scrofula, whose deviations of form do not appear to be incurable."

Pereira says: "As in bright solar light we feel more active, cheerful, and happy, while obscurity and darkness give rise to a gloomy and depressed condition of mind, so we employ isolation in the open air as a mental stimulus in melancholy, lowness of spirits, and despondency."

Sanatory Inferences.—The inferences deducible from the foregoing considerations are sufficiently obvious. All persons, in order to acquire and maintain the best condition of health and strength, should be frequently exposed to the light of the sun, except when oppressively hot. Children are generally maltreated, more especially in cities, in being kept almost entirely excluded from sunshine. Many good mothers are more fond of the delicate faces and pale complexions of their little ones, than intelligent in relation to their physiological welfare. A little sun-browning occasionally of their faces, necks, hands, and feet, and, finally, of their whole bodies, would not only render their development more perfect and enduring, but tend to the production of the greatest symmetry and beauty in manhood and womanhood. Parents should not be too careful in putting umbrella-hats and bonnet-sunshades on the heads of their children every time they run out of doors.

Almost all persons, young or old, who live in cities, can invigorate the skin and improve the genera' health, by frequent exposures of the whole body to the air of a well-lighted room, applying moderate friction to the surface at the same time. Light as well as air is generally excluded from the surface by too much or too tight clothing, which evil such exposures in some degree would counteract.

Dwelling-houses ought to be constructed with especial reference to light. Those rooms which are most occupied should be the best lighted, as the kitchen and sitting-room. The sun should be allowed free access to the yard and out-grounds. Shade-trees and shrubbery, useful to some extent around the dwelling, should never be so thick as to shut the direct rays of the sun out entirely. The influence of light in dissipating and decomposing noxious vapors and deleterious gases, which collect in and around low grounds and dark places, is very great.

The sudden exhilaration and invigoration experienced by the pent-up denizens of our large towns, when they go from their dim counting-rooms, gloomy offices, and basement workshops, to rusticate a few days in mountainous regions, is due nearly as much to the greater strength of the natural light as to the greater purity of the air.

CHAPTER III.

OF DRINK.

NATURE'S BEVERAGE.—Nature has provided no other drink for man, nor for animals, nor for vegetables, than *pure water;* and no animal but man seeks any other either as a beverage or as medicine. Its value as a beverage is in all cases in proportion to its purity. In plants water is employed as a vehicle to convey the nutrient elements absorbed by the roots throughout their various structures. In animals provided with a stomach for receiving aliment, it is the medium by which the materials of nutrition are conveyed to all parts of the body, and the waste matters carried away. Milk, which constitutes the principal food of the young mammal until the teeth are developed, contains about ninety parts of water in a hundred, and though often employed as a beverage by adults, is properly regarded as food. All the *diluent* preparations, which fill so large a space among medical prescriptions, owe their whole powers of dilution to the water alone.

IS MAN A DRINKING ANIMAL?—The question whether man is by nature a drinking animal, or whether the water required for his organism is sufficiently supplied in his *natural* food, has been raised within the last half century. Dr. Lambe, of England, has very ably argued the negative of the first position named; but the majority of dietetic writers hold the opposite opinion. It is, however, perfectly certain—and the fact has been proved by the direct experiments of Dr. Alcott and others—that those who adopt a regimen exclusively vegetable, and make a large proportion of their food to consist of succulent fruits and watery vegetables, can be healthfully sustained and nourished without water-drinking. It is also certain that those who eat much animal food, use salt, spices, and greasy dishes freely, and who have to employ a large proportion of concentrated farinaceous substances—which is, indeed, the general plan of the dietary system of civilized society—

require a large amount of water to carry off the saline particles and other impurities, and allay the artificial fever which they produce. In either case the thirst is the safe rule of practice.

QUANTITY AND TIMES OF WATER-DRINKING.—Writers are remarkably discordant in their notions as to the quantity of water a person should take into the stomach, and also as to the times for taking it. Some think we should drink as little as possible; others are of opinion that we should swallow all we can; one class of writers recommends all drinking to be done between meals, and another class advises us to drink abundantly at meals. It is easy to discover the sources of these discrepancies. Writers are too apt to deduce general inferences from individual peculiarities. What is precisely right for one person may be exactly wrong for another. If the dietetic and other voluntary habits of all people were strictly physiological, we could give them all a rule without exceptions, and the same rule. But the quantity of water useful or necessary depends on all the habits of life, amount of exercise, quality of food, the employment of stimulants, condiments, etc. The kind of occupation also affects the question; for example, a person laboring in a dry, warm atmosphere will require more drink than one working in a cool, moist air.

The amount of water contained in the various alimentary substances in common use, shows the relation which the quantity of the water necessary to employ as drink bears to the kind of food. Thus, in one hundred parts (rejecting fractions) water constitutes, of gum arabic 17, sugar-candy 10, arrow-root 18, wheat 14, rye 16, oats 20, barley 13, maize 18, peas 16, beans 14, lentils 15, potatoes 75, turnips 92, carrots 87, beets 87, artichoke 79, white cabbage 92, black bread 32, beef tea 98, blood 80, fresh lean meat of beef, mutton, veal, pork, deer, chicken, and pigeon 74 to 78, cod, haddock, sole, carp, and trout 79 to 82, ox's liver 68, calf's sweet-bread 70, white of egg 68, yolk of egg 85, cow's milk 87, human do. 87, goat's do. 86, ass's do. 91, ewe's do. 85.

The quantity of water contained in aliments, however, does not determine their nutritive power, for some substances, as butter and hog's lard, contain scarcely any water, yet are capable of supplying the body with much less nourishment than milk, which is about seven eighths water.

As to the best times for drinking, it is not difficult to give a general rule; but people who live variously must vary it accordingly. Unquestionably the best time for water-drinking, as a habit, is when the stomach is entirely empty—on first rising in the morning, and half an hour or an hour before meals Persons who take habitually a tumbler of pure water at those times, and eat plain food, will seldom experience much thirst; but those who employ thirst-provoking aliments or seasonings should assuage that thirst by water-drinking, even at meals. There are many morbid conditions of the system in which it is advisable to drink freely, even at meals, and without regard to thirst, but these will be more appropriately considered hereafter. One rule, however, of almost universal application for dietetic or remedial purposes is, never to drink, either at meals or at other times, to the extent of producing any decidedly uncomfortable heaviness, distention, or oppression of the stomach. Those who have weakened their digestive powers, and rendered the sensibility of the nervous system morbidly acute by the use of tea, coffee, etc., should accustom the stomach to the impression of cold water gradually, beginning with only a part of a tumbler, and increasing the quantity as the tone of the digestive organs improves.

TEMPERATURE OF DRINK.—*Cool*, but not very cold water appears to be most perfectly adapted to all the purposes of the animal economy. Without doubt the human system possesses a wide range of adaptability, and can, provided the general habits are reasonably correct, be very well sustained on water rather warm or very cold. It is well known that in the hot season, particularly in our cities, many laborers die very soon after drinking freely of iced-water. This matter ought to be well understood, for there is surely no necessity for any one to die in this way. It is not the iced-water alone that destroys them, but this proves an exciting cause when the system has been brought into an unfavorable state of vital resistance. I never knew or heard of any person dying or being seriously injured by the free use of iced-water—as free as the thirst demanded—who was temperate and simple in all his eating and drinking habits. All who are fatally injured by drinking iced-water, as far as I have been able to observe, or can learn from others, are among those who use some kinds or combinations of dietetic articles which provoke a great degree of factitious thirst: for example, baker's bread, and butter, stale salted meat, as ham or codfish, old cheese, plum-pudding, etc. Of course such persons feel a necessity for drinking freely, and as iced-water seems a grateful antidote to the feverishness artificially produced in the stomach, they are apt to indulge injuriously. There is no safety for such persons, except in either eating wholesome food, which does not provoke thirst, or in drinking water of a moderate temperature. But the great danger is with those who, in addition to the bad diet just mentioned, add the poison of intoxicating drinks. In fact, very few die in consequence of drinking cold water in hot weather, except those more or less addicted to alcoholic stimulants—probably not more than one in ten. The tendency of all forms of alcoholized beverages—from soft wines and ales to small beers and porters, and from hard ciders and rough brandies to harsh rums and strong gins—is to weaken and paralyze the nerves of the stomach; and when these exhausted nerves are suddenly chilled by a large draught of cold water, it is not wonderful that reaction does not take place, nor that death ensues.

Artificial Drinks.—Under this head I purpose to speak briefly of a variety of made-up drinks, some of which are intended as luxuries, others as medicines. "Ardent spirits, malt liquors, wine and cider," specially anathematized by name and nature, and deservedly excommunicated from use and fellowship by the total abstinence societies, I need not dwell upon. They are poisons, in every sense inimical to the human constitution; in fact, deleterious to every organized thing in existence, and are produced *only* from the decay, destruction, and decomposition of the products of organized matters. They deserve commemoration only for the mischiefs they have done, and execration only for the miseries they are now inflicting on human society I cannot, however, refrain from uttering a word of lamentation in this place, and expressing my regret and astonishment that there should be any found in this enlightened day and country, and among the leaders of mankind, especially among medical gentlemen and Christian ministers, who profess to guide the body to health and the soul to heaven—who *profess* to take true science and the Bible as *their* guides, yet who not only indulge in the intoxicating bowl themselves, but even commend it to their fellow-creatures! Surely the number of clergymen who have fallen from their pulpits in consequence of misinterpreting Paul's advice to Timothy, and the number of physicians who have filled drunkard's graves, ought to admonish *them* that "wine is a mocker, and strong drink is raging."

Tea possesses strong nervine and moderate narcotic properties, and considerable astringency, due to the presence of tannin. All the properties of tea are subject to much variation. Usually the green teas possess more astringency than the black; they are also, as found in our markets, to a great extent adulterated with coloring matter, commonly Prussian blue. The less injurious effects of black teas evidently depend on their purer quality and weaker strength, as a concentrated extract of either is powerfully and equally poisonous It is amusing to read the conflicting testimonies of medical authors respecting the operative effects of tea as a beverage and we sometimes find conflicting opinions expressed by the same author. Thus says Pereira: "Strong green tea produces on some constitutions, usually those popularly known as nervous, very severe effects. It gives rise to tremor, anxiety, sleeplessness, and most distressing feelings. On others, however, none of these symptoms are manifested. Part of the ill effects sometimes ascribed to tea may be owing to the use of so much aqueous liquid, to the temperature of the liquid, to milk and sugar used with it, or to the action of tannin on the digestive liquid. But, independently of these, tea possesses a specific and marked influence over the functions of the brain, not referable to any of the circumstances just alluded to. The influence of tea, especially the green variety, over the nervous system, is analogous in some respects to that of foxglove, for both green tea and foxglove occasion watchfulness, and act as sedatives on the heart and blood-vessels."

This appears to read plain enough, but in the next preceding paragraph the same author has told us: "Notwithstanding the extensive employment of tea in this country, it is no easy matter to ascertain its precise effect on the constitution."

Professor C. A. Lee, of this city, says: "A very strong decoction of *green* tea, or the extract, speedily destroys life in the inferior animals, even when given in very small doses. The strongly-marked effects of tea upon persons of a highly nervous temperament, in causing wakefulness, tremors, palpitations, and other distressing feelings, prove also that it is an agent of considerable power, and should not be used to any *great extent* by persons of *such a habit.* It not unfrequently occasions vertigo and sick headache, together with a sinking sensation at the pit of the stomach shortly after eating. It is also opposed to an active nutrition, and should, therefore, be used with great moderation by those who are very thin in flesh."

These facts are useful to us, but the medical prescription can be greatly improved upon. If the *extreme* effects of tea are manifested by the *susceptible* constitutions, the principle is clear enough that all constitutions suffer from it, though in a less egree. Instead of recommending "nervous" and "thin" persons to use it with *moderation*, the true physician, who values truth too highly to compromise it with false customs, will advise its total disuse.

Schwaan found by experiment that tannin, when mixed with artificial digestive liquids, threw down a precipitate, and rendered the fluids inert. The effect of the tannin upon the gastric juice may account in part for its influence in promoting indigestion.

It is certain that females, on account of their in-door occupations and more sedentary habits, suffer incomparably more from this, their favorite beverage, than males do; and I am inclined to think that the hot water is nearly or quite as deleterious as the herb, as the infusion is usually drank. From a pretty close observation, too, I am fully satisfied that the general prevalence of "female weaknesses"—a phrase including an extensive and formidable class of ailments—are in a great measure attributable to *warm teas*.

Almost every kind of herb that grows, except those which are really nutritious, or are violently poisonous to the stomach and bowels, preternaturally excites the action of the kidneys and urinary organs; or, to speak more physiologically, the kidneys are the excretory organs intended to throw off a great part of such foreign or waste material as is contained in infusions and decoctions of herbs. Very warm drinks are in themselves debilitating to the stomach, but the addition of the properties of the tea or other herb burdens the kidneys and urinary apparatus with an unnatural amount of labor continually. These organs, kept constantly over-excited, must become debilitated, and preternaturally irritable; and this condition of debility and irritability extends sympathetically to all the surrounding viscera; finally, the abominal muscles themselves become relaxed, and, with the general nervous exhaustion produced by the active nervine and narcotic properties of the tea throughout the system, a foundation is laid for the whole train of maladies, displacements of organs, and disordered functions, which are so general among females of the present day.

The history of these complaints, and the history of artificial beverages, particularly the employment of hot tea and coffee, show that there has been an intimate connection between the origin, progress, and prevalence of those diseases and these beverages. Fifty or an hundred years ago these complaints were comparatively rare. Mothers in those days did not commence tea-drinking in childhood; their bodies were nearly developed and their constitutions well formed before *their* mothers allowed them to indulge in enervating slops. But now tea-drinking commences sometimes before the period of childhood—in babyhood. I have seen a regular tea-toper in a baby under two years of age. It is very common in these days for children of five and six years of age, little girls especially, to drink their two cups of tea or coffee morning and evening. Is it wonderful that in early youth they are precocious in infirmities, and become chlorotic or cachectic, and complain of spinal irritation, mismenstruation, nervous debility, and a train of local affections wholly unknown in simple or in savage life?

Coffee possesses the same nervine and narcotic properties as tea, without its astringency. It usually acts as a laxative to the bowels for awhile in those unaccustomed to its use; but its long-continued employment always results in constipation. Its operative effects are, in most persons, rather more exciting and disturbing to the mental and organic functions than those of tea. Most persons who accurately notice their feelings under its influence, find a greater derangement of the digestive functions and the secretion of the liver, than results from the use of tea. From all the testimony I can gather from medical and dietetical writers, coupled with some degree of personal observation, I should judge it to be more directly injurious to the digestive process, and more exhausting to the general nervous energy, than tea, and less injurious to the kidneys and pelvic viscera.

Medical authorities are as self-contradictory in regard to coffee as they are about tea. Pereira says: "Employed moderately, I believe it to be a wholesome and slightly nutritive beverage." But in the same paragraph Pereira continues: "The *immoderate* use of coffee is *said* to produce various nervous disorders, such as anxiety, tremor, disordered vision, palpitation, and feverishness." Professor Lee speaks like a man who loves a good cup of the exhilarating decoction. He says: "We should consider that cordials and stimulants are, at least occasionally, useful, and that, whether useful or not, mankind always have, and probably always will, make use of them. But of all those which have hitherto been introduced, none, perhaps, combine so many excellent with so few evil qualities as that of coffee. To moderately nutritive properties it adds those of a mild and cordial stimulant, without producing those peculiar narcotic effects which so often accompany the use of strong green tea."

The eulogy of Dr. Lee is out-eulogied by Abd-al-Kadir Anasari Djezeri Hanbali, son of Mahommet: "O coffee! thou dispellest the cares of the great; thou bringest back those who wander from the paths of knowledge. Coffee is the beverage of the people of God, and the cordial of His servants who thirst for wisdom. When coffee is infused into the bowl, it exhales the *odor of musk*, and is of the *color of ink*. The truth is not known except to the wise, who drink it from the foaming coffee-cup. God has deprived fools of coffee, who, with invincible obstinacy, condemn it as injurious."

Chocolate, though destitute of the nervine properties of tea and coffee, contains a large proportion of fat or oil, called *butter of cacao*, which is difficult of digestion, and particularly injurious to dyspeptic stomachs. Chocolate is prepared from the seeds of the *theobroma cacao*, a native plant of the West Indies and Central America. The kernels of the roasted seeds are ground in a mill, whose sole rests on a heated iron plate, by which they are made into a brown pasty mass, then sweetened with sugar or honey, mixed more or less with sago, flour, or starch, and generally flavored with vanilla or cinna non.

Chickory, or *suckory*, is a preparation of the roasted roots of a plant, called *wild succory*, or *wild endine*, which is cultivated in Holland, Belgium, and Germany. It is used to adulterate coffee, and a spurious article is sold for chickory, made of roasted peas and beans, damaged corn, and coffee husks, and colored with Venetian red or Armenian bole.

Cocoa is another preparation of the seeds of the *theobroma cacao;* it is somewhat less greasy than chocolate, but has no other advantage.

There are a great variety of *acidulous* drinks in popular use. Most of them are prepared juices of fruits and sugar, as *lemonade*, *apple-tea*. *Bottle soda-water*, as generally prepared, is merely a mixture of carbonic acid gas in sweetened water. These beverages, in a hygienic point of view, possess but little importance. The only reason that the appetite demands them is, because the sense of taste is so torpified by stimulating food and seasonings, that it cannot relish simple water; still, they cannot be considered quite as healthful as pure water. *Effervescing* preparations of soda and tartaric acid, and of seidlitz powders, are decidedly injurious as common beverages, because they introduce into the system a large quantity of debilitating neutral salts. *Ginger* and *root beers* have had an extensive employment among popular beverages. The latter is rendered pungent by yeast fermentation, which develops from two to four per cent. of alcohol; this, of course, is against its healthfulness; but as such preparations will not keep but a very few days without becoming sour, the manufacturer often finds it profitable to add an additional quantity of alcohol. These drinks are trash at best, and worse than useless in their tendency to keep up artificial appetences, requiring strong, pungent, or gross beverages to satisfy.

In relation to the milder kinds of malt liquors, *small beer*, or *table beer*, as it is called, *porter*, *pale ale*, and *brown stout*, Pereira talks precisely like an "old-fashioned English gentleman." I quote Pereira mostly, because he is the latest and most approved author on dietetics as well as *materia medica* in the allopathic school. He says: "The practice of taking a moderate quantity of mild malt liquor, of sound quality, at *dinner*, is in general not only unobjectionable, but *beneficial*. Considered dietetically, beer possesses a three-fold property: it quenches thirst; it stimulates, cheers, and, if taken in sufficient quantity, intoxicates; and, lastly, it nourishes or strengthens." Surely his admiration of the virtues of grog was not excelled by that of the toper, who found it amply sufficient for food, drink, and *lodging*. Who can wonder that drunkenness is the distinctive vice of Christendom, when the professors of the healing art teach such ridiculously false doctrines? But let us quote also Pereira's reasoning: "Its power of appeasing thirst depends on the aqueous ingredient (water) which it contains, assisted somewhat by its acidulous constituent. Its stimulating, cheering, or intoxicating power is derived either wholly or principally from the alcohol which it contains. Lastly, its nutritive or strengthening quality is derived from the sugar, dextrine, and other substances contained in the extract. Moreover, the bitter principle of hops confers on beer tonic properties." If the reader can discover in such reasoning any thing but the veriest nonsense, I confess he has the advantage of me.

Different Kinds of Natural Waters.—The natural waters of the globe have been classed into *common waters*, comprising rain, spring, river, well or pump, lake, and marsh waters; *sea waters*, including the ocean and the salt lakes or inland seas; and *mineral waters*, to which class belong all the springs, streams, or pools usually regarded as medicinal.

Rain water is the purest of all natural waters. When collected in cities, it is more or less impure at the commencement of the shower, from admixture with foreign matters suspended in the atmosphere, and is often loaded with the particles washed from the roofs of the buildings. After several hours of continuous rain in cities, and a much shorter time in country places, it comes down almost perfectly pure. Air is a constant constituent of or admixture with rain water, and it contains a slight trace of carbonate of ammonia, which is probably a product of animal decomposition, and the cause of rain water so readily running into the putrefactive process. *Snow water* does not differ materially from rain water, except in not containing air. That it is injurious to health has long been a vulgar error; eating snow, however, does not quench thirst; but melted snow is as efficacious for this purpose as rain water.

Spring water only differs from rain water in having percolated through the earth, and having, during its passage, either imparted some of the particles it held in solution to the soil, or taken up soluble matters from the soil, or both. Its properties will therefore depend entirely upon the nature of the soil. A majority of the springs in the United States are *hard*, owing to earthy and saline matters, the most common of which are sulphate and carbonate of lime. There are, however, many *soft water* springs; enough, in fact, to answer all the drinking purposes of as dense a population as the country can sustain, if it were conveyed to and distributed among the dwellings. The people in the country are generally singularly inattentive to the important matter of providing themselves with *pure soft* water. They are very apt to get their supply from the most convenient spring, instead of the best. If they fully appreciated the importance of good water, they would not locate the dwelling-house until they had located the spring or well.

River water is an admixture of rain and spring water; it always holds in suspension a greater or less amount of extraneous matter, and in and around cities is strongly contaminated with decomposing animal and vegetable matters. Much of the river water in this country, as it runs through the sparely-populated districts, is comparatively quite pure and healthful.

The water of the Thames, and in the vicinity of London, contains, as impurities, about 20 grains of solid matter to the gallon. Of this, carbonate of lime constitutes about 16 grains, and sulphate of lime and common salt about 3½ grains.

The Croton water of New York contains but a trifle over four grains of solid matter to the gallon, only a grain and a half of this being carbonate of lime; sulphate of lime, the chlorides of calcium and magnesium, and the carbonate of magnesia constitute a little over two grains. The Cochituate water of Boston is equally as pure, and the Schuylkill of Philadelphia nearly as pure.

Previous to the introduction of the Croton river, the Manhattan water supplied to our citizens contained, in Chambers and Reade streets 125 grains of impurities to each gallon; in Bleecker-street 20 grains; and in Thirteenth-street 14 grains. Some of the wells in the lower part of the city contained 58 grains. The water in the wells of Boston and Philadelphia were in no better condition.

The usual results of drinking very hard waters, and those strongly impregnated with the exuviæ of animal and vegetable substances, are severe dysenteries or protracted diarrheas, and chronic affections of the kidneys.

Well water is generally more impregnated with earthy salts, especially bicarbonate and sulphate of lime, than river water, or even spring water. Its hardness is shown by its curdling and decomposing soap, instead of mixing with it readily and forming a *suds*, as will soft water. Sulphate of lime (gypsum, plaster of Paris) is a frequent cause of diarrhea.

Horses manifest such an instinctive repugnance to hard water, that they will drink out of a turbid and muddy pool, provided its water is *soft*, in preference to partaking of the clearest and most transparent water, if it be *hard*.

Lake water is generally very impure, being a collection of rain, river, and spring water, contaminated with putrefying animal and vegetable matters.

Marsh water is similar to lake water, but still more loaded with offensive and putrescent organic matters. The stench arising from marshy and swampy grounds, which are occasionally inundated from the sea, is owing to the decomposition of the sulphates of the sea water by the putrefying vegetable matters, which process evolves the intolerable sulphureted hydrogen gas.

Sea water contains on the average 3½ per cent. of solid matter. The amount varies considerably in different seas, and in different parts of the same sea. Its composition also varies in different localities. An analysis of 1000 grains of the water of the Mediterranean gave the following result: Water 959.26, chloride of sodium (common salt) 27.22, chloride of potassium 0.01, chloride of magnesium 6.14, sulphate of magnesia 7.02, sulphate of lime 0.15, carbonate of lime 0.20. Iodine, and bromide of magnesium have been found in some sea waters.

Taken into the stomach, sea water excites thirst, nausea, and, in large doses, vomiting and purging.

Mineral waters are classed according to the character of their prevailing impurities. Those whose predominating active principle is iron are called *chalybeate* or *ferruginous*. *Sulphurous* or *hepatic* waters are strongly impregnated with sulphureted hydrogen, which gives them an odor like rotten eggs. *Carbonated* or *acidulous* waters contain carbonic acid, which renders them sparkling and pungent. Of the *saline* mineral waters there are many sub-varieties, as the *calcareous*, *alkaline*, *silicious*, etc.

The *medicinal* fame of the "Congress water" at Saratoga is derived from the great amount of its *deleterious* ingredients. One gallon contains the following impurities: Chloride of sodium (common salt) 385.0 grains, hydriodate of soda 3.5 do., bi-carbonate of soda 8.982 do., bi-carbonate of magnesia 95.778 do., carbonate of iron 5.075 do., silex 1.5 do., hydro-bromate of potash, a trace; in all, 597.943 grains. Each gallon also contains 311 cubic inches of carbonic acid gas, and 7 of atmospheric air.

Dr. Steel, of Saratoga, very judiciously advises those who wish to experience the full benefit of this water to drink it only *once a day*—about three pints early in the morning; and he remarks very sensibly: "It would be much better for those whose complaints render them fit subjects for its administration, if the fountain should be locked up, and no one suffered to approach it after the hours of nine and ten in the morning." If it should be locked up at all hours of the day and night, and a stream of pure soft water substituted, the advantage to the invalid portion of the guests would be still greater.

The *Iodine Spring*, at that place, differs from the former mainly in containing 3½ grains of iodine to the gallon, with a little more than half the quantity of the other ingredients. The *Sans Souci Spring*, at Ballston Spa, differs from the Congress principally in containing carbonate of lime, instead of bi-carbonate of magnesia, and possessing altogether a little less than half the amount of impurities.

TESTS OF ORDINARY IMPURITIES.—The following are the tests (copied from Pereira's "Food and Diet"), by which the presence of the usual impurities of common waters may be ascertained:

1. *Ebullition.*—By boiling, air and carbonic acid gas are expelled, while *carbonate of lime*, held in solution by the carbonic acid, is deposited; this deposit is the fur or crust which lines tea-kettles and boilers.

2. *Protosulphate of Iron.*—If a crystal of this salt be introduced into a phial filled with the water to be examined, and the phial be well corked, a yellowish-brown precipitate (sesquioxide of iron) will be deposited in a few days, if *oxygen gas* be contained in the water.

3. *Litmus.*—Infusion of litmus, or syrup of violet, is reddened by a *free acid.*

4. *Lime-water.*—This is a test for *carbonic acid*, with which it causes a white precipitate (carbonate of lime), if employed before the water is boiled.

5. *Chloride of Barium.*—A solution of this salt usually yields, with hard water, a white precipitate, insoluble in nitric acid; this indicates the presence of *sulphuric acid*, which, in common water, is combined with lime.

6. *Oxalate of Ammonia.*—If this salt yield a white precipitate, it indicates the presence of *lime*, carbonate and sulphate.

7. *Nitrate of Silver.*—If this occasion a precipitate insoluble in nitric acid, the presence of *chlorine* is inferred.

8. *Phosphate of Soda.*—If the lime contained in common water be removed by ebullition and oxalic acid, and to the strained and transparent water ammonia and phosphate of soda be added, any *magnesia* present will, in the course of a few hours, be precipitated in the form of the white ammoniacal phosphate of magnesia.

9. *Tincture of Galls.*—This is used as a test for *iron*, with solutions of which it forms an inky liquor (tannate and gallate of iron). If the

test produce this effect on the water before, but not after boiling, the iron is in the state of *carbonate;* if after as well as before, in that of *sulphate. Tea* may be substituted for galls, to which its effects and indications are similar. *Ferrocyanide of potassium* yields, with solutions of the *sesquisalts of iron*, a blue precipitate, and, with the *protosalts*, a white precipitate, which becomes blue by exposure to the air.

10. *Hydrosulphuric Acid* (sulphureted hydrogen).—This yields a dark (brown or black) precipitate (a metallic sulphuret), with water containing *iron* or *lead* in solution.

11. *Evaporation and Ignition.*—If the water be evaporated to dryness, and ignited in a glass tube, the presence of *organic matter* may be inferred by the odor and smoke evolved, as well as by the charring. Another mode of detecting organic matter is by adding *nitrate* or *acetate of lead* to the suspected water, and collecting and igniting the precipitate, when globules of melted lead are obtained, if organic matter be present. The *putrefaction* of water is another proof of the presence of organic matter. *Nitrate of silver* is also a test, as before mentioned.

Purification of Common Waters.—*Filtration* removes all insects, living beings, and all suspended impurities, but it does not deprive water of the substances it holds in solution. *Boiling* destroys the vitality of any animals or vegetables it may contain, expels air or carbonic acid, and causes the precipitation of carbonate of lime. Sometimes it may be advantageous to *boil* water first, and *filter* it afterward. *Distillation* purifies water from every thing except traces of organic matter; it is, however, a process too troublesome and expensive for general employment. *Chemical agents* are sometimes made use of to free water from particular ingredients. *Alum*, two or three grains to a quart, will cleanse muddy water; the alum decomposes the carbonate of lime; sulphate of lime is found in solution, and the alumina is precipitated in flocks, carrying with it mechanical impurities. Though this process renders the water clear, it adds nothing to its healthfulness, but renders it even harder, by converting the carbonate into sulphate of lime. *Alkaline carbonates* soften water by decomposing all the earthy salts, and precipitating the earthy matters; the carbonates of soda and potash are much used in washing on this account; they do not render the water any purer, nor fit for drinking or culinary purposes.

Adulterations of Common Water.—The purest water is liable to become impregnated with poisonous properties when conveyed through some kinds of metallic pipes, particularly leaden ones. The air contained in very pure water rapidly corrodes lead; distilled water, from which the air is excluded, has no action on it until air is again admitted, when a thin white crust of carbonate and hydrate of the oxide of lead is speedily formed. Rain water is often impregnated from the lead of roofs, gutters, cisterns, and pipes. Combinations of lead, iron, and zinc, and other mixed metals, as in cases where iron bars are used to support leaden cisterns, the introduction of iron pumps into leaden cisterns, etc., often produce a galvanic action which dissolves a portion of the lead. The leaden covers of leaden cisterns are also a source of contamination; the water evaporates from the cistern in the form of pure or distilled water, and condenses upon the lid, which it corrodes, and then falls back into the cistern impregnated with the metal. Such cisterns should have wooden covers.

Various saline matters impair the corrosive action of water and air, and exercise a protecting influence. The carbonates and sulphates afford the best security against lead poisoning, because they form a protecting crust upon the surface of the metal. Dr. Lee declares that "Palsy is often met with in the city of New York among grocers and porter-house keepers, and is doubtless occasioned by their drinking beer in the morning which has stood in the lead pipes over night."

Chemists do not agree respecting the action of our Croton water on its leaden conduits; but experience settles the question affirmatively. It becomes our citizens, therefore, to exercise a constant watchfulness in its employment, which is, to let as much water run as the leaden pipes contain to their junction with the iron pipes in the streets, before drinking it. With this precaution, and the frequent emptying of the leaden pipes through the day, it is not probable that any appreciable injury will be experienced from the lead. But these facts prove that the principle of conveying water through our dwellings by leaden pipes is wrong, and a substitute should engage the attention of ingenious men and philanthropists.

CHAPTER IV.

OF FOOD.

Chemical Elements of Food.—In the present state of chemical science all known bodies, mineral and organized, are regarded as constituted of fifty-five simple substances, which are called chemical elements. Of these fifty-five elements nineteen have been found in organized bodies, animal and vegetable. Of these nineteen elements thirteen are regarded as essential constituents of the human body, viz., *carbon*, *hydrogen*, *oxygen*, *nitrogen*, *phosphorous*, *sulphur*, *iron*, *chlorine*, *sodium*, *calcium*, *potassium*, *magnesium*, and *fluorine*.

Pereira lays down the following postulate: "A living body has no power of forming elements, or of converting one elementary substance into another; and it therefore follows that the elements of which an animal is composed must be the elements of its food."

If this position is correct, any alimentary substance capable of sustaining the structures of the human body, must possess all of the chemical elements above-named among its constituents. We do not, however, find such to be the fact. Milk affords complete nutrition to the young mammal, and occasionally to the adult; wheat and apples are capable of perfectly nourishing the body; yet neither of these articles, nor all together, yield to chemical analysis all of the elements above-named.

It is, moreover, probable, and I think demonstrable, that, to a certain extent, the vital functions of a living organism have the power of transmuting substances supposed to be elementary. This is proved by the fact, that the lime found in the bones of the chick when it quits its shell did not pre-exist in the recent egg. It could not be derived from the shell, because the membrane which lines its interior is not vascular; hence its only source is the transmutation of some other substance. The accuracy of Pereira's proposition may be admitted, or, rather, it cannot be controverted, with a qualification he has afterward expressed, viz., that many substances now regarded as elementary may be in reality compounds, which the body, though not able to create, may compose and decompose.

Liebig, and most of the recent writers on physiology and organic chemistry, have distinguished foods into *nitrogenized* and *non-nitrogenized*—a distinction based on the presence or absence of nitrogen when the articles are subjected to chemical analyses. It is *assumed* that the former only are capable of transformation into blood, and of forming the substance of the tissues; hence Liebig has called them the *plastic elements of nutrition*. The non-nitrogenized foods he denominates *elements of respiration*; their use in the animal economy being, according to his notion, to keep up the animal heat, by yielding carbon and hydrogen to be oxidated in the lungs. The following tabular arrangement, copied from Pereira, shows the absurdities in which men of the most extensive learning become involved, in the attempts to square all the phenomena of life by the comparatively insignificant chemical processes and experiments they can perform in a chemical laboratory:

NITROGENIZED FOODS, *or Plastic Elements of Nutrition*		NON-NITROGENIZED FOODS, *or Elements of Respiration.*	
Vegetable	Fibrine.	Fat.	Pectine.
"	Albumen.	Starch.	Bassorine.
"	Caseine.	Gum.	Wine!
Animal	Flesh.	Cane Sugar.	Beer!!
"	Blood.	Grape Sugar.	Spirits!!!
		Sugar of Milk.	

Whenever any man of science names any form of intoxicating *drink* among the *foods* of the human body, I want no further evidence that he is calculating the problems of life on principles fundamentally erroneous. Again, if nitrogenized foods are capable of nourishing the tissues *because* of their nitrogen, it would follow that those aliments which contain the largest proportion of nitrogen would be most nutritious. But this does not hold true in practice, for flesh-meat contains fifteen per cent. of nitrogen, while wheat, rye, oats, barley, corn, rice, peas, beans, and lentils contain only from two to five per cent.; yet each of these articles is more nutritious than flesh. Rice, which contains less than two, and wheat, which contains but a fraction over two per cent. of nitrogen, are three times as nutritive as flesh-meat, notwithstanding this contains nearly seven times as much nitrogen.

The truth seems to be that an alimentary substance is more or less nutritious, not according to the presence or absence of nitrogen, or any other single constituent, but according to the constitutional relation of the whole substance, as compounded by the arrangement of all its constituent elements. The most wholesome aliment and the most deadly poison may be composed of the same chemical elements, the only difference being in the proportions in which their constituents are combined.

It is true, furthermore, that nearly and probably all of the alimentary substances which are capable of sustaining the prolonged nutrition of animals, contain greater or less proportions of nitrogen, oxygen, carbon, and hydrogen, with more or less of a number of other substances, which are called elements.. And it is quite clear to my mind that no substance entirely destitute of either nitrogen, oxygen, carbon, or hydrogen, possesses much alimentary value, either as a "plastic element of nutrition," or as an "element of respiration." If fats, oils, alcohol, etc., are taken into the stomach, they must be disposed of in some way; and as they are not convertible into the tissues, they are oxidated in the circulation, and expelled by the lungs, liver, skin, kidneys, and bowels. That part of this excretory process which is performed by the lungs has been mistaken for a special vital process, by which the body is warmed; and the commotion of the organism in getting rid of these offensive materials has been mistaken for a functional process, which makes use of wine, beer, and spirits in the nutritive economy of the system. Such errors, emanating from such high authorities in the scientific world, have a disastrous effect on the public mind, and tend powerfully to check the progress of all the reforms of the age.

The per centage of carbon contained in the aliments in common use, rejecting fractions, is as follows: Wheat, dried *in vacuo* at 230° Fahr. 46, oats, do. 50, rye, do. 46, potatoes 12, do. dried 44, turnips 3, do. dried 42, artichoke, dried 43, peas 35, do. dried 46, lentils 37, beans 38, fresh bread 30, black bread, dried 45, ox blood 10, do. dried 51, fresh lean meat 13, dry lean beef 51, roasted veal 52, sugar-candy 42, butter 65, mutton fat 78, hog's lard 79, olive oil 77. Alcohol, an aliment according to Liebig and Pereira, contains 52.

Oxygen and hydrogen exist in acetic acid, starch, gum, and sugar, in the proportions which form water; in oil, alcohol, malic acid, gelatin, gluten, animal and vegetable fibrin, albumen, and casein, the hydrogen is in excess; in pectin, citric acid, and tartaric acid the oxygen is in excess.

Phosphorus is found in the muscular and nervous tissues of the body, in the bones, in the spermatic fluid, and in the ovary. In some diseases the breath of patients emits a strong phosphoric odor. Phosphorus is also a constituent of nearly all vegetable substances, existing in combination with lime or magnesia.

Sulphur is also found in the fibrinous and albuminous tissues, and in hair, bone, casein, and the saliva. Metallic matter held in the mouth is often discolored by the action of sulphur; and gold plates used to support artificial teeth, and the amalgam of silver, sometimes employed to fill decayed teeth, often become incrusted with metallic sulphuret. Sulphur is a constituent in nearly all the vegetable substances employed as food. Culinary vegetables generally contain it; the *cruciferæ* in abundance. Asafœtida, which contains a large proportion, is sometimes used as a seasoning or condiment; and although it would not be inviting to a majority of American olfactories or palates, some Oriental nations consider it as "food for the gods." Sulphur is readily detected in mustard, white cabbage, potatoes, almonds, peas, and other vegetables.

Iron is found in the *ashes* of animals and vegetables. The quantity, however, detected in organized beings is exceedingly small, and the precise state in which it exists in living beings is entirely unknown. Chemists find a very small quantity in the blood corpuscles and hair, but are unable to assign it any office. Liebig's theory, that the color of the blood depends on iron, has been positively disproved. A slight trace of iron is found in most vegetable articles used as food; for examples, milk, mustard, cabbage, potatoes, peas, and cucumbers. It is by no means yet proved that iron is an essential constituent of any living being. Its liability to oxidation, its general employment in agriculture and the arts, and its abundance in the mineral kingdom, afford at least good grounds for conjecture that the variable quantities found in plants and animals are accidental ingredients.

Pereira remarks: "But the well-known influence of chalybeates in the disease called *anæmia*, in which the blood is found to contain a smaller quantity of iron than in a state of health, favors the notion that the proper color of the blood is in some way connected with the amount of iron contained in it; for one of the most characteristic symptoms of this malady is an absence of the natural vermilion tint of the complexion."

Unless the preparations of iron in the hands of European practitioners operate very differently from those prescribed by American physicians, Pereira must labor under a great mistake. The medical journals of this country have, during a year or two past, reported many cases of anæmia treated with chalybeates, nearly every one of which terminated fatally. The particulars of several cases may be found in the Water-Cure Journal for 1850.

Chlorine is found in the blood, in combination with sodium, forming common salt; in the gastric juice, combined with hydrogen, constituting hydrochloric acid. It is also found in saliva, and in all the excretions. It is a constituent of nearly all vegetable aliments, from whence a sufficient supply is derived for the wants of the animal organism. The dietetic use of salt, therefore, to furnish chlorine to the system is unnecessary.

Sodium exists in most of the animal tissues and secretions. A large part of that found in the different solids and fluids is doubtless derived from the use of table salt, for it is not an ordinary constituent of vegetables unless they grow in the neighborhood of salt water.

Calcium, in the form of a subphosphate of lime, is found in all the animal solids, in the blood, and in most of the secretions. It is a constituent of most vegetables; it is found in the cereal grains, onions, garlics, rhubarb, grapes, gum, and unrefined sugar.

Magnesium, in small quantities, is found in the blood, teeth, bones, nerves, glands, and other parts of the body. It is also a constituent of grains, potatoes, and other vegetables.

Potassium is found in minute traces in the blood, solids, and several of the secretions. It is a constituent of most kinds of vegetables, especially inland plants; it is readily detected in grapes and potatoes.

Fluorine has been detected by Berzelius in minute quantities in the bones and teeth of animals, in the form of fluoride of calcium. It is never found in plants, and it is probably, when found in animals, an accidental ingredient rather than a normal constituent.

PROXIMATE ELEMENTS OF FOOD.—Water, gum, sugar, starch, lignin, jelly, fat, fibrin, albumen, casein, gluten, gelatin, acids, salts, and *alcohol*, are called *alimentary principles* by Pereira and other authors. They are all compounded of two or more chemical elements, and all of them, except alcohol, are produced in the process of organic growth and development in the vegetable kingdom. Alcohol, as already stated, results from the death and putrefaction of organic matter. Foods proper are compounds of these proximate elements in various proportions, as these are compounds of the ultimate elements. Physiologists, in directing so much of their attention to the investigation of the chemical qualities of alimentary principles, and so little to the physiological effects of aliments themselves, have taught more errors than truths in relation to food and diet.

None of the proximate elements of food are capable of the prolonged nutrition of animals, though gluten, which is in reality a very compounded substance, may alone sustain life for a considerable time. Nor is the power of an alimentary principle, or an aliment proper, to sustain the animal organism, at all proportioned to what is chemically regarded as its nutritive property. Dogs fed on sugar, or butter, or fine flour, become plump and adipose, but die of starvation in a few weeks. Horses and cattle confined to the most nutritious grains soon grow sickly and die; and the human being, restricted to a diet of starch, fibrin, or superfine flour, soon becomes unhealthy. But a suitable admixture of bones, grass, straw, woody fibre, bran, etc., usually considered as innutritious, allows the animal organism to select and assimilate such nutritive materials as are needed to maintain the integrity of its structures and functions, and reject the rest.

Water, constituting about three fourths of the entire weight of the body, and being essential to the performance of all the vital processes, may be regarded as *liquid aliment*, all the other aliments or foods being *solid*, or solids dissolved in water. Its properties have been considered in the preceding chapter.

Gum is the *mucilaginous* alimentary principle of authors. It exists almost universally in plants. The gums called *Arabic*, *Senegal*, *East Indian*, *Barbary*, *Cape*, *tragacanth*, *cherry*, *plum*, and *bassora*, exude spontaneously, and concrete on the stems of trees or plants. The following articles contain, in one hundred parts of gum or mucilage, rejecting unimportant fractions: Barley-meal 4, oatmeal 2, wheat-flour 2 to 5, wheat-bread 18, rye-meal 11, corn 2, rice 0·1 to 0·71, peas 6, garden bean 4, kidney bean 19, potatoes 3 to 4, cabbage 3, sweet almonds 3, ripe green gage 5, ripe fresh pears 3, gooseberries 0·78, cherries 3, ripe apricot 5, ripe peach 5, linseed 5, marshmallow root 35.

Sugar is very generally distributed throughout the vegetable kingdom. Barley-meal contains about 5 per cent., oatmeal (including bitter matter) 8, wheat-flour 4 to 8, wheat-bread 3 to 4, rye-meal 3, corn 1·45, rice 0·05 to 0·30, peas 2, sweet almonds 6, figs 62, ripe green gage 11, tamarinds 12, ripe fresh pears 6, ripe pears kept some time 11, ripe gooseberries 6, ripe cherries 18, ripe apricot 11, ripe peach 16, melon 1·5, expressed carrot juice evaporated to dryness 94, beet-root 5 to 9, cow's milk 4·77, ass's milk 6·08, woman's milk 6·50, goat's milk 5·28, ewe's milk 5.

Sugar, though taken freely into the stomach, and sometimes reproduced in the secretions, as in the urine of diabetic patients, is never found in healthy blood. It must therefore undergo decomposition before it is admitted into the circulation.

Most of the *raw* sugars of commerce contain various impurities, and the *purified* or *refined* sugars have a constipating effect on the bowels. The best article for dietetical purposes is that of a pale yellow color, with large, clear, brilliant crystals. *Syrup* is made by dissolving two pounds and a half of sugar in a pint of water. *Molasses* is the viscid fluid which drains from raw sugar. *Treacle* is a dark-brown uncrystallizable syrup, which drains from the molds in which refined sugar concretes.

Sugar is the basis of an immense quantity and variety of hard confectionary—*lozenges*, *brilliants*, *pipe*, *rock*, *comfits*, *nonpareils*. They are mixed more or less with flour, starch. gum, and often other less wholesome articles, flavored with a variety of pungents and perfumes, and not unfrequently medicated with calomel, tartarized antimony, morphine, and many other poisons. The whole of it is abominable trash at best; and although the children of our cities have their hands full of it a good proportion of the time, every mother ought, and all *intelligent* mothers will, expel it from their houses.

Starch is found in the seeds, fruits, roots, stems, tubercles, and mosses of a large portion of the vegetable kingdom. It constitutes the *amylaceous alimentary principle* of authors, and is known under the various names of *amylum*, *starch*, *fecula*, and *farinaceous matter*. Wheat-flour yields in one hundred parts 56 to 72 parts, wheat-bread 53, barley-meal 67, oatmeal 59, rye-meal 61, maize or corn 81, rice 82 to 85, peas 32, garden bean 34, kidney bean 36, arrow-root plant 12 to 26, yam 12 to 22, bread-fruit 3, tapioca plant 13, Iceland moss 45, batatas 9 to 13, kidney potato 9, red potato 15.

The much larger quantity of starch contained in corn than in the potato, has suggested the preparation of it from the former article. Recently several manufactories of corn starch have been established in this country, and starch made from this grain is now in common use as a dietetic article as well as for the toilet. Its value as a food is far inferior to that of the whole grain. In fact, it is employed more as a desert or *superfluity* than as a nutriment.

Dr. Prout thinks starch "differs from sugar in being a *necessary* article of food, without which animals could not exist, while sugar is not." But as starch is not found in animal food, and as there are many animals of the carnivorous kind which eat no other, this position can only be correct in its application to herbivorous animals.

The different kinds of amylaceous matters in common use are *sago*, *tapioca*, *arrow-root*, *rice starch*, *potato starch*, *corn starch*, and *lichenin*, or *feculoid*, obtained from Iceland moss. Sago is the medulla or pith of the stems of various species of palms; it is manufactured principally in the Moluccas, and comes to us in the form of *sago-meal*, *pearl sago*, and *common sago*. The first is principally used in making sago-sugar; the second is generally employed for domestic purposes. Tapioca is obtained from the roots of a plant, said to be poisonous, in the Brazils. Its irregular, lumpy form is owing to its having been dried on hot plates. *Cassava bread*, used in Brazil, Guiana, Jamaica. and other places, is made of the whole roots of the plant, which are grated and then pressed in a hair bag. Arrow-root is obtained from the roots of the plant, whose botanical name is *maranta arundinacea*. There are several varieties in market, as West Indian, Tahiti, East Indian, Portland, etc.

In a dietetical or medicinal sense there is very little to choose in these different forms of starch. They are highly commended by physicians to children and invalids, but as food they are incomparably inferior to the whole grains, vegetables, and fruits from which they are derived.

Lignin is the woody fibre which constitutes the basis of al. vegetable structures. It also forms the skin of potatoes, the husk of grapes. gooseberries, etc., the peel and core of apples and pears, the skin and stone of plums, peaches, etc., the seed-coats of the kernels of nuts, the membranous covering of beans and peas, the pod of melons, cucumbers, etc., and the bran of grains. The per centage contained in various aliments is: Rice 4·8, barley 18·75 (husk), oats 34 (bran), ryo 24 (husk), ripe apricots 1·86, ripe green gages 1·11, ripe peaches 1·21, ripe gooseberries 8·01, ripe cherries 1·12, ripe pears 2·19, sweet almonds 9 (and seed-coats), peas 21·08 (amylaceous fibre), garden bean 25·94 (amylaceous fibre and membrane), kidney bean 18·57 (do.), potatoes 4·03 to 10·05 (amylaceous fibre), cocoanut kernel 14·95.

Lignin, or wood, when divested of all its soluble matters, repeatedly subjected to the heat of an oven, and finally ground to a fine powder, yields a flour, on being boiled with water, resembling corn-flour, and capable of being made into a jelly or loaf-bread, which is both agreeable and nutritious. The nutritive importance of lignin in the animal economy is equal to that of starch, or of any other proximate element, for none of the others, nor all together, can perfectly sustain the integrity of the organism without some admixture of the woody element, which authors usually put down as innutritious and indigestible. Pereira thinks it serves as a *mechanical stimulus* to promote the action of the bowels—a queer phrase for him to apply to what he calls an alimentary principle. Dr. Prout remarks: "Of the numerous shapes assumed by lignin, the best adapted for excremental purposes is undoubtedly the external covering of the seeds of the *cerealia*, and particularly of wheat. Bread, therefore, made with undressed flour, or even with an extra quantity of bran, is the best form in which farinaceous and excremental matters can be usually taken; not only in diabetis, but in most of the other varieties of dyspepsia accompanied by obstinate constipation. This is a remedy, the efficacy of which has long been known and admitted; yet, strange to say, the generality of mankind choose to consult their taste rather than their reason, and by officiously separating what nature has beneficently combined, entail upon themselves much discomfort and misery."

Jelly is found in both animals and vegetables. *Vegetable jelly* constitutes the *pectinaceous alimentary principle*, so called because it has for its base starch and *pectin*, or *pectic acid*. Pectin and pectic acid are regarded by some chemists as identical. One or both are found in most pulpy fruits, currants, apples, pears, quinces, apricots, plums, and in melons, gooseberries, blackberries, raspberries, strawberries, bilberries, mulberries, cherries, tomatoes, oranges, lemons, and tamarinds. The artichoke, onion, carrot, turnip, celery, bee:, and many other roots, yield a portion of it. Sugar promotes the solidification and gelatination of pectin and pectic acid, and is, therefore, conveniently employed in the preparation of fruit jellies. *Jams* are mixtures of vegetable pulps with sugar. *Carrigeen*, *pearl*, or *Irish moss*, are veg eto-gelatinous substances resembling pectin.

Considered dietetically, fruit jellies are among the slight deviations from the healthful preparations of food. They are far less valuable than the crude fruits, or the fruits dried, stewed and sweetened, or preserved in their own inspissated juices.

The *organic acids* constitute the *acidulous alimentary principle* of authors. They are the *acetic*, *citric*, *tartaric*, *malic*, *oxalic*, and *lactic*. Those chemists who regard tea as nutritious add to this list *tannic acid*. It is not certain that *acetic acid* is entitled to a place among organic elements. It is found in pyroligneous acid, vinegar, sour beer, and sour wine; but these materials are not the products of formation, but of retrogradation. Vinegar, which is generally considered as almost identical with acetic acid, is very far from being alimentary. Like alcohol, it is a product of fermentation; and although it is regarded as "agreeable," "cooling," "refreshing," "antiseptic," etc., by the medical profession, it is certainly very debilitating to the human stomach. Its tendency to produce leanness has long been known. Young girls who have employed it freely to diminish an unfashionable plumpness of body, have soon found themselves fatally consumptive. If any argument can be drawn from antiquity in favor of the propriety of its dietetical employment, the same argument may be made to sanction every evil thing under the sun.

Citric acid is found in the lemon, orange, citron, lime, shaddock, cranberry, and, mixed with an equal quantity of malic acid, in the red currant, strawberry, raspberry, cherry, and bilberry. In the pulp of the tamarind it exists, mixed with malic and tartaric acids.

Tartaric acid is found in the free state in tamarinds, grapes, and pine-apples. In the form of cream of tartar it exists in tamarinds, grapes, and mulberries. This acid is much employed in effervescing compounds.

Malic acid is extensively distributed; it is found in apples, pears, quinces, plums, apricots, peaches, cherries, gooseberries, currants, raspberries, strawberries, blackberries, pine-apples, barberries, elderberries, grapes, tomatoes, tamarinds, and other fruits.

Oxalic acid is found in garden rhubarb, common sorrel, wood sorrel, and some other vegetables. It may be produced by the action of nitric acid on sugar, starch, gum, wool, hair, silk, and many vegetable acids.

Lactic acid exists in sour milk; it is also generated in the *souring* process of various vegetables; for example, when oatmeal sours in a large quantity of water. Liebig states that no lactic acid is found in a healthy stomach, but that in some dyspeptic individuals sugar yields lactic acid, attended with flatulence and preternatural acidity of the stomach. These facts prove conclusively to my mind that this acid is, like vinegar, a product of destructive decomposition, instead of organic formation, and hence is in no sense an aliment.

The precise chemical offices which the vegetable acids perform in the animal economy is not obvious, nor is it of the least consequence for us to know. It is sufficient that they exist in those fruits and vegetables which nature has provided for our nourishment. And if nature has assigned them any nutritive duty, it is at least probable that she has provided them in about the proper quantities and proportions, just as she has the sugar, salt, starch, gum, and all the other nutritive elements, so that we may use them as we find them, without troubling ourselves to manufacture an extra supply by way of "*necessary*" seasonings.

Fixed oils constitute the *oleaginous aliments*, and the *oily alimentary principle* of authors. Under this head some authors include also the volatile oils of those vegetables which are used as condiments—mint, marjoram, savory, sage, thyme, carraway, anise, fennel, parsley, mustard, horseradish, garlic, onions, eschalots, leeks, cinnamon, nutmeg, mace, cloves, pepper, allspice, ginger, bitter almonds, peach leaves, cherry, laurel, etc. Some of these vegetables do indeed possess alimentary properties, but the volatile oil residing in them is as destitute of nutritive virtue as vinegar or alcohol.

The fixed oils are: *Fat*, *suet*, *tallow*, *lard*, or *axunge*, *marrow*, *grease*, *butter*, and *blubber*, derived from the animal kingdom, and *olive oil*, *almond oil*, *walnut* and other *nut oils*, derived from vegetables.

The quantity of oil or fat in 100 parts of the following substances is: Filberts 60, olives 32, olive seeds 54, walnuts 50, earth-nut 47, cocoanut (fleshy part) 47, almonds 46, plums 33, white mustard 36, black mustard 18, grape stones 11 to 18, maize 9, dates 0·2; yolk of eggs 28, ordinary flesh-meat 14, ox liver 4, cow's milk 3·13, human do. 3·55, ass's do. 0·11, goat's do. 3·32, ewe's do. 4·20, bones of sheep's feet 5·55, bones of ox head 11·54.

Fats are peculiarly liable to become rancid on exposure to the air; a high degree of heat also produces chemical changes which render them exceedingly acrid and irritating to the digestive organs; hence *frying* is a very objectionable method of cooking.

Pereira says: "Fixed oils, or fat is more difficult of digestion, and more obnoxious to the stomach than any other alimentary principle. Indeed, in some more or less obvious or concealed form, I believe it will be found the offending ingredient in nine tenths of the dishes which disturb weak stomachs. Many dyspeptics, who have most religiously avoided the use of oil or fat in its obvious or ordinary state (as *fat meat*, *marrow*, *butter*, and *oil*), unwittingly employ it in some other more concealed form, and, as I have frequently witnessed, have suffered therefrom." Liebig, as already stated, considers fatty matter the principal fuel by which the animal heat is sustained. Dr. Beaumont ascertained that the gastric juice had a very slow and feeble action on fatty matters, either in or out of the stomach. Dr. Combe states that there is one form of dyspepsia in which the fat of bacon is digested with perfect ease, when many other apparently more appropriate articles of food oppress the stomach for hours. Prof. Lee, of this city, remarks: "We have treated many cases of cholera infantum, where every thing would be rejected from the stomach except salt pork, or fat bacon, rare broiled, and given in small quantities." I think an explanation of the cases mentioned by Drs. Combe and Lee may be found in the fact that such stomachs, and usually the duodenum also, are loaded with foul, acid, acrid, or putrescent secretions, which the grease mingles with, and for a time obviates their irritation. If *warm water* had been freely given, and the cutaneous function attended to, the pork and bacon might have been spared with advantage. Brandy will often quiet a dyspeptic's stomach, and at the same time be one of the worst quieters he could employ, and calomel will often "stay on the stomach" when the patient would be better if it were off. Professor Dunglison, in his recent work on Human Health, says, "Oleaginous substances are eminently nutritious;" an assertion pre-eminently susceptible of disproof.

The most objectionable dishes, on account of their fatty character, at ordinary tables, are yolk of eggs, livers, brains, strong cheese, butter-cakes and toast, pastry, marrow-puddings, suet-puddings, hashes, stews, broths, and several kinds of fishes, as eels, sprats, salmon, and herrings.

The vegetable fixed oils are less indigestible, and from their less putrescent tendency, more healthful than the animal. Indeed, it is highly probable that persons long accustomed to a plain, unstimulating, and unconcentrated diet, could employ the oily fruits, seeds, and nuts as a part of their aliment with entire physiological satisfaction.

Vegetable fibrin, *albumen*, *casein*, and *gluten*, and *animal fibrin*, *albumen*, and *casein*, constitute the *proteinaceous alimentary principle of Pereira*, which, except in not including gelatin, agrees with the *albuminous alimentary principle* of Dr. Prout. *Protein*, however, from which this group of proximate elements is named, has no real existence in organized beings at all; but chemical analysis resolves the fibrin, albumen, and casein of both animal and vegetable substances into *a something and* salt, sulphur, phosphorus, potash, soda, and phosphate of lime, and this *something*, which is formed in the process of analysis, is called protein. Protein, from whatever substance obtained, exhibits the same identical composition, that is, as nearly as can be determined by chemical analysis, which is always imperfect, and never quite uniform in determining the atomic constitution of complicated organic substances.

The fibrin, albumen, and casein of animals are chemically identical with the fibrin, albumen, and casein of vegetables. According to Liebig, they are *produced* by vegetables only, although the animal organism is capable of converting one of them—one modification of protein, into another. If this be true, and if the proteinaceous compounds—the "plastic elements of nutrition"—only are capable of forming the tissues, all the truly nutritive materials of animals not only exist in, but are *formed* in vegetables; and this fact forms a strong presumption in favor of the superiority of a purely vegetable diet—taking the aliment directly from the vegetable kingdom in its primitive purity and vitality, before it is vitiated by the taint of animal deterioration and putrefaction.

Vegetable fibrin exists abundantly in wheat, rye, barley, oats, maize, rice, and the juice of grapes. It is also found in buckwheat, and in many newly expressed vegetable juices, as of carrots, turnips, and beet-root; it exists also in the raw gluten obtained from wheaten flour Animal fibrin is the principal constituent of lean flesh, and is found in the blood. One hundred parts of lean beef contain of fibrin about 18, veal 17, mutton 20, pork 17, chicken 17, cod, haddock, sole, each about 13, pancreas of calf 8, blood of sheep 0·03, blood of ox 0·37, blood of hog 0·46.

Vegetable albumen is found in abundance in oily seeds—almonds, nuts, etc.; it is a constituent of wheat and other grains, and a considerable quantity is contained in the juices of carrots, turnips, asparagus, cauliflowers, cabbages, etc. It differs from albumen in not coagulating when heated, and from fibrin, in dissolving in water. Animal albumen exists in the solid state in flesh, glands, and viscera, and in the fluid state in the egg, and in the serum of the blood. The quantity contained in 100 parts of the following aliments is: Blood of the ox, hog, goat, and sheep 18 to 19, beef 2·2, veal 2·6 to 3·2, pork 2·6, deer 2·3, pigeon 4·5, chicken 3, carp 5·2, trout 4·4, sweet-bread of calf 14, caviare (fresh) 31, liver of ox 20, yolk of egg 17, white do. 15, East India isinglass 7 to 13

Vegetable casein has been called *legumin*, because it is found chiefly in leguminous seeds—peas, beans, lentils. Almonds, nuts, and other oily seeds contain it with albumen. Many vegetable juices yield it in small quantities. It is soluble in water, unlike fibrin, and uncoagulable when its aqueous solution is heated, unlike albumen. Animal casein is the coagulable matter in milk, and forms its *caseum*, or curd. In the liquid state it does not coagulate by heat. *Cheese* is the coagulated casein deprived of its whey, and mixed with more or less of butter. When *rich* in butter, cheese is very liable to undergo spontaneous decomposition, and generate active poisons. The strong, piquant flavor of old cheese depends on oleic acid, and an acrid oil, both extremely unwholesome. The per centage of casein in milk is: Woman's 1·52, goat's 4·02, ewe's 4·50, ass's 1·82, cow's 3 to 4·48. In two samples of cow's milk, the animals fed on potatoes and hay, one yielded 15·1, the other only 3·3.

As a food, liquid casein, curd, and fresh cheese are wholesome articles, but all old cheese is an exceedingly obnoxious aliment. Dr. Dunglison says: "Cheese is supposed to be an excellent condiment, and accordingly it is often systematically taken at the end of dinner, as a *digestive*." Dr. Dunglison *ought* to have added, especially as he was writing the "Elements of Hygiene," that the supposition was a very erroneous one, and the practice a very bad one.

Gluten is the tenacious elastic mass which is left of wheaten dough after washing away the gum, sugar, starch, and albumen. It is a mixture of several organic principles, and is regarded as one of the proteinaceous compounds. Liebig's *vegetable fibrin* is the insoluble portion of gluten when it is boiled in alcohol. *Mucin* is the substance which deposits as the hot alcoholic solution of the soluble portion of gluten cools, and the portion remaining in solution is called *gluten*. The *pure gluten* of authors is the compound of *gluten* and *mucin*. It is the gluten of wheaten flour which renders it adhesive, and conveniently manufactured into *macaroni*, *vermicelli*, and similar pastes; to its larger proportion of this ingredient, wheat owes its superiority to other grains for the purposes of making *fermented* bread, crackers, and cakes. In the ordinary commercial process of bread-making (bakers' bread) the gluten is more or less destroyed, and converted into acetic acid, which is neutralized by ammonia, or some other alkali. If the panary fermentation is allowed to proceed beyond the point of converting the sugar of the flour or meal into carbonic acid gas (which being diffused among the ductile and tenacious particles of gluten, puffs up, or *raises* the dough), the process of decomposition attacks the gluten itself, which it literally *rots*, and although such bread may be exceedingly light and spongy, and expand into the "largest loaf," it is very unwholesome, compared with *good bread*, and after standing twenty-four hours becomes insipid and disagreeable.

The quantity of glutinous matter contained in the *cereal* grains is liable to great variation, according to soil, manner of cultivation, species of grain, etc., if we may trust the deductions of chemical analyses. Wheat has been found to contain, in 100 parts, 12 to 35, barley 5 to 6, oats 4 to 8, rye 7 to 10, rice 3 to 4, corn 3 to 6, common beans 10, dry peas 3½, potatoes 3 to 4, red beet 1·3, common turnips 0·01, cabbage 0·8.

All of these proteinacious aliments—gluten, casein, albumen, and fibrin—as well as fat, starch, sugar, and gum, have been fed separately to dogs and other animals, in order to ascertain their nutritive properties. The animals all died of *starvation*, and physiological science profited—just nothing at all, unless it was from the mortality of the dogs! If animals were intended by nature to subsist on any *single element* of nutrition, consistency would seem to demand that such element should be accessible in some way except through the tedious process of culinary preparation or chemical analysis. Such *unnatural* dietetic experiments can only result in "cruelty to animals."

Gelatin is regarded by Dr. Prout as an imperfect kind of albuminous matter. Gelatin and albumen are, however, not convertible into each other by any known chemical process. Those tissues of animals called gelatinous—skin, tendons, cartilage, cellular and serous membranes—by boiling, yield a substance called gelatin; and this substance, with water, forms a tremulous mass, called *animal jelly*. The quantity of gelatin found in 100 parts of the following substances is: Muscles of beef 6, do. veal 6, do. mutton 7 do. pork 5, do. chicken 7, do. cod 7, do. haddock 5, sole 6, sweet-bread of calf 6, antlers of stag (hartshorn) 27, caviare (fresh) 0·5, spongy bones 39, hard bones 43 to 49, isinglass 70 to 93.

Gelatinous substances are moderately nutritious, but generally, in the form of stews, hashes, soups, etc., difficult of digestion, on account of the fatty matters they contain; gelatin easily becomes rancid and putrescent when exposed to a high degree of heat, and is then extremely offensive to the stomach. *Calf's foot jelly* is a favorite with physicians and invalids, but far inferior, dietetically or medicinally, to Indian or wheat-meal gruel.

A few years ago a Gelatin Commission was appointed in Paris, for the purpose of ascertaining the nutritive virtues of bones and other refuse animal matter, with the view of providing a *cheap* diet for the poor! After a series of experiments, which caused a large number of dogs to "bite the dust," it was finally concluded that gelatin alone would not sustain animal life—a conclusion that correct physiological principles would have settled without the experiments. As a specimen of the extremely absurd manner in which those experiments have usually been conducted, I quote the following from Pereira's "Food and Diet:" "M. Donné tried the effects of gelatin on himself. He took daily from 20 to 50 grammes (308½ to 771¾ grs. troy) of dry gelatin, in the form of a sugared and anomatized jelly, with either lemon or *some spirit*; and from 85 to 100 grammes (1312 to 1543½ grs. troy) of bread. At the expiration of six days he had lost two pounds in weight, and during the whole time was tormented with hunger, and suffered with extreme faintness, which was only alleviated after dining in his usual way."

Such "experiments" are not worth criticising, except to exhibit the foolish and frivolous manner in which those who assume to teach us physiology derive the facts which they parade with such flourishes in their "scientific" books. Any man accustomed to a "good dinner" every day, as the phrase is usually understood, and spirituous liquor with it, would suffer hunger, or, rather, craving and faintness, on first changing his dietetic habits to greater abstemiousness and simplicity, whether the change was to better or worse.

The gelatinous substances commonly employed in the preparation of jellies, solutions, etc., are *isinglass* and *hartshorn*. The former is procured from the *air-bag* or *swimming-bladder*, sometimes called the *sound*, of various fishes. The Russian and Siberian *sturgeons* yield the finest kinds for domestic purposes. *Blanc-mange* is a jelly prepared of Russian isinglass dissolved in milk, and flavored with sugar, lemon, etc. *Cod sounds*, procured from the common cod-fish, are used as a substitute for isinglass; the *glue* obtained by boiling cod sounds dries into a hard substance, and is used in the shops for gluing pieces of wood together. Glue is also prepared from the skins and hides of beasts and the bones of animals, for both dietetical and commercial purposes. The shavings of the antlers of the stag are employed in the preparation of the *decoction of hartshorn*; *hartshorn jelly* is made by boiling down half a pound of the shavings in three quarts of water to one quart, and flavoring with lemon, wine, etc. Jellies made from *calves' feet*, *calves' heads*, *cows' heels*, *sheep's trotters*, and *petit-toes* (sucking pigs' feet), are in great repute as delicate aliments for epicures and invalids. I regard them all as miserable trash at best.

The *salts* which are found to exist in very small quantities in vegetables and fruits constitute the *saline alimentary principle* of authors.

Chloride of sodium (common salt) and the *earthy phosphates* are the most frequently found in vegetable aliments; and some chemists regard salts of potash and compounds of iron as indispensable constituents of our food, because they are generally found in the human body, and frequently in vegetable productions.

Perhaps there was never a greater and more general delusion abroad than that in relation to the nature, properties, and uses of common salt. It can be shown, with almost the certainty of a mathematical demonstration, that it possesses no nutrient properties, and is in no sense a dietetical article, nor in any sense of any possible use for any purpose of the animal economy; and yet medical writers are continually echoing the stale phrase, "that animals cannot exist without the free use of salt;" and this directly in face of the facts, that hundreds of species of animals never taste of salt, and that millions of the human race have lived healthfully, and died of a good old age, without employing it at all; and that, furthermore, hundreds of thousands of human beings now live in the enjoyment of excellent health, who have never used salt either as a food or a condiment. The stereotyped statements so frequently copied in medical books and journals are really amusing for their very absurdity. Pereira says: "It is a necessary article of food, being essential for the preservation of life and the maintenance of health." Dunglison says: "Salt is a natural and agreeable *stimulant* to the digestive function; a diet of unsalted aliment generating disease, chiefly of a cachectic character. Children who are not allowed a sufficient quantity of this *useful condiment*, are extremely liable to worms." Liebig says: "Salt is essential to the formation of bile in the herbivora, and to that of gastric juice." These expressions, and a hundred similar ones which could be quoted from as many authors, are purely fictitious, as is proved by the whole history of the animal kingdom, and the experience of a large portion of the human family. But let us look at the theory or philosophy of the matter.

Dr. Dunglison admits that salted meats are more indigestible than fresh, and he says also: "When highly dried they become more or less coriaceous, and of a texture very unfit for the due action of the gastric secretions." Dr. Paris thinks: "Salt combines with the animal fibre of salted meats, by which the texture is so changed as to render them less nutritive as well as less digestible." "Certain fish," says Dunglison, "when salted, as the *anchovy*, *cod*, *haddock*, *herring*, etc., are used as relishes in the way of condiments. They are *stimulating*; but the *combination of flesh and salt is very indigestible*, and unfit for the dyspeptic." Pereira says: "The antiseptic power of salt is by no means well understood." Liebig says: "Fresh flesh, over which salt has been strewed, is found, after twenty-four hours, swimming in brine, although not a drop of water has been added. The water has been yielded by muscular fibre itself, and having dissolved the salt in immediate contact with it, and thereby lost the power of penetrating animal substances, it has on this account separated from the flesh. The water still retained by the flesh contains a proportionally small quantity of salt, having that degree of dilution at which a saline fluid is capable of penetrating animal substances. This property of animal tissues is taken advantage of in domestic economy for the purpose of removing so much water from meat that a sufficient quantity is not left to enable it to enter into putrefaction."

If Liebig's explanation be true—and I believe it is true, and it is corroborated by the experiments and opinions of other distinguished chemists—that the antiseptic property of salt is owing to its abstracting from the animal fibre its aqueous particles, thus rendering it less capable of solution and decomposition, it proves also that salt is anti-dietetic in the exact ratio that it is antiseptic, for digestion implies the decomposition and transformation of the elements of the alimentary substance. But some authors, among whom are Paris and M. Eller, have expressed the opinion, and proved it by experiments, that salt actually combines chemically with the animal tissues, thus effecting to some extent their destruction; hence a large quantity of it, or what is usually called the "free use of salt," cannot be otherwise than seriously injurious.

The following *awfully* convincing argument in favor of salted food is frequently quoted by "old school" writers on hygiene: "Lord Somerville, in an address to the English Board of Agriculture, refers to a punishment that formerly existed in Holland. The ancient laws of the country ordained men to be kept on bread alone, *unmixed with salt*, as the severest punishment that could be inflicted upon them in their moist climate. The effect was horrible; these wretched criminals are said to have been devoured by worms engendered in their own stomachs." Whether this story is fact or fiction, the principle applicable to its explanation is obvious enough. It is true that salt will kill many kinds of worms; and if the bread fed to the Hollander convicts was really a bad, rotten, *wormy* article, there can be no doubt that the addition of salt enough to destroy the vermin was a decided advantage.

The fondness of domesticated animals for salt is often referred to as evidence that the desire for salt is a necessary and natural instinct in all animals: and the fact that the deer of our forests seek the *licks* of salt water, is adduced in evidence of the same natural instinct. But it should be remembered that domesticated animals have domesticated tastes, and that *civilized* horses, sheep, cattle, and hogs, are just as liable to acquire depraved appetites as civilized men. I have known cows to break into the "sap-bush" in maple-sugar districts, and drink themselves almost to death on syrup, yet no one would pretend that sugar, molasses, or treacle, was a natural food for cattle, except as it exists in the juices of vegetables. It should be observed, too, that the wild animals who frequent the salt water pools, only do so habitually in the warm season, when insects and worms are troublesome.

The *scurvy*, which is owing principally to a diet consisting of a large proportion of salted provisions, is a disease whose symptoms indicate an exceedingly impoverished state of the blood, and a putrescent condition of all the fluids and solids of the body. The *antiseptic* property of salt does not therefore render it wholesome. The truth is, the term antiseptic has no applicability to a living body or its aliment. It is a property which preserves dead organic matter in a fixed, unchangeable state; and so far as it affects any living tissue, it must deaden its vitality.

The dietetical rule for the employment of salt is very simple—*the less the better.* I do not suppose a very moderate quantity is harmful to any appreciable extent. A very little may be so diluted by the fluids of the stomach, and so readily washed out of the system as to occasion no important inconvenience. But if used habitually to the extent of provoking unnatural appetite and exciting thirst, it cannot be otherwise than prejudicial to the whole organic domain, occasioning glandular obstructions, rigidity of the muscles, producing general irritation of the mucous membrane of the alimentary canal, and loading the circulating fluids with a foreign ingredient, which the excretory organs must labor inordinately to get rid of.

So far as common salt and its elements (sodium and hydrochloric acid) exist in esculent fruits and vegetables, so far I admit they are alimentary. But it seems to me quite clear that nature has put the saline as well as the acid and alkaline elements of our food together in exactly the right proportions, so that the wants of the organic economy do not require us to make any extraneous additions.

Probably those who have never tried the experiment would be surprised to learn how easily the appetite for very salt food is overcome. Many persons, on restricting themselves to less than one fourth the usual quantity for one month, have found the palate as well satisfied as it was previously on four times the quantity. The diminution of quantity can then be carried still further without sacrificing much gustatory pleasure, for, as the unnatural irritant is withdrawn, the sense of taste becomes proportionally keen, so that food, before unpalatable without high seasoning, is relished with little or none.

The remarks in relation to common salt are equally applicable to the dietetical nature of all other saline ingredients found in alimentary substances, although none of them are in use as condiments. The *phosphate of lime*, which is the basis of the bony structure, is found more generally in vegetables than any other salt. The earthy phosphates are found in one hundred parts of wheat 0·36 to 0·9, rye 0·06 to 4·18, barley 0·1 to 0·6, oats 0·16 to 0·6, rice 0·4, garlic 1·1, casein 6·0, milk 0·1975, blood 0·03, bones 45 to 56, muscular flesh of ox a trace, do. of calf 0·1, do. of pig a trace, do. of roe 0·4, do. of chicken 0·6, do. of trout 2·2, corn, potatoes, milk, and many other foods contain the earthy phosphates.

Minute quantities of the salts of potash are found in most vegetable foods, and in the blood, solids, and secretions of animals. The state in which the compounds of iron exist in the system, and the manner in which they are introduced, are entirely unknown; and it is questionable whether they are in any degree natural constituents of alimentary substances.

Aliments, or Foods Proper.—Having treated of the ultimate or chemical elements of food, and the proximate elements compounded of the ultimate, we come now to the consideration of aliments, or foods proper, which are compounds of the proximate elements. Pereira terms the proper foods "*compound aliments*," a name predicated on the mistaken notion that the alimentary principles were really *simple* aliments. He might as well call the oxygen and the hydrogen of the water we drink *aqueous principles*, and their combination in the form of water *compound drink!*

Whatever may be the natural dietetic character of man—a question to be discussed in the succeeding division of this work—both the animal and vegetable kingdoms are made subservient to his nutrition. Hence the obvious propriety of treating this branch of our subject under the general divisions of animal and vegetable food.

§. *Animal Food.*—Animal substances yield the alimentary principles called *proteinaceous*, *gelatinous*, and *oleaginous*, to which may be added the *sugar* of milk. They are derived from flesh, blood, bones, cartilages, ligaments, cellular tissue, viscera, milk, and eggs. All the species of animals which human power and ingenuity have been able to grasp—beasts, birds, fishes, reptiles, and insects, and every viscus or structure of each animal—brain, lung, heart, stomach, in testine, kidneys, skin, etc., has been more or less employed as human aliment.

In the more civilized countries the mammals—*neat cattle*, *sheep*, and *hogs*, afford the principal supply of food; the *deer*, *rabbit*, *hare*, *elk*, *moose*, *buffalo*, and *bear*, belong to this class, and are used to some extent in many countries. Even the horse, dog, cat, rat, and mouse, are common food among the Kalmuck Tartars and some other tribes of the human family. Of *birds* those principally eaten are the common fowl, turkey, goose, duck, partridge, woodcock, and pigeon, though a great variety of other *game* birds are common at the refectories. The only *reptiles* which are much sought after in the United States are the various kinds of *turtles*, the most common of which are the *salt water terrapin*, *painted tortoise*, *broad terrapin*, *red-bellied terrapin*, *geographic tortoise*, *snapping turtle*, *soft-shelled turtle*, and the *green turtle*. The common *water-frog* and the *bull-frog* are occasionally eaten, and the *flesh of vipers* was once in repute as an analeptic or restorative diet for invalids. Of *fishes* our brooks, rivers, lakes, and oceans furnish an endless variety, from the *whale* of a hundred tons to the *shrimp* of a tenth part of an ounce. The *shell-fish* employed as food are the *lobster*, *crawfish*, *crab*, *prawn*, *shrimp*, etc.—the crustaceous; and the *oyster*, *mussel*, *cockle*, *whelk*, *scallop*, *limpit*, *periwinkle*, etc.—the mollusks.

The best animal *food* is, beyond all peradventure, that derived from the herbivora—beef, mutton, etc. Those animals which derive their nourishment directly from the vegetable kingdom will certainly afford a purer and more wholesome aliment than animals who subsist on other animals—the carnivora. Omnivorous animals, that eat indiscriminately vegetables or other animals, are far inferior to the purely herbivorous as food for human beings. Of the hog, whose filthy carcass is converted into a mass of disease by the ordinary fattening process, I need only express my abhorrence. Although swine flesh and grease, under the names of *pork* and *lard*, are staple and favorite articles of food throughout Christendom, common observation has long since traced the prevalence of scrofula, erysipelas, and a variety of glandular and eruptive diseases resulting from impure blood, to their general employment. If there are any animals which should be exterminated from earth, mad dogs and fattened hogs are among them. If, as Dr. Adam Clarke suggested at a dinner where a smoking roaster of a pig *graced* the table, the animal was "cursed under the law," how can it be blessed under the gospel? The flesh of animals that subsist exclusively on vegetable food contains a greater portion of nutritive matter, according to chemical analysis, than the flesh of any other animals.

But the quality of the food derived from herbivorous animals may be greatly varied by circumstances. Very young or very old animals are less healthful than young, nearly full-grown, or middle-aged. Animals which have been excessively fattened, or stall-fed, and those which have been hard worked, are deteriorated as food; and animals that have been "slopped" with liquid preparations, the refuse matters of the kitchen, or the filthy excrements of distilleries, are very unclean and unhealthful.

There is also a choice in the different parts or structures of all animals when we come to the matter of converting them into the actual substance of the organs and structures of our own bodies. The very best part of any animal for any human being to eat is the lean flesh or muscular fibre; and that flesh is unquestionably the most wholesome which is found in animals neither fattened nor emaciated. But some allowance must be made for the masticatory ability of human teeth, "as society is now constituted." Flesh-meat requires thorough mastication. Human beings have not the tearing teeth of the tiger and the wolf, nor the cutting motion of the jaw which belongs to the carnivora. Moreover, the teeth, jaws, and gums of most people who live in the ordinary way are preternaturally sensitive and tender; and in addition to all this, a large portion of people, even young people, in civilized society, wear artificial teeth. They cannot, therefore, well masticate tough meat, as is often demonstrated in the cases of choking in the attempt to swallow half-chewed flesh. For this reason the animal had better be in good condition, and only the most tender fibres selected as food. Epicures generally have their flesh kept until it becomes tender from age; but such tenderness is the condition of incipient putrefaction, and although the article may be very easily disposed of by the teeth, and very quickly *dissolved* in the stomach, it can never be well *digested*, nor can it ever be converted into pure blood and sound tissues. It is advantageous to break up the fibres of tough meat by thoroughly pounding before cooking.

The process of decomposition commences in a dead animal the moment that life is extinct, although it may not be *offensively* apparent to our senses for some hours or days after death And as living animals can derive no nutriment from any solid food except it be in its organized state, it follows that the flesh of animals as food deteriorates continually after the animal is killed; and hence the sooner butcher's meat is employed after being killed, the more wholesome. It may, however, be immediately frozen, and kept a long time without injury. The manner of slaughtering the animals also affects the quality of their flesh. They should always be *killed allopathically*—begging pardon of my "old-school friends," if I have any—that is, *bled* in such a manner as to empty the vessels as cleanly as possible, and never *executed* by stunning, pounding, wringing the neck, etc. The blood not only contains the nutrient elements of the food, but the waste matters to be expelled from the body, and also such accidental impurities as may have obtained admission into the body; and the more bloody any kind of animal food is, the more unclean, putrescent, and unwholesome. Dr. Dunglison utters the following flat contradictions on the same page of his late work on Human Health. In speaking of the Roman custom of killing animals by running a red-hot spit through the body, he says: "This mode of slaughtering was replete with objections, if regarded in an alimentary point of view. The flesh of animals thus killed is dark colored, owing to the retention of blood in the vessels, and hence it becomes *speedily putrid.*" *Per contra*, says Dr. Dunglison: "When an animal is killed accidentally, *without bleeding*, its flesh is *not unwholesome*, although it may not be *palatable*, in consequence of the *blood remaining in the vessels.*" And yet again says Dr. Dunglison, as if to render confusion as confounded as possible: "The blood is the most putrescible of all fluids, and consequently animals, under such circumstances, do not keep sound so long as when they are bled to death." And yet once more says Dr. Dunglison: "Caution should always be observed in eating animals that have died from, or been killed during *disease.* Although the meat may often be innoxious, at other times it would *seem to be* capable of producing disease, and even death." The body of an animal dying from disease *may be healthful food*, says Dr. Dunglison. Of such thoughtless and senseless *gabble* is the great mass of medical and dietetical books afloat made up. The bloody drippings from broiled flesh which are so eagerly "spooned out" by many persons to season their potatoes, or "sop" their bread with, are always more or less charged with animal excrement, and never fit to be taken into the stomach, albeit some medical books prate about that stuff being the "juice" and "strength" of the meat!

The Mosaic law, which forbade the Jews to eat the blood of any beast or bird, or to partake of their flesh, unless the throat had been cut, in order to drain off the blood, was founded on correct physiological principles. As a further precaution against eating blood, they were required, previously to boiling meat, to let it soak half an hour in water, and then lie an hour in salt; the object of this proceeding was to draw out any remaining portion of blood the flesh might contain In regard to the philosophy of dietetics, Moses was far in advance of the majority of the Christian teachers of the present day.

The sausages sold in the shops under the name of *black pudding* are made of pig's blood mixed with fat, seasoned with aromatics, and inclosed in the prepared intestines.

Brande and Schlossberger give the following proximate composition of muscular flesh:

100 Parts.	Water.	Albumen, or Fibrin.	Gelatin.	Nutritive Matter.
Beef,	74	20	6	26
Veal,	75	19	6	25
Mutton,	71	22	7	29
Pork,	76	19	5	24
Chicken,	73	20	7	27
Cod,	73	14	7	21
Haddock,	82	13	5	18
Sole,	79	15	6	21

The comparative healthfulness of other parts of animals can be readily determined by a reference to the physiological principles already adverted to. The fatty matters, next to the blood, are the worst alimentary substances; and, notwithstanding artificially depraved appetites generally crave unnatural aliment with an intensity proportioned to its impurity, such fact does not alter the truth, nor should qualify our manner of expressing it. The kidney, whose function is to eliminate from the body a large proportion of its most putrescent materials, though often considered a "dainty dish" by epicures, is certainly unfit to eat. A cooked kidney always exhales a urinous odor. The liver stands in the same relation to the human stomach. Next in the order of their unfitness are the brains, lungs, stomach, and intestines, skin, cartilages, tendons, etc. All these viscera and structures are made into a variety of fashionable dishes, and all have their admirers; but just as far as we depart from lean flesh in selecting aliments from the animal kingdom, just so far does their value depreciate.

The dietetic character of animal food is also affected by the manner of cooking. It is to be preferred lightly or but moderately cooked, providing a due degree of tenderness of fibre is secured. In broiled steaks this may be accomplished by pounding; but large, thick, roasting pieces are apt to be tough if not well cooked. *Broiling*, on all accounts, is the best method of cooking all flesh-meat. *Boiling*, taking care to skim off any floating particles of oil, is better than *roasting*; and this again is better than *frying*, which is a method never to be recommended.

Another argument may here be stated in favor of the position that muscular flesh is the best form of animal food, which is, the absolute identity of the chemical elements of pure flesh and pure blood. The analyses of Playfair and Boeckmann give the following results:

Elements.	Ox Blood.	Dry Beef	Roasted Beef.	Roasted Veal.	Roasted Deer.
Carbon,	51·95	51·83	52·590	52·52	52·60
Hydrogen,	7·17	7·57	7·886	7·87	7·45
Nitrogen,	15·07	15·01	15·214	14·70	15·23
Oxygen.	21·39	21·37	24·310	24·91	24·72
Ashes,	4·42	4·23			
	100·00	100·00	100·000	100·00	100·00

The *milk* of the mammals, though an animal secretion, can hardly be called animal food, in strict language. It contains, on the average, nearly ninety per cent. of water, and about ten per cent. of solid matter. consisting of butter. casein, sugar, and various salts. The *cream* of cow's milk, according to Berzelius, consists of butter 4·5, casein, or curd 3·5. whey 92·0=100·0. By agitation, as in *churning*, the globules of fatty matter unite. and form *butter;* the residue is called *buttermilk:* it consists of casein. serum, or whey, and a very small quantity of butter. *Skimmed milk* very soon becomes acid and curdy. The admixture of an acid or rennet (which is the infusion of the fourth, or true stomach of the calf), immediately coagulates it, separating the casein. or curd. from the whey. The addition of acetic acid will cause a still further separation of coagula, which has been called *zieger*. *bracotte*. etc. After the separation of casein and zieger, the whey left yields *lactic acid*, *salts*, and some nitrogenous substances. one of which is supposed to be *osmazome*. Osmazome, however. does not appear to be a tangible reality, but a flavor or effluvia developed by the chemical changes which take place in several animal substances during the process of cooking—heating, roasting, boiling, etc.

Good milk is a homogeneous but not viscid liquid, not coagulable by heat. When examined by the microscope it appears to consist only of transparent spherical globules. The cream yielded varies from five to twenty per cent., as tested by the *lactometer*, which, by the way seems to be a very unsatisfactory instrument for the purpose.

No secretion is so readily affected by the ingesta, or the general health of the animal producing it, as the milk. The taste, color, and odor of cow's milk are readily modified by the food. Children are easily salivated, narcotised, catharticised, and poisoned and disordered in many ways, through the mother's milk. The organic instincts, true to the *first* principle of self-preservation, determine the accidental impurities of the body to this channel as the most ready way of expelling them from the body Nursing mothers have little idea how much disease, pain, and misery they inflict on their little ones, nor how frequently they commit *infanticide*, by taking irritating aliments and drinks, and injurious drugs into their own stomachs. If I could present this subject to them in all its force, and in all its bearings on their happiness, and on the well-being of the human race, as I hope to attempt in a future publication, I am certain there would be a sudden and very radical revolution in the way of dieting mothers and doctoring children.

The milk produced by cows fed on distillery slops, which, to the disgrace of municipal authorities, *rich* men are permitted to sell to the poor in nearly all our large cities, is not only very innutritious, but absolutely poisonous. In New York, Brooklyn, and Williamsburgh, several thousand cows are kept in close and horribly filthy stables, fed on warm slops, and other refuse matters of the distilleries, which rot their teeth, weaken their limbs, and render their whole bodies masses of disease; and their milk is furnished to our citizens as a principal article of diet for their children!

Although milk cannot be considered a necessary or strictly natural food for mammals, except during the period of infancy, when the teeth are undeveloped—and no animals of the class mammalia, save man, employ it otherwise—it is nevertheless, when pure, the best form of aliment out of the strict order of natural foods. It contains all the elements requisite for prolonged nutrition, and except in certain abnormal states of the digestive organs, its moderate employment is attended with no inconvenience. Some invalids cannot enjoy, and some dyspeptics cannot tolerate it; but exceptional cases from morbid conditions are not rules for healthy persons.

Butter, as prepared for the table, is a different article dietetically from its fatty particles as they exist in milk. The former must rank with all animal oils, in being difficult of digestion, but slightly nutritive, and liable to generate rancid acids in the stomach. There is, however, a great difference between fresh-made and slightly salted butter, and that which is old and highly salted. Compared with the latter the former is almost innocuous. Melted and cooked butter is, wherever found, a very deleterious aliment. *Sweet cream*, from its solubility in water, and greater miscibility with the saliva, is far preferable to butter. Indeed, I am not aware that experience assigns to it any injurious or even unpleasant effects as an aliment.

The fresh curd of milk is perfectly wholesome, and pot-cheese, when made of milk as soon as it becomes sour, and before it gets bitter, is also a harmless article. Green cheese is not very objectionable, but old, strong cheese is one of the most injurious and indigestible things in existence. It is also one of the most constipating articles to the bowels that can be found. It is a common *fancy* among medical men, and a common *whim* among the people, that old, strong, rank cheese, though itself very indigestible, stimulates the stomach to digest other things; hence almost all the medico-dietetical works quote the old adage:

> "Cheese is a mity elf,
> Digesting all things but itself."

There is more poetry than truth in the doggerel distich. Old cheese occasionally undergoes spontaneous decomposition, during which process acrid and poisonous elements are developed, as is frequently the case with bacon and sausages.

Next to the flesh of the herbivora, or rather the *graminivorous* animals, the *flesh of birds* affords the most wholesome form of animal food. All of the species of the feathered tribes in common use, however, are not equally wholesome. Their alimentary value depends in a great degree on their food and manner of life. Pereira says: "Rapacious birds, as the *hawk* and *owl*, are not eaten, partly, perhaps, from prejudice, and partly because those which touch carrion acquire a cadaverous smell." I should think the stench alluded to was a sufficiently *strong* reason for refusing to eat them, without imputing any thing to the score of prejudice.

The *white-fleshed* birds—*chicken*, *turkey*, *partridge*, *quail*, etc.—are very nearly as nutritious and digestible as beef. Chicken flesh is called the "least stimulating of animal foods" by medical writers, but I think the assertion is wholly gratuitous. The *dark-fleshed* birds, as *game birds*, *grouse*, *robin*, *woodcock*, *snipe*, etc., are less nutritive and less digestible, but more greasy and savory to epicures. Pereira says of the flesh of these birds: "It is richer in ozmazome, and when sufficiently kept it acquires a peculiar odor, called *fumet*, and an aromatic, bitter taste, most sensible in the back. In this condition it is said to be *ripe*, or *high*, and is much esteemed as a luxury." This "fumet," so highly prized, is the stench of putrefaction, as is the "cadaverous smell" of carnivorous birds. Prof. Dunglison eulogizes this fumet still more extravagantly: "The solubility of game, grouse, etc., is amazingly increased, as well as the *luxury of the repast*, by keeping it until it has attained the requisite *fumet*; which indicates that *incipient putrefaction* is diminishing its cohesion." The *luxury of putrefying animal flesh* sounds strangely to those who do not go to epicures and "riotous livers" to learn their dietetic rudiments. It is unfortunate for the cause of human health and longevity, that physiologists do not consult nature and common-sense more, and cooks and refectories less, in seeking for the facts and principles of hygiene.

The aquatic birds, *geese* and *ducks*, are strong, rancid, and oily, and extremely unwholesome. The *canvas-back* is considered one of the greatest of luxuries; but here, as in a majority of cases, the luxury consists in the pampering of an exceedingly depraved appetite.

The manner in which fowls are fattened for the markets of many large towns, though it commends them to the tastes of epicures, detracts very much from their purity as food. They are confined in dark places, sometimes their eyes are put out or stitched up, and crammed with a paste made of barley-meal, mutton suet, molasses, and milk; this *ripens* them in a fortnight, when, if they are not immediately killed, a fever or general inflammation comes on, which frequently destroys them.

Particular parts of certain birds have long been celebrated as "delicate morsels" by epicures; as the *brains* of the ostrich and peacock, the *tongues* of the nightingale and flamingo, the *trail*, or *intestine* of the woodcock, the *enlarged liver* of the goose, etc. This last article is a diseased condition of the liver, called by physiologists *fatty degeneration*, and is produced by confining the goose in a dark, warm place, and stuffing it with food and charcoal. Sometimes in this way the liver swells enormously, weighing two pounds. The body of the goose also becomes very fat, and in the language of Pereira, "excellent for the table." Pereira says of this morbid liver: "It is obvious, therefore, that these *diseased* livers must be difficult of digestion, and unfit for persons with delicate stomachs." Why should any persons, be their stomachs delicate or indelicate, eat "diseased" livers?

The *eggs* of oviparous animals, when fresh and rare-boiled, are moderately nutritious and easy of digestion. They are not particularly objectionable as a part of a dietary selection, yet their virtue is rather negative than positive. Poached eggs are extremely pernicious; and eggs are very indigestible when hard-boiled or fried. One writer, Mr. Pearson, states that there are "instances of laboring people, and persons who use violent exercise, with whom eggs, hardened by boiling or frying, *agree* better than in the soft or liquid state." It is not uncommon for laboring men to suppose that hard water agrees better with their stomachs than soft water; but no intelligent physiologist will think so.

The flesh of *turtles* is prepared at the refectories in the forms of steak and soup. It is unwholesome aliment in all ways, though Sir Hans Sloane, who appears to be as high authority among flesh-eaters as Hoyle is among chess-players, says, "the livers are counted delicacies." Sir Hans also tells us that the *callepee*, or under part of the breast or belly, baked is reckoned the best piece. Moreover, Sir Hans remarks: "Persons who feed much on turtles sweat out a yellow serum, especially under the armpits." And again says our author: "The lard, or fat of the green turtle, when melted out, is of a warm yellow color, and communicates a yellow tinge to those who feed on it; whence their shirts are yellow, and their skin and face of the same color;" from all of which testimony we conclude that these reptiles are not fit for human beings to eat. The eggs of these animals are sometimes eaten.

In a general sense, *fish aliment* is far inferior to flesh. The piscivorous tribes of the human family are universally in a state of extreme mental and bodily abjection. The explanation of this fact is found in the food upon which the animals which they eat subsist—smaller fishes, worms, and insects, and the impurities of the element in which they reside—so far as salt-water fishes are concerned, which penetrate their structures, and mingle in all their fluids and secretions. Fish is not as nutritious as flesh, and is usually considered as less stimulating. The feverishness so generally noticed after a meal of fish may be imputed to the impurity of the aliment, though some regard it as evidence of stimulation. As a general rule the least oily fishes are the most wholesome, as the *cod*, *halibut*, *trout*, *whitefish*, *bass*, *blackfish*, *haddock*, *whiting*, *sole*, *turbot*, etc. *Salmon*, *eels*, *herrings*, *pilchards*, *sprats*, *mackerel*, *shad*, etc., are among the oily varieties. Dr. Dekay, in a late work, enumerates 440 species of fishes belonging to the State of New York, hence the varieties distributed over the aqueous portions of the globe must be innumerable.

The objectionable nature of fish aliment is generally made still more objectionable by the usual method of cooking—frying, and the indigestible additions of melted butter, lobster-sauce, egg-sauce, etc.

The idea has been extensively entertained that fish diet greatly intensifies the procreative powers, and Tourtelle refers to the numerous children found in seaports as proof. But there is no evidence that ichthyophagous people propagate faster than others. Were the opinion correct, it would afford another argument against the sanatory nature of the food; for it appears to be a law of the animal kingdom that the rapidity of propagation increases with the increase of the causes which destroy the animal.

The Egyptian priests were forbidden to eat fish, and among the aquatic animals which Moses prohibited to the Hebrews were, "Whatsoever hath no fins nor scales." A law similar to that of Moses was made by Numa Pompilius for the Romans. In tropical climates many species of fish are absolutely poisonous, especially at particular seasons, producing, when eaten, violent itching, colic, burning heat in the throat, nausea, giddiness, blindness, cold sweats, often terminating in death. Dr. Burrows enumerates twenty kinds of poisonous fish. The nature of this poison is wholly unknown.

The fishes found in the clear water of lakes, rivers, and rivulets are greatly superior to those which inhabit muddy or foul waters. Some kinds of fish are eaten whole, as the *white bait*. Nearly all the parts and viscera of these animals are eaten more or less, not excepting the *milt* or *testicle* of the male, and the *roe* or *ovary* of the female. The former, called the *soft roe*, and the latter, called the *hard roe*, are among the "esteemed luxuries" of sensuous epicures. The *caviare*, which Dr. Dunglison calls "an article of national food," is the preserved roe of the sturgeon and various other fishes, salted, peppered, and further flavored with minced onions. The milt of the herring has been recommended by several distinguished physicians—Ritter, Neumann, Frank, Siemerling, and Hufeland—as a remedy for various diseases; and, what is specially amusing, its effiacy was ascribed to the *common salt* it contained!

Of the crustaceans, *lobsters*, *crabs*, *shrimps*, and *prawns*, are those most generally eaten. They are all exceedingly indigestible, and a frequent cause of disordered digestive organs. The peculiar odor and taste of these animals are due to a resinous substance of the membrane enclosing the shell, and which becomes red by boiling. Pereira says: "Both the crab and the lobster excite, in some constitutions, *urticaria*, or nettle-rash, and even colic."

Of the class mollusca, the *oyster* is the greatest favorite with the lovers of sea-food. They are not very nutritive, containing only about 12½ per cent. of solid matter. When eaten raw they are more digestible and wholesome than when cooked in any manner. Oysters have had the reputation among medical men of being a specific for dyspepsia, scrofula, and consumption, but the more intelligent physicians of the present day specially prohibit them in those diseases, except when they deem it policy to compromise with the appetites or prejudices of their patients. *Mussels*, *clams*, *scallops*, *cockles*, and even *snails*, are eaten to a considerable extent by people on the sea-coasts. The former are frequently poisonous. Dr. Lee states: "It is a very common thing for persons to be poisoned in this city (New York) by eating mussels produced from our adjacent waters." Eruptive and paralytic affections are said to be the results of being poisoned by these animals. The *vineyard* or *great snail*, has been, and still is, in England, not only a *popular* but a *regular* remedy for consumption. Fulvius Hirpinus, of Roman celebrity, had several *snail parks* in his garden, where he kept and fattened the "most famous and excellent" snails, each variety having a park to itself. He fed them upon a pap made of sweet wine, honey, and flour; "and under this diet," says Dr Dunglison, "they became so *wholesome* and delicate, and were so much esteemed, that they were sold for eighty quadrants the dishful." I am of opinion that the wholesomeness of an aliment is not to be determined by the tastes of epicures, or its price in the market!

But few insects are employed as food among civilized people at the present day. The *grub-worm* was in repute as a "delicacy" in the days of Pliny. *Locusts*, *grasshoppers*, and some species of *spiders*, have been eaten. In South America *centipedes* are eaten. The Brazilian Indians are fond of the *white ant*; and the West Indian negroes relish a species of *caterpillar*. On the dietetic value of these insects I need not dwell.

§. *Vegetable Foods.*—The vegetable kingdom affords the purest aliments, as well as the greatest variety of alimentary principles. Vegetable foods are found in the form of the *seeds*, *fruits*, *roots*, *buds*, and *young shoots*, *leaves*, *flowers*, and *stems*, of flowering plants, and *lichens*, *ferns*, *sea-weeds*, and *mushrooms*, of flowerless plants.

The seeds and fruits are the most important and most useful of human aliments; yet it would be difficult to decide which of these is most necessary, for the perfection of nutrition requires both.

The seeds commonly employed are the cereal grains—*wheat*, *oats*, *barley*, *rye*, *rice*, *maize* or *Indian corn*, and *millet*; the leguminous seeds—*peas*, *beans*, and *lentils*; the cupuliferous seeds—*chestnuts*, etc.; and the oily seeds or nuts—*almonds*, *walnuts*, *hazel-nuts*, *butternuts*, *filberts*, *cashew-nuts*, *cocoa-nuts*, etc.

The most common alimentary fruits are the drupaceous or stone fruits—*peaches*, *nectarines*, *apricots*, *cherries*, etc.; the pomaceous fruits—*apples*, *pears*, *quinces*, etc.; the baccate or berried fruits—*currants*, *gooseberries*, *whortleberries*, *cranberries*, *grapes*, *elderberries*, etc.; the aurantiaceous fruits—*oranges*, *lemons*, *limes*, *citrons*, *shaddocks*, etc.; the curcubitaceous fruits, pepones, or gourds—*cucumbers*, *melons*, *squashes*, *pumpkins*, etc.; leguminous fruits, legumes, or pods—of the *tamarind*, *bean*, etc.; the synochus fruits—*figs*, *tomatoes*, etc.; the sorosis fruits—*mulberries*, *pine-apples*, etc.; the etæno fruits—*strawberries*, *raspberries*, *blackberries*, etc.

In the order of roots, tubers, and subterranean stems, we have the *potato*, *turnip*, *carrot*, *beet*, *parsnip*, *artichoke*, etc.

Among buds and young shoots we find *onions*, *leeks*, *garlics*, *shallots*, *asparagus*, etc.

Leaves and leaf-stalks furnish us *cabbage*, *spinach*, *cauliflower*, *broccoli*, *cowslips*, *milkweed*, *turnip tops*, *potato tops*, *dandelion tops*, *let-*

tuce, mustard tops, endive, water-cress, common cress, celery, rhubarb, sorrel, plantain, etc.

Of the receptacles and bracts, the flower-heads of the garden artichoke are the best known.

The stems of several palms yield a farinaceous food, as sago. The pulpous stems of a *fern-tree* in New Zealand are eaten, and esteemed an excellent vegetable.

The tuberous rhizomes of ferns, in Polynesia and other parts of the world, yield a farinaceous matter, which is occasionally employed as food.

Many lichens, of which *Iceland moss* is the most familiar example, are used dietetically and medicinally.

Several species of algæ or sea-weeds—*Irish moss, Ceylon* or *Jafna moss*, etc., are also employed both as food and medicine.

Several species of the fungi or mushrooms are considered edible. The best known among them are the *field mushroom, boletus, morel, truffle, pepper dulse*, and *tangle.*

Of the *cereal grains* wheat and rice are the most extensively cultivated. Although they possess about an equal amount of alimentary properties, the wheat is far superior as a single article of diet. Those who employ a diet mostly of rice require a larger proportion of succulent fruits, or watery vegetables, or ligneous matter, as leaves, roots, etc., than those who subsist principally on the whole grain of wheat, for the reason that the latter contains in the bran a much larger proportion of lignin. But even wheat is too nutritious and concentrated of itself, and requires the admixture of a due proportion of fruits, or other succulent and, comparatively, innutritious vegetables.

It appears to be a confirmed habit among dietetical writers and medical practitioners to write and speak of animal food, as compared with bread and other preparations of the grains, as being more "nourishing," more "substantial," etc., in the face of all human experience and all chemical investigation, which prove the latter to contain at least three times as much nutriment in a pound as can be obtained from the best flesh-meat. Those tribes of men, laborers, hunters, etc., who subsist almost wholly on flesh, fish, or fowl, devour on the average about seven pounds per day; while those persons in similar circumstances and occupations who subsist almost exclusively on farinaceous vegetable food, eat but little more than one pound. In fact, the quantities of animal food consumed by some human beings, who are carnivorous in practice, seem almost incredible. Captain Parry relates the case of an Esquimaux *lad*, who, at a meal which lasted *twenty hours*, consumed 4 lbs. raw sea-horse flesh, 4 lbs. broiled ditto, 1½ pint gravy, besides 1¾ lbs. bread, 3 wine glasses raw spirits, 1 tumbler strong grog, and 9 pints of water. Captain Cochrane states, in a "Narrative of Travels through Siberian Tartary," that he has repeatedly seen a Yakut or Largouse eat forty pounds of meat in a day! It is stated that the men in the service of the Hudson's Bay Company are allowed the daily rations of seven or eight pounds of ordinary flesh-meat.

The world is full of examples of laboring individuals, even in cold climates, subsisting on coarse bread, not exceeding the average amount of one pound of wheat, rye, or corn daily; and the millions of China and India subsist on much less than that quantity of rice, with only animal or other food enough to amount to a condiment or seasoning.

For the purpose of making *raised* or *fermented* bread, wheat is superior to all other grains, on account of its large proportion of gluten. The wheat of hot climates, as a general rule, contains more gluten than that of cool climates. The Southern or *red wheat* of this country is more glutinous than the Western or *white wheat;* hence the Southern flour is called *stronger* by the bakers, and is capable of being puffed up into the largest, and, for the manufacturers, the most profitable loaf. Wheat also proves more palatable to a majority of people in its various forms of preparation than any other grain. Boussingault gives the following analysis of wheat, rye, and oats, which makes them almost identical in chemical constituents. The other grains cannot differ essentially from these:

Ultimate Elements.	Wheat.	Rye.	Oats.
Carbon,	46·1	46·2	50·7
Hydrogen,	5·8	5·6	6·4
Oxygen,	43·4	44·2	36·7
Nitrogen,	2·3	1·7	2·2
Ashes,	2·4	2·3	4·0
Total,	100·0	100·0	100·0

The proximate constituents of the grains are: *Starch, albumen, fibrin, gluten, mucin, sugar, gum, oil, lignin, earthy phosphates,* and *water.*

The methods by which wheat is prepared for the table are very numerous. The *very best* is unquestionably the *unleavened wheat-meal bread.* The yeast *brown bread* ranks next in wholesomeness. *Fine bread,* made of flour, with the addition of a quantity of rye-meal, or coarse-ground Indian meal, or both, is an excellent article. The common *superfine bread,* especially as prepared for the market by the bakers, is the lowest order of bread-kind in the scale of healthfulness. All the bakers' bread with which I am acquainted—and I have examined it very extensively—is over-fermented, by which much of the starch as well as the sugar is destroyed, and more or less of the gluten decomposed, and converted into acetic acid, which acid is neutralized by ammonia, or other alkaline matters. This is the reason that stale bakers' bread is so unpalatable after it is fairly cold, while good domestic bread preserves its sweetness and flavor for a week or two. Universal experience as well as physiological science pronounced all *fresh* fermented bread unwholesome. Fermented bread is never fit for the stomach until it has been twelve hours from the oven, and is not in its best condition under twenty-four hours. There are two reasons why new bread, when fermented, is prejudicial to the digestive organs. Its texture being soft, spongy, and adhesive, it is not well masticated and insalivated; and again, the process of fermentation not only develops the carbonic acid gas which raises the dough, but also converts a small portion of the elements of the saccharine matter into alcohol; this alcohol is probably not perfectly dissipated by the heat of the oven, nor until the bread has been many hours from it. To make the best bread it is essential to have a good article of flour—if fresh-ground the better—fine, fresh, sweet yeast; the dough must be well kneaded, so as to diffuse the yeast equally through the mass; the loaf must be placed in the oven the precise moment when it is sufficiently light, or it will be *heavy* from deficient, or *sour* from excessive fermentation, and baked in a brick oven from an hour to an hour and a half, according to the size of the loaf. Very good yeast bread may be baked in a stove or kitchen-range by observing carefully all the above conditions.

Wheaten grits (cracked wheat), an article rapidly getting into popular favor through hydropathic auspices, simply boiled, make an excellent dish, seasoned with a little sugar or milk. For children there is nothing in the world superior, from the very moment they are able to take any food except the mother's milk. I know it will almost horrify some good mothers and kind nurses to be told that cracked wheat, "bran and all," is proper aliment for the delicate, susceptible stomachs of little infants; while many a college-bred M.D. is ready to declare that such coarse, rough, *scratchy* food is enough to tear its tender bowels all to pieces; and I know, too, that the great "standard authors" of the medical profession, and all their little echoes throughout the country, proclaim the bran part a "mechanical irritant;" and yet I know the assertion I make to be true. Let those who oppose this kind of diet for children, if they can, give some *rational* reason why thirty children per week in the city of New York die of the disease called *convulsions*, a disease whose almost exclusive cause is obstruction, or constipation, and this condition being almost universally produced in them by the various preparations of fine flour. *Farina*, formerly called *pearl wheat*, contains more of the ligneous, or branny property, and is hence far preferable to fine flour for mush or pudding. *Semolina*, *soujee*, and *mannacroup*, are also granular preparations of wheat similar to farina, considerably employed in England. *Maccaroni*, *vermicelli*, and *caglivari paste*, are pasty preparations of wheaten flour. *Hot rolls* are rendered tender and brittle by excessive fermentation, but are, for the same reason, very indigestible and unhealthful. *Rusks*, *tops*, *bottoms*, *buns*, etc., are fermented, and for the same reason unhealthful when fresh; they are also less digestible from the additions of butter, sugar, and milk. *Gingerbread* is made extremely light by means of carbonic acid gas, but the combination of *flour*, *treacle*, *butter*, *alum*, and *potash* is a serious objection to its wholesomeness. The common *sea-biscuit*, or *ship-bread*, is made of either wheat-meal, or flour containing a considerable proportion of bran, simply mixed with water, and baked. It is hard and compact, and very wholesome. *Wheat-meal crackers (Graham crackers)* when made without shortening, and not over-fermented, are a good article for exercising the teeth, and promoting the salivary secretion.

Cakes, in almost endless variety, are made of superfine flour, butter, lard, sugar, eggs, with spices, essences, fruits, or alcoholic liquors, for seasonings. Of course they are pernicious, as a general rule, according to their complexity. *Plum-cake* is a fair specimen of the average character of the cakes of cook-books and popular recipes. All dietetic writers of any respectability agree as to its unfitness, while the common *fruit-cake* and *wedding-cake* are as universally regarded as exceedingly indigestible trash. *Pancakes*, or *fritters*, are fried in hog's lard. *Griddle-cakes*, made of wheat-meal, or of flour and Indian meal, or of rice or buckwheat, are a tolerable article, provided they are cooked on soapstone griddles without grease. A very palatable and comparatively wholesome cake may be made of wheat-meal, sugar, and sweet-cream, or good rich milk in place of the cream. Those who become accustomed to unbolted farinaceous food, will generally prefer this kind of cake to that made of fine flour, even as a matter of taste.

Puddings are sometimes made of wheaten flour; but no form of boiled flour can be very digestible or wholesome. *Bread puddings* are the best of these preparations; *hasty* and *batter puddings* next in the descending scale. The *plum* or *suet pudding* is one of the most pernicious compounds ever invented; it is generally made of bread crumbs, currants, raisins, beef suet, salt, citron, eggs, sugar, mace, and nutmeg, and eaten with butter, sugar, and wine for sauce. *Dumplings* are another form of boiled flour and fruit; they can be made so as to be tolerably light and digestible, but as usually served up at refectories they tax the digestive powers very severely.

Considerable attention has of late years been given by bread-makers to various methods of manufacturing raised bread without yeast; employing in its stead acids and alkalies, usually hydrochloric acid and sesqui-carbonate of soda. If the proportions of these articles are exactly balanced, and their admixture with the dough carefully managed, the acid, uniting with the alkali, forms common salt, while carbonic acid gas, without leaving any free acid or alkali, is set free to raise the dough. A variety of other experiments have been tried in this country and in England, but I believe they have never succeeded in realizing quite as good an article as can be made with the best of yeast, skillfully managed. Two years ago one of our city bakers commenced the manufacture of bread raised with an acid and alkali. The baker conscientiously supposed his article to be more wholesome than the ordinary fermented bread, but wishing to be well assured of the fact, he submitted specimen loaves to the medical gentlemen of the New York Academy of Medicine, requesting a professional opinion concerning its hygienic character. The Academy referred the matter to a special committee, but there it rested; and notwithstanding the urgent importunities of the manufacturer, the Academy has not even yet seen fit to express any opinion.

Oats have been extensively used as food by the people of Scotland and the northern parts of England, and to some extent in this and other countries. The entire seeds of oats contain, in 100 parts, about 66 of meal to 34 of husk. 100 parts of dried oatmeal yielded, according to Dr. Christison's analysis: *Starch* 72·8, *sugar and mucilage* 5·8, *albumen* 3·2, *oily-resinous matter* 0·3, *lignin, or bran* 11·3, and *water* 6·6. *Oatmeal* is prepared by grinding the kiln-dried seeds, deprived of their husk and outer skin. *Groats* are the grains deprived of their integuments.

Oatmeal is usually employed in the form of *mush*, *porridge*, or *stirabout*, prepared by simply boiling in water, and *oat-bread*, or *oat-cakes*, made by rolling the dough into very thin cakes, and baking it before the fire, or in a stove or oven. These preparations are more wholesome than those of fine wheaten flour, because they contain a larger proportion of lignin, or bran, and are hence more laxative, or rather less constipating. Persons unaccustomed to oatmeal sometimes complain of acidity after eating it; but such a result may occur on first eating any kind of grain to which the stomach has not been habituated;

it is, however, more frequently noticed with respect to rye and corn than the other grains.

Barley is but little used as human food in modern days, the breweries converting nearly the whole crop of the world into the poisons called *malt liquors*. It is, however, far from being the most inferior of grains, either in chemical constituents or physiological properties. The *seeds* of barley contain, in 100 parts: Meal 70·05, husk 18·75, water 11·20. 100 parts of *barley-meal* yield: *Starch* 67·18, *fibrous matter* 7·29, *gum* 4·62, *sugar* 5·21, *gluten* 3·52, *albumen* 1·15, *phosphate of lime with albumen* 0·24, *water* 9·37.

Various preparations of barley are in repute for the sick-room. Pereira considers *barley-water* as a "*light, mild, emollient, demulcent* liquid, *slightly nutritive*, and very *easy of digestion*;" a rare combination of medicinal virtues, truly, for steeped seeds of grain to possess! Less learning would be displayed, but more intelligence communicated, by calling the water in which a little barley-meal had been boiled *diluent* and *nutritive*, the former being the property of the water, and the latter the property of the grain. *Scotch, hulled*, or *pot barley*, is the seeds deprived of their husks; and when these seeds are rounded and polished they constitute *pearl barley*. *Patent barley* is the farina obtained by grinding the pearl barley to powder. Barley contains too small a quantity of gluten to make good bread by panary fermentation.

Rye is considerably employed as food among the inhabitants of northern Europe, and in New England. In Germany and Sweden it is the principal ingredient in bread. The entire *seeds* of rye yield, in 100 parts: *Meal* 65·6, *husk* 24·2, *water* 10·2. *Rye-meal* contains, in 100 parts: *Starch* 61·07, *gum* 11·09, *gluten* 9·48, *albumen* 3·28, *saccharine matter* 3·28, *husk* 6·38. *Rye-meal* mush is somewhat more laxative to persons unaccustomed to it than wheat-meal mush, and is a valuable food in constipation and torpid bowels.

Buckwheat is sometimes employed in bread-making. In Germany and France it is in common use for pottage and puddings; and in the United States it is extensively cultivated, and eaten in the form of griddle-cakes. It is not in itself objectionable; but the melted butter and sugar with which buckwheat cakes are seasoned, and the burned grease used in cooking them render them exceedingly noxious. The *itching* and *skin diseases* generally attributed to buckwheat, are really chargeable to its accompaniments—pork gravy, sausages, butter, sugar, etc.

Rice is the principal grain of India, China, and most Eastern countries. It is also extensively cultivated in the West Indies, Central America, the southern countries of Europe, and the southern parts of the United States. The composition of *Carolina rice* is, according to Braconnot, in 100 parts: *Starch* 85·07, *woody fibre* 4·80, *glutinous matter* 3·60, *oily matter* 0·13, *sugar* 0·29, *gum* 0·71, *phosphate of lime* 0·40, *water* 5·00, with traces of *acetic acid*, *phosphate of potash*, *chloride of potassium*, and *vegetable salts of potash and lime.*

In nutritive properties rice does not differ materially from wheat, although it is much less adapted to prolonged nutrition as an exclusive article of diet, because of its small proportion of lignin or bran. From the fact that the cholera first appeared in a rice-growing country, and has prevailed extensively in countries where this grain is the principal food of the inhabitants, a suspicion has arisen that a rice diet was among the causes of cholera. Although a rice diet alone would be incapable of producing such a disease, there can, I think, be hardly a question that a diet almost exclusively of rice would produce a predisposition, enabling other sources of impurity and debility readily to develop the disease. In fact, this principle is fully illustrated by the phenomena of cholera and bowel complaints as they appear in this country. The ordinary employment of concentrated farinaceous foods with us (food containing too small a proportion of what is called innutritious matter, to keep the excretories free and unobstructed) absolutely produces a general predisposition to bowel complaints, only requiring some disturbing agent of the nature of an exciting cause, to induce diarrhea, dysentery, cholera morbus, cholera infantum, inflammation of the bowels, or Asiatic cholera, according to the combination of all the predisposing and exciting influences. Obstruction, constipation, irritation, and inflammation always result, unless due relations between bulk and nutriment are maintained in our aliments; and hence the more concentrated or nutritive the grain or flour we employ, the greater should be the proportion of the less nutritious vegetables and succulent fruits. An immense amount of disease, suffering, decrepitude, and premature death result from a misunderstanding of, or inattention to, this simple and obvious principle; and the advice emanating from medical men, boards of health, medical councils, etc., in cholera seasons, recommending the people to abstain from fruits and vegetables, and eat principally rice, superfine flour, dried beef, smoked herring, etc., has destroyed many lives and saved none.

The best preparation of rice is that of simple *boiling*; it should not be stirred sufficiently when cooking to break up or mash the seeds. *Rice, milk*, and *sugar* make one of the best plain puddings. *Rice griddle-cakes*, which contain eggs and sugar, are somewhat offensive to all stomachs, and especially so to dyspeptics.

The various remarks which medico-dietetical writers have perpetrated concerning the nature of rice as an aliment, afford some amusing examples of the loose and thoughtless manner in which men may reason when they have no settled principles to reason from or upon. Thus says Dr. Dunglison, in allusion to the constipating effects of rice upon the bowels: "Perhaps the cause of its having astringent properties assigned to it is its *long retention* in the stomach when that organ is debilitated. This is probably owing to its possessing but little *stimulating power*." Was ever greater nonsense uttered! Again, says Dr. Dunglison: "Formerly the idea prevailed that rice, *when habitually eaten*, is possessed of poisonous properties"—as though its *nature* depended on whether we eat it constantly or occasionally! Bontius thought that the use of rice tended to the production of blindness. Probably he was not aware that disordered vision, giddiness, etc., is a very common effect of too concentrated food and of excessive alimentation in all countries.

Maize or *Indian corn* is extensively employed as food in America, Asia, and some parts of Europe. Its proximate composition in 100 parts, as analyzed by Dr. Gorham, is: *Starch* 77·0, *zeïn* (a substance somewhat resembling gluten) 3·0, *albumen* 2·5, *gum* 1·75, *sugar* 1·45, *extractive matter* 0·8, *cuticle and ligneous fibre* 3·0, *phosphate*, *carbonate*, and *sulphate of lime*, nearly 1·5, *water* 9·0. In nutritive power and wholesomeness maize is but little inferior to wheat. It has not enough of the glutinous property to make light loaf bread alone, but makes an excellent bread with the addition of a portion of wheat-meal or wheaten-flour. The *coarse-ground* meal is incomparably superior to the fine-ground for all cooking purposes. *Samp* is made by boiling the broken grains until soft; *hominy* is a preparation of the grain between samp and meal; and *Indian mush* is the boiled meal. These are all excellent dishes as a part of a dietetic course. *Corn*, *Indian*, or *Johnny cakes* are made by wetting the meal with water, or milk, or both, and baking in a stove, oven, or before the fire. The Indian method of baking under hot ashes is, for healthfulness, still better. Sometimes these cakes are sweetened and raised with *sour milk* and *bi-carbonate of soda*. This preparation is not as wholesome as the former, but far superior to most of the *sweet-cakes* made of fine wheaten flour. *Saleratus* is very generally employed in this country in nearly all kinds of Indian or wheaten cakes, but it is a most pernicious article. For *plain puddings* the coarse Indian meal, or hominy, is the best article, excepting, perhaps, wheaten grits and rice. Milk and sugar are all the seasonings wanted to make as rich a pudding as human appetites *ought* to desire.

Our New England mothers and grandmothers had a method of making a most delicious and salutary bread, without raising or fermentation, in which Indian meal was the chief ingredient. Due portions of the meals of corn, rye, and wheat were kneaded into a rather soft dough with water or milk, and *baked all night* in an iron bake-kettle, which was well covered with coals and hot ashes. In the morning an article "fit for a king" and all other "lords of creation," was brought forth from the baker. Such mothers would be godsends to the puny children of this degenerate age.

Dr. Lee says: "A pound of corn, when cooked, makes from two and a half to three and a half pounds of food, and this will suffice for the daily support of a laboring man. If an individual could be supported on this alone, his annual expense for food would be but $3 65, or say $15 to a family of five. The average cost of potatoes may be put at about half a cent a pound, and allowing five pounds per day to an adult individual, the expense will be about $9 a year. When we consider that it is not unusual for land to yield one hundred bushels of corn to the acre, or thirty tons of potatoes, we may form some estimate of the population which this country is capable of supporting from the produce of the soil."

We may see the munificence of the Creator, in making provision for all our *natural* wants, in a stronger light by varying the calculation. Let us suppose an acre of land planted with corn, half an acre with potatoes, and good apple-trees surrounding the whole—all to be in the best state of cultivation. We would then have a combination of foods capable of fully sustaining the organism in its highest integrity; and nutrition enough from an acre and a half to sustain at least thirty human beings.

Millet or *hirse* is less employed than any other cereal grain. It is cultivated in some places as a garden plant, and used in cooking puddings, seasoning porridge, etc.

Peas, beans, and *lentils* possess nearly the same proportions of ultimate chemical constituents as the cereal grains. In proximate composition they are more oily and amylaceous. They are most digestible when green and fresh. When dried and old they produce more or less flatulence, and sometimes colic in persons accustomed to a concentrated or stimulating diet. This objection, however, is generally soon overcome in those who adopt a plain and correct dietary system. Not a little of the indigestibility charged upon the luginninous seeds is justly due to the grease, butter, and seasonings with which they are usually cooked and served.

The *nuts* or *kernels* are generally oily, and, to most stomachs, indigestible. The chestnut, however, contains no oil and when cooked is pleasant and considerably nutritive; it is employed as a staple article of food in some countries. It is at least probable that all, or nearly all, of the nuts are in themselves natural and wholesome food; their indigestibility resulting from the abnormal state of the digestive organs we have produced by our artificial and enervating habits of life. *Bitter almonds*, though extensively used by cooks and confectioners, contain poisonous properties; the volatile oil obtained from them is a more potent poison than Prussic acid.

At the head of the *fruit kingdom* stand the apple-tree and the grape-vine. Many other fruits are as wholesome in their season, and some are more nutritive, but none are so hardy and enduring, nor capable of such extensive cultivation. The varieties of the apple that can be produced are almost innumerable. The sweet, subacid, and mealy kinds are the most nutritious. If well grown and fully ripe they may be eaten in the raw state, roasted, or baked, with nearly equal advantage as a part of the meal, or they may be stewed and sweetened. They can also be preserved by drying, or in their own inspissated juices, the year round.

Unfortunately, grapes are cultivated much more for the purpose of manufacturing intoxicating wine, than for human sustenance. An argument in favor of this use, or rather abuse, of the fruit of the vine, has been predicated on the opinion somewhat prevalent, that wine-growing countries were the most temperate ones. But Dr. Bell, M. Villerme, M. Perier, Mr. Bulwer, and other standard writers, have shown this opinion to be an error. In France nearly one thousand millions of gallons of alcoholic drinks were consumed in 1830, of which wine constituted more than half. Several Americans who have resided in Paris testify that "drunkenness is the prevailing curse of the laboring classes of France."

Of the different varieties of grapes the *Isabella* and *catawba* are more generally cultivated in this country; the former of these is most common in our markets, and most highly esteemed. Dried grapes are called *raisins*. The *muscatels* and *blooms* are sun-dried. Sometimes the grapes are dipped in a mixture of water, ashes, and oil, and afterward sun-dried, by which treatment the juice exudes and candies on the fruit. The *small* or *Corinthian raisin* is the *black currant* sold at our groceries.

There is an old adage which says, "Fruit is gold in the morning, silver at noon, and lead at night." The proverb is founded more in our artificial habits than in nature. Those who are accustomed to a plain vegetable diet can take fruit with equal pleasure and profit at either meal. But stomachs weakened by enervating drinks or concentrated aliments can tolerate fruits much better in the fore part of the day.

The opinion is common that the fruits produced in different climates or localities are most suitable for the inhabitants residing there. Unquestionably this is true so far as quality and maturity are concerned; for most kinds of fruit being exceedingly perishable, are of necessity gathered before fully ripe, when they are to be transported on long voyages. For this reason many of the peaches and strawberries brought to the New York market are far inferior, both in flavor and dietetical virtues, to those picked and eaten where they are raised.

Almost all persons can use nearly all sorts of fruits in our markets, excepting, perhaps, the very acid kinds, with freedom and advantage. providing they are well grown, perfectly ripe, and are eaten only at meals. Those persons with whom they *seem* to disagree should gradually accustom themselves to their employment—eat a very little at first, and increase the quantity as the stomach will bear. We have many varieties of *pumpkins* and *squashes*, which are not only excellent for pies, but make a delicious sauce. The only cooking they require is to be well boiled. As a general rule, those of the firmest, heaviest texture are the best flavored and most nutritious.

Of the edible roots the *potato* holds the first rank. It is nearly or quite as nutritious as the best flesh-meat, and in ultimate chemical composition is almost identical with the cereal grains, containing, in 100 parts: *Carbon* 44·0, *hydrogen* 5·8, *oxygen* 44·7, *nitrogen* 1·5, *ashes* 4·0. Its proportion of solid matter is 24·1 to 74·9 of water. The potato alone is capable of sustaining the prolonged nutrition of human beings, as has been verified by repeated experiments. *Potato starch* is extensively sold under the names of *potato flour*, *English arrow-root*, *corn starch*, etc. A mixture of potato starch and chocolate has been sold in England under the name of *Bright's universal sanative breakfast beverage.*

Two or three years ago Professor Mülder entered into a profound philosophical contemplation of the nature and properties of the potato, and came to the conclusion that its use, "as an article of food, was the principal cause of the physical and mental degeneracy of the people of those nations who employed it." The learned professor had undoubtedly mistaken the effects of intoxicating liquors, tobacco, and many other noxious agents, for those of the innocent potato.

The *Carolina* or *sweet potato* contains considerable saccharine matter, and is equally digestible and wholesome as the common or Irish potato, making due allowance for habit. When boiled until soft, but without destroying their shape, potatoes are probably more nutritive and wholesome than when prepared in any other manner.

Potatoes have long been celebrated as a preservative against the scurvy; and it has puzzled physicians exceedingly to determine in what particular part or element this antiscorbutic property resided. Some have ascribed it to citric acid. I am of opinion that this virtue resides equally in every part of the tuber, and that its preventive power in this disease is due to its healthfulness as an article of food, and not to any particular *medical* property. In fact, all good fresh fruits and vegetables are antiscorbutic.

With regard to the other esculent roots, *turnips*, *parsnips*, *beets*, *carrots*, etc., they are of but little value in an alimentary point of view, yet useful in preserving the due relations of bulk and nutriment with those who partake of a large proportion of farinaceous food. To most stomachs they prove more or less flatulent, but this depends very much on the vigor of the digestive powers, and the other dietetical habits. A perfectly healthy stomach can manage them without any difficulty.

Of the cruder vegetable products the *cabbage* is the most nutritive. It contains considerable nitrogen as well as sulphur. An Edinburgh physiologist—Dr. Johnson, I believe—has lately "discovered" that it possesses more muscle-making property than wheat; but his inference is drawn from the mistaken opinion that foods are nutritive to muscular tissue in proportion to the nitrogen they contain. As cabbage contains more than ninety per cent. of water, its nutritive power must be less than ten per cent., while we know wheat possesses from eighty to ninety per cent. of nutriment.

Pot-herbs, including *cabbage*, *spinach*, *asparagus*, and a variety of *leaves*, *leaf-stalks*, *stems*, *young roots* and *shoots*, *receptacles*, *bracts*, *flowers*, etc., are generally grateful and wholesome; always so to healthy stomachs. If they ever prove injurious, it is from the melted butter, oil, vinegar, etc., with which they are too often cooked and eaten. These aliments, too, prove flatulent to many stomachs; and the rule already mentioned is applicable to these and all other crude and watery vegetables. Delicate stomachs must get gradually accustomed to their use, if they would avoid unpleasant effects. *Salads* are usually eaten with mustard, vinegar, pepper, salt, and oil, and are objectionable mainly on account of the seasonings. *Lettuce* contains the narcotic principle of opium, and is injurious on that account.

Most of the fruits herein mentioned, and some of the vegetables, are employed in making pies and pastry. As usually prepared by the baker, they are of course exceedingly pernicious, for however delicious and wholesome the fruit of itself may be, the crust is far otherwise. But excellent, and delicious, and even healthful pies can be made of the mild-flavored or sweet fruits, simply sweetened, with a crust of wheat-meal or fine flour, shortened with potatoes, and seasoned with new milk or sweet cream.

Condiments, or *seasonings*, though not in any sense alimentary substances, are so commonly employed with almost all articles of food, that they deserve a moment's notice in this connection. Those in general use, in addition to salt and vinegar, already discussed, are *mustard*, *cayenne*, *black pepper*, *allspice*, *cinnamon*, *cloves*, *mace*, *nutmeg*, *horse-radishes*, *ginger*, etc.; various other pungent and spicy substances are frequently employed. They all tend to blunt the organic sensibilities, and the more acrid are extremely irritating to the whole mucous surface. Though the majority of dietetical writers commend them, and nearly all medical writers declare them to be indispensable, I know of but one physiological rule in relation to them—*the less the better*. It is true that an appetite partially palsied by their use, cannot appreciate the flavor of aliments without them; and stomachs accustomed to digest under their irritation, will not at first work as satisfactorily in their absence, but the same rule obtains with regard to liquor, tobacco, or any other artificial habit. *Hunger* is the only natural sauce; and those persons who can summon moral and animal courage sufficient to abstain from acrid seasonings of all kinds, will find, in a short time, that the God of nature has made all the foods He has intended we should eat extremely palatable, without endowing them with any properties to provoke our appetites to the injury of the vital domain. He made the food savory enough for us to "eat to live;" if we over-season it, we may soon find ourselves too closely allied with those who "live to eat," to have pure appetites or sound health.

CHAPTER V.

OF TEMPERATURE.

VICISSITUDES OF WEATHER.—The wonderful power of the living organism to develop, maintain, and regulate its own heat, enables human beings to exist in great extremes of climate, and exposed to numerous and sudden vicissitudes of weather. Franklin, Parry, Ross, Back, and other northern navigators, have been exposed for months together to a temperature varying from 50° to 70° below zero, while in the oasis of Mourzouk, and many parts of the tropical zone, the thermometer often ascends to 130°. The maximum of heat noticed by travelers in various places is: Equator 101°, Cape of Good Hope 111°, Bassora 114°, Cairo 104°, Madras 104°, Pendicherry 112°, Paris 101°, Guadaloupe 101°, Surinam 90°, Martinique 95°, Vera Cruz 96°, Vienna 96°, Warsaw 93°, Copenhagen 92°, Petersburgh 87°, Iceland 69°. In New York city the thermometer has a range of about 100°, rarely, however, rising to 100°, and seldom sinking below 0. The changes of temperature in this climate frequently amount to 40° or 50° in twenty-four hours.

Generation of Animal Heat.—The more energetically the organic functions are performed, the more rapid is the generation of animal heat; hence the animals of cold climates, whose actions are vigorous, manifest a higher bodily temperature than those of hot climates, whose motions are more sluggish. The quadrupeds of the frigid zone are said to have a higher temperature than those of any other region of the globe; an arctic fox, killed in an atmosphere of 14°, was found by Capt. Lyon to have a temperature of 106¾.

Capacity to Endure External Heat.—The human body is capable of enduring for a considerable time a highly-heated atmosphere, when the air is dry. Mechanics whose occupations require it, often endure, without perceptible inconvenience, an elevation of 250° to 280°. Some workmen have entered the furnaces of iron-foundries while the floor was red-hot, and the thermometer stood at 350°. Chabert, the "Fire-king," was in the habit of entering an oven heated from 400° to 600°.

Artificial Heat.—As the human body is a self-regulating machine, within certain limits, as respects its temperature, it follows that all artificial means of supplying heat to the body can only be regarded as necessary evils. Fire relaxes and debilitates the skin and the whole system; yet in cold climates and seasons we have no better way of maintaining the requisite temperature of our rooms. These should always be warmed equally throughout every part, and the temperature kept as low as possible, consistently with comfort. The comfortable point of out-door air depends very much on the temperature we have previously been accustomed to; it also varies in different climates and seasons. In this country it ranges from 65° to 75°; but when the thermometer has been for some days between 90° and 100°, a depression of fifteen or twenty degrees imparts an uncomfortable sensation of cold; and in spring a sudden elevation from 30° or 40° to 75° imparts an oppressive sensation of heat. A room permanently heated above 55° to 60° can hardly be consistent with health, and a few degrees less is still better for most persons. Those who occupy rooms warmed by grates should never sit directly before the fire. Many persons have a habit of sitting with their faces close to a hot fire, but such habits are not only very weakening to the whole skin, but particularly injurious to the brain and nervous system.

Healthfulness of Climate.—It has been proved by ample experiment that the aeration of the blood is more rapid in cool or cold than in warm or hot air, owing to the circumstance that rarefied air contains less oxygen in the same bulk than cold air. But I cannot subscribe to the doctrine generally advanced in medical books that all warm climates, or even hot climates, are *necessarily* unhealthful. It is well known that bilious attacks, diseases of the liver, fluxes (as diarrhea, dysentery, and cholera), and some forms of fevers, are more prevalent in hot climates, especially among those who go from a northern to a southern latitude. But I think a better explanation can be found in another way. It is as well known that persons can endure, with apparent impunity, in a cold, bracing air, riotous living, excessive alimentation, constipating food, and many other erroneous habits, which will inevitably produce disease, and frequently death, in a hot, enervating atmosphere. The travelers who visit pestiferous Africa, the Englishmen who remove to the scorching suns of British India, and the Northerners who go to the sickly South, may find the true explanation of their liability to disease in their own dietetic errors.

Undoubtedly the more mild and uniform climates are most conducive to permanent health and longevity. Examples, however, are not wanting of individuals attaining the age of 165 in Russia, and of 200 in Arabia. Variable climates, like England and the United States, are more favorable to activity of mind and body—a rapid development of all the physiological and mental powers; yet that excess of action must sooner exhaust their vitality. Various parts of the United States have furnished numerous examples of centenarians, but I believe Joice Heath, who reached the age of 162, was the oldest person this country ever produced. Rev. Mr. Harvey delivered a temperance lecture in the Broadway Tabernacle in this city, in 1846, at the age of 114.

Common Colds.—"Catching cold" is usually attributed to a sudden transition from a warm to a cold atmosphere; but I believe more colds result from the contrary change—from a cold to a highly-heated atmosphere, especially the sudden change from a cold, out-door atmosphere, to the confined air of a hot room. I need not say that the body, when excessively cold, should be warmed very gradually. When very hot, however, the body is better enabled to resist extreme cold, and may be suddenly exposed to it with impunity, provided it has not been warmed by any debilitating process or agency, as hot, confined air, severe and exhausting exercise, etc. Colds are more frequently produced by *unequal temperature* than by extremes of either heat or cold. Thus, when a part of the body usually covered with clothing is exposed to a strong draught of air, when the rest of the body is protected with clothing or bedding, a cold is very easily caught. Again, a person accustomed to wear boots in the winter season, will often "take cold" by wearing shoes a few hours, even though he remain within doors, and his feet feel perfectly comfortable. Young ladies, at balls and parties, often make such changes in their clothing as to expose some parts of the body usually covered, as the neck, or cover some parts usually undressed, as the hands and head, or dress some parts thinly which have been accustomed to thicker clothing, the feet and arms, for example, by which the usual temperature of the body is unbalanced, and severe colds produced.

A very common way in which a severe cold, or a great disturbance of the body which is usually denominated a cold, is produced, is eating a very full evening meal after fasting all day, and then retiring soon after to rest, and sleeping in a warm room, or a room heated by hot air. The temperature of the apartment, aided perhaps by bad ventilation, relaxes the body, so that the stomach cannot relieve itself of its burden, and in the morning the sufferer awakes, if indeed he has slept, feverish, sore, and inflammatory, and with all the manifestations of a hard or confined cold.

It is also to a crowded state of the stomach, as much perhaps as to the relaxing temperature and bad air, that the colds so generally following balls and dancing assemblies are to be attributed. The viands at these parties are all so prepared as to tempt the appetite to excessive indulgence, when the state of exhaustion requires exactly the opposite —fasting, so that the muscular system may have its due supply of nervous energy for the restoration of the motive powers.

Those who are exposed to cold, pure, out-door air, may eat very intemperately, as respects both quality and quantity, and suffer but very little, compared with those who commit the same error in the enervating atmosphere of a crowded assembly, when the body is in a state of exhaustion, the whole muscular system relaxed, and the digestive powers proportionately

Mean Temperatures.—The following table of mean temperatures has been compiled from meteorological registers:

Places.	Latitude.	Mean Temperature of several years.	Mean Temperature of different Seasons.				Mean Temperature of	
			Winter.	Spring	Summer.	Autumn.	Warmest Month.	Coldest Month.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
New York	40.40	53.78	29.84	51.26	79 16	54.50	80 78	25.34
Philadelphia	39.56	53.42	32.18	51.44	73.94	56.48	77.00	32.72
Washington, D. C.	38.53	55.56	36.80	53 83	75 90	56.59	79.13	34 66
Cincinnati	39.06	53.78	32.90	54.14	72.86	54.86	74.30	30.20
Charleston, S. C.	32.47	60.18	51.09	66.73	80.89	67.55	82 81	49.43
Natchez, Miss.	31.34	64.76	48.56	65.48	79.16	66.02	79 70	46 94
St. Augustine, Fl.	29.48	72.23	59.29	71.47	82.73	75.15	83 94	56.60
Vera Cruz	19.11	77 72	71.96	77.90	81.50	78 62	81.86	71.06
Havana	23.10	78.(8	71.24	78.98	83.30	78 98	83.84	69.98
Barbadoes	13.10	79 03	76.07	79.00	81.00	80.00	91.00	65.0
Cumana	10.27	81.86	80 24	83 66	82.04	80.24	84 38	79.16
Quebec, L. C	46.47	41.74	14.18	38.84	68 00	46.04	73.40	13.81
Eastport, Me.	44.54	42 44	23 44	38.58	60 54	45.43	63.52	20.91
Nain, Labrador	57.08	26.42	0.60	23 90	48 38	33.44	51.80	11.20
Newport, R. I.	41.30	51.02	33.82	46 87	68.70	53 83	71.46	32 14
Geneva	48.12	49.28	34.70	47.66	64.94	50 00	66,56	34 16
Paris	48.50	51.08	38 66	49.28	64.58	51.41	65.30	36.14
Florence	43 46	59 00	44.30	56.00	74.00	60 70		
Rome	41.53	60.40	45.86	57.74	75.20	62.78	77.00	42.26
Madeira	32.37	64.56	59 50	62.20	69 33	67.23		
Algiers	36 48	69.98	61.52	65.66	80·24	72.50	82 76	00.08
London	51.30	50.36						
New Orleans	30.	69.01						
St. Louis, Mo.	38.46	55.86						
Jamaica		80.06						

CHAPTER VI.

OF EXERCISE.

Necessity for Exerise.—To secure the full and perfect development of the body, nature has implanted among the mental propensities a special organ of motion. The phrenological organ of "mirthfulness," or "playfulness," seems to be intended to secure this end, by prompting to frequent, free, active, and vigorous exercise. Young animals, especially of the mammiferous class, manifest this disposition very early; and young children must have their frequent "play-spells," or be sick—there is no alternative. I am disposed to believe that it is impossible for a healthy adult to be otherwise than active in body or mind, or both, and that *laziness* is actually a disease, dependent on some abnormal condition of the organism.

It is true that a variety of social circumstances may operate to produce an indolent disposition of mind and inactive habit of body, as extreme poverty, excessive wealth, grinding servitude, tyrannical government, etc.; but all these also produce a primary condition of ill health. So of personal habits, dissipation, gluttony, dietetic errors, or unhealthful voluntary habits in other respects; they all conduce to the production of a morbid condition.

Nothing is more discouraging to the future prospects of a young child than a disposition to sit still, be quiet, keep out of mischief, etc. Such children may give the nurse and schoolmaster but little trouble in keeping them "out of the way;" but in after life their parents may find it somewhat troublesome and expensive to provide them attendants and doctors.

Physiology of Exercise.—The function of respiration, by which the blood is vitalized, and the nutrition of the muscular structure, on which depends all the motive power or strength of the system, are intimately connected with the circulation of the blood, and this with active exercise. This principle is well illustrated in the effects of gymnastics and training, by which the muscles of any part of the body are remarkably invigorated by regular, systematic exercises. People of all trades and occupations find those parts of the muscular system which are habitually the most exercised to be the most powerful. Thus farmers have the whole muscular system nearly equally developed; blacksmiths, joiners, carpenters, sailors, etc., have strong arms and chests; travelers, dancers, etc., are disproportionately developed in the muscles of the lower extremities; shoemakers, tailors, etc., have a tolerable development of the arms and chest, but suffer in the lower extremities and abdomen; merchants, clerks, and others who pursue an easy, in-door occupation, have slender muscles generally; and professional men, whose exercise is more intellectual than bodily, exhibit large brains, with slender muscles.

Varieties of Exercise.—For hygienic purposes there are many exercises equally advantageous. All that is necessary is that all parts of the body be actively and frequently exercised, within the bounds of not producing fatigue amounting to exhaustion; that is to say, a degree of fatigue which is not readily recovered from on resting. All exercises, however, to secure their full benefit, should be coupled with an object of either utility or amusement, otherwise the mind is apt to labor adversely to the body. Occupation—some useful business pursuit, which requires and hence secures attention and labor during several hours of each day—is absolutely essential to the highest sanatory condition of the body, for nothing else will insure so constant, regular, and equally divided exercise for both body and mind.

Amusements and plays could be advantageously alternated to vary the monotony of the exercises; and indeed social and family recreations would constitute prominent features of all physiologically regulated neighborhoods. Among the active exercises which may be beneficially resorted to as pastime, are *walking*, *running*, *leaping*, *dancing*. *Boxing* and *fencing* are physiologically adapted to expand the chest, and, in fact, strengthen the whole muscular system, but they are too closely associated with pugilism, and barbarism, and brutalism to be recommended, especially as many other exercises are equally beneficial. *Wrestling* is a dangerous method of developing the muscular power. *Ten-pins*, *billiards*, etc., are excellent exercises physiologically, but no better than *sawing wood*, *planing boards*, *digging potatoes*, *hoeing corn*, *raking hay*, etc., etc. *Singing*, *declaiming*, *reading aloud*, are admirable methods of cultivating the vocal powers, and increasing the capacity of the respiratory apparatus. *Riding on horseback* is one of the best exercises in cases of weak digestive powers, as is also riding in a carriage without springs over a rough road, or street paved with cobble stones. *Hunting* and *fishing* are highly recommended by some hygienic writers, but the ideas of gormandizing, and the exhibitions of cruelty with which they are associated, are hardly becoming a refined, enlightened, and Christian people. Such amusements are more appropriate to *savage* than to civilized life.

Of the passive kinds of exercise, *riding in easy carriages*, *sailing*, *swinging*, etc., they are rather to be regarded as mere amusements, or as expedients for the invalid. They are highly serviceable, and, indeed, indispensable to such valetudinarians as have not strength to get a sufficiency of the out-door air without them.

Exercises of Children.—Our social organization is very defective in its provisions for the appropriate exercises of infants and young children. The *cradle* is a most unphysiological method of exercising a child to sleep; its primary object was to save the nurse trouble, but a child accustomed to be rocked to sleep will give the nurse more trouble in the end than one accustomed to sleep without such assistance. The motion of the cradle, too, is injurious to the brain and nervous system. The modern "baby-jumper" is a better contrivance, but even this can be advantageously superseded by giving the child "the largest liberty" to exercise in its own way. Plenty of room, a smooth floor, and a plentiful supply of any kind of "playthings" which are not dangerous—India-rubber balls, baskets, brooms, rattle-boxes, etc.—afford the opportunities which a child will always improve to the best possible advantage. Unfortunately, among the poorer classes of our cities young children are kept in stupid inactivity, simply because they have no room to stir; and this confinement makes them sickly, puny, peevish, and finally indolent.

Times for Exercising.—In regard to the times for exercising, the common instincts of mankind have generally guided them correctly. The most severe and active exertions should never be performed on a full stomach, nor immediately before or after a meal. The best hygienic regulation for a laboring or business man, who takes three meals a day, and is regular in his habits of retiring at night and rising in the morning, is to exercise moderately an hour or so before breakfast, perform the severest labor between breakfast and dinner, and work moderately again between dinner and supper. Much evening work is a violation of "the natural order." Persons of sedentary occupations should choose such exercises as they can habitually and regularly attend to, all of which should be as much out-door as possible. Their most active exercises should take place on first rising in the morning, and at other times of day when the stomach is partially empty. Vigorous evening exercises are also suitable for them.

"Nature lives by toil;
Beasts, birds, air, fire, the heavens and rolling worlds,
All live by action; nothing lies at rest
But death and ruin."

CHAPTER VII.

OF SLEEP.

General Observations.—Sleep may be defined—the periodical suspension of all the functions of external relation. The constitutional relation of man to the changes of the seasons and the successions of days and nights, implies the necessity of sleep. All animals sleep, but no animal, save man, sleeps on his back, "with face upturned to heaven." The time of sleep required by different individuals varies greatly, according to temperament, manner of life, dietetic habits, etc. John Wesley, with an active nervous temperament, and a rigidly-plain vegetable diet, could perform mental and bodily labors almost Herculean, and sleep but four or five of the twenty-four hours; while Daniel Webster, with a more powerful, but less active organization, and the ordinary mixed diet, "has a talent for sleeping" eight or nine hours.

As a general rule, in the animal kingdom, herbivorous animals sleep less than carnivorous; and the universal experience of the human race proves that vegetarians require much less sleep than the human omnivora, or those who subsist on both animal and vegetable foods. This fact must be accounted for on the principle of the greater purity, blandness, and adaptedness of vegetable food, requiring less vital expenditure to appropriate it, and exhausting the organic economy less in disposing of its waste or innutritious particles.

PHENOMENA OF SLEEP.—Profound or quiet sleep is the complete cessation of the functions of the cerebral hemispheres and the sensory ganglia, and is attended with entire unconsciousness. Dreaming implies imperfect rest—some disturbing cause, usually gastric irritation, exciting the brain to feeble and disordered functional action. Individuals of very studious habits, and those whose labors are disproportionately intellectual, require more sleep than those whose duties or pursuits require more manual and less mental exertion. But no avocation or habit affects this question so much as the quality of the ingesta.

NATURAL TERM OF SLEEP.—Physiologists are not well agreed respecting the *natural* duration of sleep. Historical data seem to indicate that a great majority of those who attained great longevity were long sleepers, averaging probably at least eight hours. The statute of nature appears to read: Retire soon after dark, and arise with the first rays of morning light; and this is equally applicable to all climates and all seasons, at least in all parts of the globe proper for human habitations, for in the cold season, when the nights are longer, more sleep is required.

A general rule, and an invariable rule for all whose voluntary habits are correct, and who retire to rest early in the evening, is, to sleep as long as the slumber is quiet, be the time six, seven, eight, or nine hours. Dreamy, restless dozing in the morning is generally much more debilitating than refreshing. Those persons who indulge largely in animal food, or eat gluttonously of any thing, and especially those who are addicted to spirituous liquors and tobacco in connection with high-seasoned animal food, are in danger of over-sleeping, even to the extent of very considerably increasing the stupidity and imbecility of mind, and indolence and debility of body, naturally and necessarily consequent upon those habits.

SLEEPING AFTER MEALS.—Some persons are partial to the *siesta*, or "dinner nap," and physicians are divided in opinion whether the habit is useful or injurious. Dr. Dunglison, who appears to be in some doubt on the subject, but rather inclines to regard a short sleep after dinner favorably, remarks: "It is *certain* that after a full meal both man and animals feel a propensity to sleep." I regard it as perfectly certain that there is no such propensity in man, except when his full meal has been an improper one. If he has slept too little the night previous, he may feel a propensity to sleep at any time during the next day, but not more after a meal than at any other time, unless his meal were fuller than the wants of his system demanded, or of too stimulating or concentrated a character to be healthful; nor is the assertion correct as respects the animals, excepting the carnivorous and gormandizing varieties. Sleeping after meals is always pernicious; and for an adult to sleep at all during the day can be regarded no better than the least of two evils when sufficient sleep is not had at night. All persons who can should do all their sleeping at once, and not eat such quantities or qualities of food as will produce the *unnatural* propensity to sleep after meals.

SLEEP FOR DIFFERENT PERSONS.—It has long been a popular *whim* that females require more sleep than males, and many physiological reasons, as whimsical as the whim itself, have been offered in support of the notion. I know of no sound argument that proves any difference so far as sex is concerned; and I think a safe rule for male and female, young and old, is, for children to sleep all they are inclined to, without the aid of extra-nervine agencies, rocking in the cradle, or paregoric drops; and for the middle-aged and old, of both sexes, to sleep all they can at one effort, between sunset and sunrise. Of course those whose business or pleasure obliges them to retire at late or irregular hours should govern themselves accordingly.

BODILY POSITION DURING SLEEP.—The *position* of the body in bed is worth a moment's reflection. It should be perfectly flat or horizontal, with the head a little raised; one common-sized hair pillow is generally sufficient. A majority of people sleep with the head too high, often elevated on two thick pillows, with a heavy bolster for the shoulders. This is certainly a very bad habit. The neck is bent, the chest is compressed, and the whole body unnaturally crooked. Children often become stoop-shouldered, or otherwise crooked, from their heads being placed on high pillows. Some physiologists object to sleeping on the back, and assign as a reason that the stomach and other abdominal viscera press upon the large blood-vessels below the heart, and thereby produce a tendency to cerebral disturbances, nightmare, apoplexy, etc. This argument only has weight with those who take late or heavy suppers, or suffer from enlarged livers or other abnormal conditions. Healthy persons, of correct dietetic habits, may sleep at pleasure on the back, or gently reclining to one side. All, however, should carefully avoid reclining nearly on the face, or crossing the arms over the chest, as that would approximate the shoulders, contract the chest, and materially affect the respiration. Sir Charles Bell thinks the incontinence of urine, which so frequently troubles children, arises from their lying on their backs. A more rational explanation of this difficulty may be found in the *paregorics*, *antimonial wines*, *herb teas*, and other weakening drugs and debilitating slops with which they are so generally stuffed by kind mothers, as per advice of sage doctors.

Beds and Bedding.—The nature of the *beds* and *bed-clothing* are of importance to those who would preserve or attain health. Feathers can only be mentioned in reprobation. Straw, corn husks, hair, and various palms and grasses, make comfortable and healthful beds. In cold weather those who are tender may use over either of them a light, thin, cotton mattress. No bed should be soft enough for the body to sink into it; and few persons who have thoroughly tried the experiment of sleeping on feathers and on straw will willingly exchange the latter for the former. Children and infants are cruelly though unwittingly abused, when compelled to sleep on feathers. I can hardly imagine that any person would be willing to have a pillow of feathers under his head, after once getting accustomed to one of hair, chaff, or even straw. Cotton is much better for pillows than feathers. The bed-clothes should be as light as possible consistently with comfort. Linen or cotton sheets are better than flannel, and for outside bedding thin quilts are best in summer, and light flannel blankets in addition in winter.

Sleeping apartments always ought to be large and well ventilated; but generally they are neither. Especial attention is therefore, as intimated in a preceding chapter, due to these circumstances. The windows or doors should be so arranged as to allow a free circulation of air; even *night* air, which many people and some medical writers appear to think is really poisonous, should have free ingress. If the sleeping-room is dark or damp, it should be occasionally dried and aired, by a fire if necessary, which may be put out before the sleeping hour. Whether fires in sleeping-rooms are to be advised or discountenanced, medical men agree as little among themselves as they do in relation to almost every other hygienic influence that can be named. While their expediency for some invalids is unquestioned, but little reflection seems necessary to convince any mind unprepossessed with vague theories that, as a habit, they cannot be otherwise than pernicious. When fires are employed during the daytime in the sleeping-room, they should be extinguished and the room well aired before going to bed. In houses heated with warm air, particular attention should be paid to ventilating the lodging-room.

CHAPTER VIII.

OF CLOTHING.

Physiological Nature of Clothing.—It is an obvious physiological fact, that the more the whole surface of the body is exposed to the external air, within certain limits, the more vigorous is its functional action performed, and the better is it enabled to preserve its own proper temperature, as well as to resist all morbific impressions from vicissitudes of weather, or the extremes of heat and cold. Clothing, therefore, which the usages of society and the severity of climates render indispensable, should, as an invariable rule, be as light and loose as possible without bodily discomfort. We must, however, recollect that comfort is very much a matter of habit, and make a due discrimination between the natural sensation of health and the morbid sensitiveness produced by false customs. Some persons wrap their whole bodies in flannel under-garments, and yet are ready to go into a "shivering fit" at every unusual breath of cold air: while others eschew those garments entirely, and endure the coldest weather of this climate with much less discomfort.

Materials of Clothing.—The substances principally employed in the manufacture of clothing in civilized countries are, *linen*, *cotton*, *silk*, *wool*, and *hair* or *down*. Those materials which are bad conductors of caloric, afford the greatest *immediate* protection from cold, as woolens or flannels; but, for the same reason, they are more debilitating to the cutaneous function; they are only to be preferred in cases of temporary exposure, or in very cold climates, or as a "necessary evil" in persons whose external surface is debilitated by bad habits of dress, until its vigor can be restored by bathing and other hygienic processes. Cotton and linen are better adapted to temperate climates, especially during the warm season; and linen for under-clothes is the best of the two in hot weather. Flannel next the skin, I am persuaded, is invariably hurtful as a habit. When woolen clothing is worn, it should be the outside garments; these may be of any quantity or thickness necessary to keep the body comfortable, while cotton or linen only comes in contact with the skin. The discrepancies among medical authors on this subject are almost ludicrous; some advocating the use of flannel next the skin, at all times and in all seasons; others condemning it as a fruitful source of colds, coughs, pulmonic and rheumatic affections, etc. "As regards the chest," says Sir George Lefevre, "a very light kind of woolen waistcoat should not be dispensed with even in the dog-days." I would much rather prohibit it in winter than prescribe it in summer. In the last cholera season (1849) the New York Board of Health, by authority of their Medical Council, recommended, as among the preventive measures, "the wearing of flannel next the skin," during the hot weather of June, July, and August. And on this hint a medical adventurer has since invented medicated aprons and bandages to keep the bowels *warm*, or, as the proprietor says, "retain the animal heat," and thus prevent bowel complaints. These notions are too absurd for serious refutation. Silk is a bad conductor, and for this reason females find silk dresses very uncomfortable in very warm weather. Furs are worn in this country more for ornament than use. They are the warmest clothing materials known, and by overheating the part of the body to which they are applied, render it extremely susceptible to cold. Fur neckcloths, caps, etc., are very pernicious.

Color of Clothing.—In a strictly hygienic regulation of dress, color cannot be wholly disregarded. White colors reflect the rays of caloric; black absorbs them. Light-colored clothing is therefore more comfortable and sanatory in warm weather than dark-colored, because the former repels the heat, and the latter readily receives and retains it. Various experiments have shown that the heat-reflecting or heat-retaining property of different fabrics varies exactly with their lighter or darker shades of color. This difference is, however, much greater in the luminous rays of light than in the non-luminous. When, therefore, we are not exposed to the sun, the subject of color is of less importance. The absorbing power of dark surfaces renders the skins of dark-colored animals, as well as of the darker persons or races of the human family, less liable to be scorched or blistered by the direct rays of the sun, than are those of a lighter color

Particular Garments.—Fashion seldom consults hygiene in the matter of dress. The hat is generally too stiff, heavy, and hot. It ought to be as light and soft as possible, and as thoroughly ventilated as a bed-chamber. This could easily be accomplished without marring its beauty. The common neck-stock or cravat is one of the worst articles known; by confining and heating the throat it predisposes to colds, rheumatism, quinsy, bronchitis, etc. I have known several persons in New York city, who were habitually the subjects of two or three severe attacks of quinsy a year, entirely cured by continually exposing the neck in all weathers, and bathing it daily in cold water. That the natural clothing of an unshaven beard is a protection against affections of the throat and lungs, I have no doubt. But if we will render ourselves preternaturally susceptible by shaving, we should not aggravate the susceptibility by binding up the neck with tight clothing. Females are generally debilitated by too heavy an amount of clothing about the back and hips. The custom with some females of oiling the hair, then combing it very smooth, and fastening it in a bunch on the top of the head, is very injurious to the scalp and brain; in fact, a common source of headache and nervousness. Stockings of cotton and linen are better than flannel, except when the feet are exposed to both extreme cold and moisture. Garters are a common cause of *varicose veins* in the lower extremities. Fur gloves are a bad article; so are India-rubber shoes, except as over-shoes to slip on temporarily. Straps for fastening the pantaloons tightly to the boot or shoe, I believe are almost or quite out of fashion; it is well they are so, for they render all the motions of the body stiff and awkward, and cause an injurious pressure to be exerted on the knee-pan and shoulders. Several cases of *synovitis*, attended with extreme weakness of the muscles around the knee-joint, have lately come under my notice, produced, without any doubt, by wearing pantaloon straps. Suspenders, when the trowsers are loose and easy, are not objectionable; although the sailor, whose vocation requires the utmost freedom from all restraint in the muscles of the chest and upper extremities, finds it more convenient to support the trowsers by the tightened waistband.

Custom has dealt more cruelly with infants than with adults in the style of clothing. Swathing, bandaging from head to foot with the view of getting the body in shape, and bandaging the abdomen to prevent the child from becoming "pot-bellied," are fashions happily fast going into disrepute, under the teachings of hydropathic and physiological writers. The new-born infant wants no bracing or supporting from the clothes. All the clothing required in infancy and childhood is easy, loose, flowing garments, sufficient to preserve the requisite temperature.

Bed and Body Linen.—It is always of importance that the bed and body linen be well aired daily, and frequently changed. Strict attention to the depurating function of the skin requires that the under-garment or shirt worn during the day should never be slept in during the night. The sheets, too, which collect more or less of the matters of perspiration, should be well exposed to the air every day. How often the shirts worn in the daytime require changing, depends something on the amount of exercise, perspiration, etc.; generally two or three times a week are advisable.

General Rules.—The first physiological rule of dress is, to have all garments as light in texture and as loose in fashion as is consistent with bodily comfort, and as will admit of the most perfect freedom in the exercise of every muscle of the body. The second is, to observe regularity and uniformity. Boots, shoes, hats, caps, thin and thick stockings, gloves, mittens, neck-dresses, head-dresses, etc., when worn at all, should be always worn under similar circumstances—not indiscriminately changed or alternated. As intimated in a preceding chapter, inequality of clothing is a far more frequent cause of "colds" than deficient clothing. If a person exposes a part of the body usually protected by clothing to a strong current of cold air, he will take cold sooner than by an equal exposure of the whole body.

CHAPTER IX.

OF BATHING.

Reasons for Bathing.—Were human beings in all other respects to adapt themselves to the laws of their organization, and were they in all their voluntary habits in relation to eating, drinking, clothing, exercise, and temperature, to conform strictly to the laws of hygiene, I do not know that there would be any physiological necessity or utility in bathing at all. But in civic society the laws of life and health are transgressed in a thousand ways; and the sum total of all the unphysiological habits of civilized life is, a condition of body characterized by deficient external circulation, capillary obstruction, and internal congestion or engorgement. To counteract this morbid condition no single agent or process is more effectual than bathing the whole surface of the body daily with cool or cold water. As a general rule, therefore. a daily bath should be as regularly attended to as are the daily meals.

METHODS OF BATHING.—For hygienic purposes there are various methods of bathing equally advantageous; the particular process is merely a matter of convenience. The towel or sponge bath, plunge, or shower, are, in ordinary cases, equally useful. The first-named is accessible to all persons, at all times, where a coarse towel and a quart of water exist. The others require less time and are more agreeable to persons accustomed to bathing. A portable apparatus for travelers has lately been constructed, which may be conveniently packed in a trunk or carpet-bag, and used in the bedroom of the hotel, or state-room of a steamboat. After the ablution, in whatever manner performed, the whole body should be thoroughly rubbed with a crash towel

TIME AND TEMPERATURE OF BATHS.—The best time for a genera bath is unquestionably on first rising from bed in the morning. Bath ing at any time of day, when the stomach is partially or completely empty, is better than no bath. In warm weather an additional evening ablution is refreshing and invigorating. The temperature of the water must be varied to suit different circumstances of constitutional health and vigor. The general rule is, that cool or cold water, short of producing any permanently disagreeable chill, is the best. Of course, persons of deficient blood and low vitality should use tepid water; and extremely feeble individuals should commence with warm water, gradually reducing the temperature as "reaction" improves. The *cold* bath may, for general purposes, include all temperatures below 60° Fahr.; the *cool*, from 60° to 72°; the *tepid*, from 72° to 85°; the *warm*, from 85° to 100°; and the *hot*, above 100°.

Infants ought to be bathed daily from birth. The water should be at the temperature of about 72° for the first three months, and reduced about five degrees every three months for a year, after which time, if the child has been well managed in other respects, it may be bathed in water of any medium temperature—say between 50° and 65°.

PRECAUTIONS IN BATHING.—No person should bathe in very cold water when the body is chilly from cold, nor when exhausted or over-fatigued from violent exercise, nor when, from any cause, the respiration is materially disturbed, nor soon after eating. Heat and perspiration are no objections to going into cold air or cold water, provided the body is not in a state of relaxation from confined or bad air, or debility from over-exertion, and the breathing is easy and natural.

CHAPTER X.

OF THE EXCRETIONS

RELATION OF EXCRETION TO NUTRITION.—From the physiology of the nutritive and the depurative functions we learn that an exact equilibrium must exist between the deposition of new material and the removal of old, in order to sustain the vital machinery in its perfect integrity of health and strength. If the nutritive functions be deficient, debility and inanition result; if the excretory functions are imperfectly performed, obstruction, congestion, inflammation, and fever prevail.

THE INVOLUNTARY EVACUATIONS.—As already explained, the *lungs*, *liver*, and *skin* are constantly eliminating from the body the greater portion of its waste, worn-out, useless, effete, and putrescent particles, their office being quite independent of the action of the will and voluntary muscles. If the food and drink is rightly apportioned in quantity and quality, and all other hygienic circumstances are duly regarded, their functional office will only cease when the body consolidates to a state of motionless density in a natural death. But when the voluntary habits are unhealthful, or when, from any morbific agencies, the involuntary excretions are checked or suppressed, we see a variety of phenomena indicative of disease. If the lungs fail in functional power, the whole surface is leaden and bloodless, the eye is dull, the face is wan and blue, the complexion is inanimate, and the extremities are cold. If the liver does not duly eliminate the bile, the blood is thick and viscid, the skin is dingy and cadaverous, the head is oppressed, the mind is confused, the nerves are weak and irritable, and the eyes yellowish or livid. If the skin fails to throw off the matters of perspiration, the lungs are oppressed, the head is giddy and painful, the mouth is parched and feverish, the heart is troubled with palpitation, the kidneys are irritated by excess of duty, and the bowels are liable to gripings, spasms, exhausting diarrheas, or inflammatory attacks.

THE VOLUNTARY EVACUATIONS.—The *bowels* and *kidneys* cleanse the body of the grosser fecal matters, and most of the surplus or extraneous saline and earthy particles If the bowels are torpid, the individual is troubled with fetid breath, bad taste in the mouth, coated tongue, gnawing or other uneasy sensations at the stomach, dry and harsh or cold and clammy skin, colic, sick headache, acrid eructations, bilious attacks, and generally hemorrhoids or piles. If the urinary secretion is deficient, dropsical accumulations take place, the head is exceedingly heavy, oppressed, and even apoplectic, the whole nervous system is excessively irritable, the cutaneous exhalation is impregnated with a urinous odor, and a low, irritative, and exhausting fever evinces the general putrescent condition of the whole body. The importance of attending to the solicitations of nature, so far as these evacuations are controlled by volition, cannot be overrated. Many persons have been seriously injured by retaining the urinary secretion for some time after its sensible accumulation. Few persons who live in the ordinary manner appear to have any intelligible idea of what constitutes a healthful and natural action of the bowels. Many imagine that *periodical regularity* is all that is desired. But they may have a movement of the bowels regularly every day, and uniformly at a particular time of day, *and still be very constipated.* The alimentary canal may still have retained fæces from one month to another. Healthful peristaltic action of the bowels demands not only that the dejections occur daily, regularly, and uniformly, but that each discharge be free, easy, and copious, but not watery, and without pain, straining, or irritation. I have seen many persons who assured me, on a professional examination, that their evacuations from the bowels were always "perfectly regular," when the furred tongue, foul breath, and turgid abdomen, assured me that this depurating function was very imperfectly performed.

Hardly a disease can be named but may have its origin in constipated bowels, and almost every habit of the present artificial state of society conduces directly to this result. The long catalogue of diseases peculiar to females, a large proportion of the fatal maladies of children, and a vast majority of the cases of dyspepsia and hemorrhoids, so common among adults of both sexes, have one of their principal causes in this condition. I need hardly add that no one can permanently enjoy good health, whose voluntary habits, in relation to diet and exercise, do not secure the integrity of this functional duty. It is a sad commentary on the boasted healing art of allopathic practice, that its professors doctor, physic, force, and purge the torpid bowels of their patients, year after year, and leave them invariably worse in the end, while they permit each and all of the causes which produce torpid bowels to operate continually, uncontrolled, unattended to, and almost unthought of.

CHAPTER XI.

OF THE PASSIONS.

MENTAL HYGIENE.—We may religiously observe all the laws of hygiene in relation to air, light, drink, food, temperature, exercise, sleep, clothing, bathing, and the excretions, and yet "lack one thing." If the passions are our masters, and not our slaves, they will rule and ruin, instead of obeying and serving us. There is no single hygienic influence more conducive to health, happiness, and long life, than a cheerful, equable temper of mind; and there is nothing that will more surely disorder the bodily functions, exhaust the vital energies, and stamp premature infirmities on the constitution, and hurry us on to an early grave, than an uneven, irritable, fretful, or passionate mental habit.

DIFFERENT PASSIONS AS AFFECTING HEALTH.—There is, in the vigorous exercise of the higher mental powers—the moral affections and the intellectual faculties—an elevating, sustaining, self-supporting influence; while the violent indulgence of the lower order of passions—the animal propensities—rapidly wears out the mental machinery, and enervates all the physiological powers. Who that has ever felt the holy inspiration of *love*, and the depressing influence of *hatred*, can fail to appreciate the importance of mental hygiene? Contrast the emotion of *benevolence*, or *gratitude*, or *veneration*, or *conscientiousness*, or *mirthfulness*, or *faith*, or *hope*, with that of *envy*, *revenge*, *jealousy*, *fear*, *grief*, *remorse*, or *despair!* One energizes the mind and reanimates the body—the other sinks, chills, and enfeebles both; one manufactures, creates, as it were, vital power—the other wastes and destroys it.

HEALTHFUL EXERCISE OF THE PASSIONS.—It is true that all the propensities with which we are endowed were intended to be exercised actively and vigorously, but always in relation to the uses or purposes for which they were given—never with violence, or in mere wantonness. When they are all exercised harmoniously with each other, their combined influence is to invigorate, ennoble, and exalt the whole being; but if one or several "grow mutinous and rave," the whole physiological and psychological nature experiences a deterioration proportioned to the time and degree in which ungoverned passion is in the ascendant.

Those who would maintain permanent and uniform health and attain longevity, should cultivate the "better passions" with the same sedulous and unremitting care that they would cultivate the best fruits and vegetables. That anger which "dwells only in the bosom of fools," should be a rare or unknown visitant, and the "evils of life" should be met with courage, fortitude, and resolution, instead of wailing, complaining, and lamentation. That unhappy disposition which treats all the little or great perplexities, crosses, trials, disappointments, or troubles, which are incidental to existence, and which more or less beset the earthly pilgrimage of every individual, with fretting, scolding, and fault-finding, not only aggravates all the "necessary evils" of life, but greatly multiplies them; and, what is worse, dissipates foolishly those talents and energies which should be devoted to overcoming obstacles, and, by profiting from the lessons of experience, "bring ing good out of evil."

THE PASSIONS AS CONNECTED WITH LONGEVITY.—In all ages of the world philosophers, divines, naturalists, statesmen, and other men whose studies and avocations were especially calculated to develop and maintain the supremacy of the moral and intellectual powers, have been proverbially long-lived. In this connection we may name among the ancients, Homer, Hippocrates, Pythagoras, Plutarch, Plato, Thales, Xenophon, Carneades, Sophocles, Zeno, Galen, Democritus; and among the moderns, Locke, Newton, Galileo, Boyle, Liebnitz, Buffon, Olbers, Blumenbach, Hahnemann, Swedenborg, Sir Edward Coke Fontanelle; and in our own country, Marshall, Jefferson, Franklin, Adams, Jay, and Madison. All of the persons above quoted were distinguished for active and laborious habits, and some of them were intense if not intemperate workers. The experience of a host of men renowned for great attainments in morals, theology, and various departments of science, proves that an immense amount of mental labor can be accomplished by an individual of ordinary natural capacity, when the propensities are harmoniously balanced, and an even, cheerful, hopeful spirit constantly cherished and maintained.

THE PASSIONS AS AFFECTING THE SECRETIONS.—It is well known to medical men that violent fits of passion will arrest, alter, or modify the various organic secretions as suddenly as will an electric shock. They may be depraved or vitiated as readily by excessive mental emotion as by a drug-poison taken into the stomach. A paroxysm of anger will render the bile as acrid and irritating as a full dose of calomel: excessive fear will relax the bowels equal to a strong infusion of tobacco; intense grief will arrest the secretion of gastric juice as effectually as belladona; and violent rage will make the saliva as poisonous as will a mercurial salivation. Many a nursing mother has sent her babe to the grave by indulging a furious emotion, which changed the character of her milk from a bland nutriment to a deadly poison. These facts, which could be multiplied to a great extent, demonstrate the law, that a sound body cannot exist unless connected with a well-balanced mind.

Physiological Law of the Passions.—The grand essential of a cheerful mind is self-control. This is the great law of mental hygiene. Those who cannot govern the lower range of propensities—the corporeal and social groups—by the moral sentiments and intellectual faculties, should study to acquire self-government as "the one thing needful" in the mental operations. It may require long, patient, and thorough discipline; it may cost much self-denial, and appear to demand great temporary sacrifices, but it is worth all it costs. Occasionally it is acquired through long years of bitter experience; and sometimes the greater part of a life is spent in suffering, disappointments, troubles, and crosses, ere the mind is found at peace with itself, and in right relations to all surrounding nature. Happy are they who can, even in such expensive schools, learn the art of adapting themselves to the invariable laws of the universe, which they cannot successfully oppose, or in any respect alter! Without self-control, let it be well understood, no one is competent to govern others. To *mothers* this principle appeals with more momentous interest than to any or all other persons; for it is their influence and example which infuse order or disorder into the infant mind, to "grow with its growth, and strengthen with its strength."

CHAPTER XII.

OF LONGEVITY.

Natural Duration of Life.—The Scriptures inform us that at one particular age of the world and state of society, "three score and ten" years were allotted to man; that at a preceding period, surrounded by different circumstances, it was ordained that "his days should be an hundred and twenty years;" and that soon after the creation, when the air was free from infection, the soil exempt from pollution, the food of man plain, simple, and natural, and the ways of debauchery and dissipation almost unknown, individuals lived on the average four or five hundred years, the maximum point of longevity recorded being nine hundred and sixty-nine years.

Without speculating upon the problem, whether the years of the early historians included the same period of time as the years of our present almanacs, it is sufficient for all practical purposes to know the general law, that human lives may be lengthened to one or two hundred years or more, or "dwindled to the shortest span," by our own voluntary individual and social habits. I can discover no physiological or natural law why man should not live some centuries, when placed under every possible favorable condition of constitution, climate, food, occupation, etc. It is obvious that, at the present day, a large proportion of our population is born with organizations incapable of manifesting the phenomena of life for a longer period than sixty or seventy years; many, indeed, have not original vitality sufficient to reach the age of manhood, and others are born too feeble to survive the days of childhood; but, on the other hand, all ages of the world, and nearly all countries, give us many examples of individuals, even under many unfavorable influences, reaching various periods of life over a hundred years; some of them nearly completing the second century, and some few, if we may credit the records, enduring into the third century. If it can be proved that *one* man may live two or three hundred years under the most favorable hygienic circumstances, we want no further evidence of the existence of a physiological law that *all* may, under precisely similar circumstances. The learned Lichtenberg, who collected many statistics on the subject of longevity, declared, "*Facts* answer that man, in general, can live from one hundred and fifty to one hundred and seventy, and even two hundred years."

Examples of Longevity.—Haller collected most of the cases of longevity known in Europe in his time. Among them were over a thousand who attained to ages between 100 and 110 years; sixty from 110 to 120; twenty-nine from 120 to 130; fifteen from 130 to 140; six from 140 to 150; one reached 169 years. The Russian statistics of 1830 give examples of two hundred and fifty-five individuals between the ages of 100 and 160. In England and Wales, during a period of eighteen years preceding 1830 over seven hundred persons were buried each of whose ages exceeded 100 years. Baker's "Curse of

Britain" gives a list of about one hundred individuals whose ages ranged from 95 to 370! Twenty-one of them reached the age of 150 and upward, and about thirty exceeded 120 years. Pliny copied from the records of the census in the time of Vespasian, the cases of one hundred and twenty-four men, living between the Po and the Apennines, who had attained ages from 100 to 140 years. At the same time there were living in Parma five men of ages from 120 to 130; in Placentia one of 130; at Facentia a woman of 132; and in Vellàgacian ten persons, six of whom were 110 and four 120 years of age. Herodotus informs us that the average life of the Macrobians was 120 years. The Circassians, according to the traveler, Mr. Spencer, attain a very advanced age. Modern statistics exhibit numerous examples of persons, in various parts of the United States, in Norway, Sweden, Denmark, Scotland, Ireland, Poland, Greece, and among the vegetarian Bramins of India, attaining more than one hundred years of age. France, Spain, and Germany afford a few examples. Many places on Long Island. in the state of New York, will compare advantageously with almost any equal number of places on the globe, as regards the longevity of their inhabitants, and the number who have attained 100 years of age. The American Indians, previous to the introduction of the white man's "fire-water," frequently lived to the age of 100 years. The following catalogue of names and ages of persons distinguished for length of years has been collected by Baker, Horsell, and others. There is a discrepancy of a few years in relation to four or five of the individuals between the ages here stated and those given by other authors. The difference, however, is not material, and can in no way affect our argument or inferences. William Dupe 95, William Dupe's father 102, his grandfather 108, Michell Vivian 100, John Crossley 100, Lewis Cornaro 100, Admiral H. Rolvenden 100, Jane Milner 102, Eleanor Aymer 103, Eleanor Pritchard 103, her sisters 104 and 108, William Pepman 103, William Marmon 103, wife of Cicero 103, Stender 103, Susan Edmonds 104, St. John the Silent 104, James the Hermit 104, Hippocrates 104, Bar Decapellias 104, Mrs. Hudson 105, Helen Gray 105, Mrs. Alexander 105, St. Theodosius 105, Mazarella 105, John Pinkham 105, St. Anthony 105, Mary Nally 106, Thomas Davies 106, his wife 105, Ann Parker 108, Gorgies 108, Simon Stylites 109, Coobah Lord 109, Democrates 109, De Longueville 110, Ant. Senish 111, Ann Wall 111, Luceja 112, Mittelstedt 112, J. Walker 112, W. Kauper 112, W. Cowman 112, E. M. Gross 112, Paul the Hermit 113, F. Lupatsoli 113, M. Mahon 114, John Weeks 114, R. Glen 114, St. Epiphamus 115, George Wharton 115, Louis Wholeham 118, Bamberg 120. Arsenius 120, Romualdus 120, John Bailes 122, Margaret Darley 130, Francis Peat 130, William Ellis 130, Bamberger 130, Peter Gorden 132, John Garden 132, Richard Lloyd 132, John Taylor 133, Catharine Lopez 134, Margaret Forster 136, John Mount 136, Margaret Patten 137, Juan Marroygota 138, Rebecca Perry 140, Galen 140, Dumitor Radaloy 140, Laurence 140, Countess of Desmond 140, Mr. Ecleston 143, Solomel Nibel 143, William Evans 145, Joseph Bam 146, Colonel Thomas Winsloe 146, Llywark Ken 150, Judith Crawford 150, Catharine Hyatt 150, Thomas Garrick 151, Francis Consist 152, James Bowels 152, Thomas Parr 152, Thomas Damma 154, Epimenides 157, Robert Lynch 160, Letitia Cox 160, Joice Heth 162, Sarah Rovin 164, William Edwards 168, Henry Jenkins 169, John Rovin 172, Peter Porton 185, Mongate 185, Petratsch Czarten 185, Thomas Cam 207, Numes de Cugna 370.

Zeno, the founder of the stoical sect, lived 100 years; Titian, the painter, nearly 100; Francis Secardia Hongo died A.D. 1702, aged 114; in 1757, J. Effingham died at Cornwall, aged 144; Alexander Macintosh, of Marseilles, lived 112 years; James le Measurer, of Navarre, 118 years; Valentine Cateby, of Preston, England, 118 years; Henry Grosvenor, of Wexford, Ireland, 115 years; John de la Somet, of Virginia, 130 years; Elizabeth Macpherson, of Caithness, Scotland, 117 years; Owen Carollan, of Ireland, 127 years; Ann Day, an English gipsy, 108 years; Cardinal de Salis, of Seville, 110 years.

NATURAL DEATH.—Diseases which produce violent or accidental death, destroy the whole human race, with few exceptions. Probably not one in a thousand dies a natural death. Even of those whose names have been held forth in the preceding paragraph as examples of extraordinary longevity, several were cut off prematurely by disease. Thomas Parr, at the age of 152, was destroyed by plethora, resulting from high living at court. Mrs. Hudson died of an acute disease resulting from taking cold at the age of 105. Richard Lloyd was in full health and strength at 132 years of age; but being persuaded to eat flesh-meat and drink malt liquors, to which he had not been accustomed, he soon sickened and died.

Natural death results from a gradual consolidation of the structures. In infancy, the proportion of the fluids of the body to the solids is much greater than in adult age, but this relation is constantly changing; the fluidity, flexibility, and elasticity of youth, as the structures harden and condense, is succeeded by the firmness, stiffness, and immobility of age; yet this change is not necessarily attended with infirmity or decrepitude. If the life has been very nearly in conformity with the laws of life, the vital energies, so powerfully expended upon the muscular system during the period of growth and development, are, after the maturity of the body, mainly concentrated in the region of intellect. There is less activity, and vivacity, and impulse, but more serenity, and thoughtfulness, and meditation. The moral and intellectual nature seems not to reach its full development until actual decline has commenced in the functions of organic life. We are accustomed to notice, as the earliest marks of senility, the decay of the teeth, and the disproportionate destruction of the functions of the external senses, especially seeing and hearing. But such is not the natural decline of life. In a perfectly normal condition of the organism, all the functions, powers, and senses decline in the same harmonious relation in which they were developed. As the process of condensation goes on equally and imperceptibly throughout the organic domain, the motive powers grow torpid, the nutritive functions are enfeebled, the sensibility becomes dull, the external senses are obtunded, and, lastly, the mental manifestations disappear—death occurs without a struggle or a groan.

Advantages of Longevity.—Some speculative writers, whose minds have been more directed to the narrow science of "political economy" than to an enlarged view of the economy of the universe, have lately found a perplexing problem in the relation of the means of subsistence to the facilities for propagation. While population, say they, increases geometrically, the alimentary productions of the earth only increase arithmetically. On this bare proposition longevity seems to be one of the greatest evils that can befall the human family. Some scheme of death appears to be indispensable, to "kill off" the surplus population, to clear the ground of *existing* human beings as fast as the "coming generations" demand their places. But such a theory places us in an awkward dilemma, and is not very well calculated to "vindicate the ways of God to man," nor give us the most exalted views of what constitutes "man's *humanity* to man." But the whole puzzle comes from mistaking the present social disorder for natural order. It is very true that in some parts of the world there is a dense population in a state of starvation; but it is equally true that the earth has capacity even there, to produce food enough for all, and to spare. Under existing governments and social arrangements, more than three fourths of all the land and all the labor, as far as the production of the means of human sustenance is concerned, is wasted, or worse than wasted. A large extent of the earth's surface has never yet been brought under cultivation, and that part of it which is cultivated the best admits of vast improvement. There is also an immense waste in raising domestic animals for food, for it requires not less than twenty times more extent of soil to nourish animals enough to furnish our food, than is necessary to supply us with food directly from the soil itself. And again, millions of acres of excellent land are worse than wasted in raising the filthy tobacco, and fruits and grains to convert into alcoholic poisons.

But there is a much more cogent argument derived from the physiological principles we have been considering, against the position that "creation is a failure;" for the idea I am controverting amounts to nothing less. It is a philosophical maxim that "intensive life cannot be extensive." The present races of human beings have a hurried, stimulated, forced, disorderly existence. Population is as much more numerous, as a general rule, as it is more depraved; the causes of multiplying the species increase with the causes of their destruction. Males and females marry at twenty, become the fathers and mothers of a "numerous offspring" at forty, find themselves old at fifty, and are compelled to die at sixty; in this way, supposing the majority of the children to arrive at maturity, and "do likewise," the world will surely fill up pretty fast, and there will be a perpetual demand for "new countries," for the surplus population, or for those other less pleasant resources, "war, pestilence, and famine." But philosophers ought always to discriminate between the existing state of affairs, and a state of affairs that may, can, or should exist.

There are many forcible reasons for believing that the earth now has, and always will have, room enough for all the population that can be produced by human beings who live according to the laws of their being, and till the ground according to the best lights of science and experience. If the human body develops slowly and healthfully, the periods of infancy, childhood, and adolescence will be greatly prolonged; the period of youth may extend to what we now call old age, while vigorous manhood may reach onward to some point between one and two hundred years, or even beyond; and under such circumstances it is probable that the number of offspring in each family would be less instead of greater than the average of the present day; at least such was the fact with the early inhabitants of the earth with whose histories we are familiar.

Again, we have many evidences that the surface of the earth actually enlarges continually. The proportion of the land is gradually gaining upon the water. Not only are the lakes, and seas, and oceans filling up, and the wild, frozen wastes of the polar regions destined to become, in due process of time, luxuriant harvest fields and flowery gardens, but it is even probable that the entire magnitude or bulk of the earth enlarges by constant accessions of matter, absorbed and condensed from the gaseous elements floating in what we call space. If these views are correct, and they are certainly not wholly speculative, they afford a complete solution of the problem of population and subsistence, and furnish politicians with a key to a system of legislation that shall not be limited to acts, enactments, and amendments of acts, almost exclusively relating to the "rights of property," but which shall, in its higher, broader, nobler grasp, comprehend also the PROGRESS OF HUMANITY.

But the chief use and purpose of a long life are yet to be named. As society is now constituted, the principal force of the mental energies of the world is expended in contriving a thousand ways and providing a thousand means to gratify the corporeal and animal passions, rendered insatiate by morbid cravings and disorders of all kinds, and in repairing, or rather attempting to repair, the mischiefs and miseries induced by bad habits. The intellectual and moral mind, the *spiritual* nature, has but little opportunity for cultivation and development until the later periods of life, and then the body is worn out, and the mind has nothing to sustain it. Even the rich stores of knowledge accumulated by those who are placed in circumstances peculiarly fortunate for moral research and scientific investigation are mostly lost to others, because their voluntary habits have so disordered the body, that the lamp of life goes out before they have time to arrange, compare, prove, and demonstrate the results of their study and experience, and communicate them to the world. The "uncertainty of life," which hangs like a depressing incubus upon the majority of minds, has a blighting effect on human intellect, and a demoralizing influence on human affections. As most people live, they feel an assurance of a special liability to some "mysterious providence," which *may* at any moment terminate their existence, and that entirely independent of any natural cause or law which they can either understand or control. The state of mind induced by such confused fears and apprehensions must be exceedingly superstitious, and nothing is more stupefying to all the powers of intellect than superstition. Such persons cannot reason well because their reflective powers are spell-bound by an absurd fantasy, and they dare not attempt to reason much for fear they will reason wrong. Imagining their safety to consist in the passive instead of the active state of mind, they make "discretion the better part of valor," and try harder to believe than to understand. But, moreover, this blinded and bigoted state of mind renders its possessor eminently short-sighted and selfish. He is unwilling to trust God, man, or nature, and aims to make sure of every thing, and enjoy as he goes along. Hence he is always pursuing petty expedients for momentary pleasure, instead of seeking permanent and substantial happiness in following out the laws of his organization. He becomes in society one who seeks to *appropriate* as much as possible, and *impart* as little as possible. He is always pre-eminently conservative, uniformly goes for keeping all things as they are, and invariably opposes all new creeds, or innovations upon established usages. So far as society, or the world, or the human family is concerned, he is useless, or rather worse than useless. But let the same person be well instructed in the philosophy of life, let him feel competent to preserve his own health, and have a full assurance that, casualties excepted, his days may be long in the land, and he will straightway look forward to a better and higher destiny, forego many present temporary gratifications, discipline his mind for the more important future, and become a more useful as well as more happy member of the social compact. Instead of finding his pleasure in abstracting all he can from the enjoyments of others, he will seek and find his highest happiness in some pursuit which will be conducive to the general good.

Special Means Conducive to Longevity.—In strict truth there are no *special* means for promoting health and attaining longevity, except in the negative sense—the avoidance of special errors. The *general* adaptation of all the hygienic agencies to the particular circumstances in which we are placed, constitutes our proper rule of action. But there is one principle involved in this subject more important than any other, and as it is more disregarded, and probably less understood, by people generally than any other, it may be well to notice it specifically in this place.

We have seen that, from the cradle to the grave, the proportions of the solid particles of the body are constantly gaining upon the fluids; natural death resulting when, provided no disease intervenes, the consolidation of the structures has progressed so far that the fluids cannot permeate the capillaries sufficiently to maintain the functions of assimilation and depuration. As the fluids and solids are both formed mainly from the materials taken into the stomach as food and drink, it follows that the character of the aliment has a controlling influence, beyond that of any other hygienic circumstance, in determining the period when natural death shall take place. Gross, concentrated, obstructing food, and all extraneous earthy or saline ingredients accidentally mingled with our food and drink, or employed as condiments, must necessarily abridge the term of our existence. All the early historians agree that the primitive inhabitants of the earth were *frugivorous*, subsisting mainly, if not wholly, on fruits. But if the primitive inhabitants employed as food roots, and tender leaves, and plants as well as fruits, they still had a kind of aliment remarkably fluid and unconcentrated as compared with the dishes generally eaten at the present day. And if, further, they employed any of the cereal grains—as flouring-mills were then unknown, and no method had been devised for separating the bran from flour—they were used in their most perfect condition, both as respects quality and preparation. The flesh of animals, it is conceded on all hands, was not then even thought of as food for human beings. So far, then, as the dietetic habits of the immediate descendants of the first pair were concerned, they united all the conditions requisite to prolong life to the utmost limit of the laws of life.

The principle, therefore, seems established, that the kind of food which contains a large proportion of fluid, as compared with its solid matter, and a large proportion of bulk, as compared with its nutriment, is best adapted to sustain permanently the integrity of the organism, provided it contain also the requisite elements for prolonged nutrition. Those who employ a diet largely farinaceous—those who make bread "the staff of life" in their dietetic system, require a large proportion of cruder vegetables, less nutritious roots, or succulent fruits. True, an individual might do very well on "bread alone," if he were rigidly abstemious, but the tendency would be, if the habit were extended through several generations, to hasten the consolidation of the structures, and bring on premature old age.

Nearly all the arts of commerce and of cookery are, and have been for many centuries, directly calculated to disorder the human body, and shorten the duration of its existence. Concentration, stimulation, and complication, with many extraneous additions, have generally been the aim of the cook, and the prescription of the physician; and the result is, that disease is the general rule of society, and health the exception, while the average period of time between birth and death has been fearfully diminished.

Another advantage in employing a large proportion of watery fruits and vegetables is, in supplying the system in this way with the water it requires, in its purest state. Most of the water used as a beverage and for cooking purposes is more or less impregnated with deleterious particles, while that found in the juices of fruits and vegetables is nearly free of every thing of the kind. We know that the organic economy requires a due supply of certain earthy matters, as phosphate and carbonate of lime, for the sustenance of the osseous system; but it is obvious that an undue supply must obstruct the minute ramifications of vessels, and render the fibres rigid and friable. The depurating organs have the functional ability to secrete and expel from the body the surplus saline and earthy matters to a certain extent; but if they are taken into the system beyond that ability, they must necessarily accumulate constantly, and exercise a very important influence in bringing the functions of life to an early termination.

I admit that a stimulating, concentrated, and even constipating and obstructing regimen, may produce a rapid development of the body; it may produce extraordinary precocity in mind or body, or both. But it is a *kind* of development unfortunate for its possessor and for society. It is a process which makes the child a *giant* and the man a *dwarf*. It may produce manifestations of maturity at twelve, and symptoms of decay at twenty. Besides, it always and invariably disorders the individual; and if, haplessly, the forced production of a man propagate his kind, the offspring will inherit a malformed and imperfect organization.

It has been urged, with reason, too, that the difficulties and pains of child-bearing are closely connected with the quality of food, as regards concentration. There is little doubt, I think, that the structures of both mother and child are more inflexible, inelastic, and unyielding, when the food has been too stimulating, too concentrated, or in any respect obstructing—a condition which obviously complicates the dangers and aggravates the sufferings of parturition. In fact, this subject has been amply and practically illustrated during the last seven or eight years in the city of New York, where nearly all the mothers and infants treated on the ordinary or allopathic system have experienced great suffering, and been "doctored through" many diseases; while all, as far as I have any knowledge, treated hydropathically, have escaped a great degree of the usual suffering, and *all* of the diseases usually incident to the lying-in period.

A late author, who has perpetrated the very common mistake of taking a fact for a principle, and a principle for a theory, and a theory for a system, and then turning the system into a *hobby*, has undertaken to show that all kinds of foods and drinks are conducive to or detractive from longevity, exactly in the ratio that their constituents contain less or more of saline or other earthy ingredients. According to his notion *wheat* is the very *worst* article of food known; the other grains are highly deleterious, while all kinds of "fish, flesh, and fowl," and even *ardent spirits* and *tobacco*, are healthful, because they contain scarcely any *phosphate of lime* or other earthy matters! As a specimen of his reasoning, or, rather, misapplication of facts, I make the following extract from his work, especially as it is a fair sample of the manner in which facts are generally misapprehended or misapplied by the medical profession:

"The peasantry of those parts of Ireland where wheaten-bread, or any kind of grain food is scarcely ever tasted, but where potatoes, fish, turnips, greens, and fresh vegetables, generally form their principal diet, all of which things contain a moderate amount of earthy matter are proverbial for health, activity, and a tolerable longevity. The English peasantry consume one half more solid grain food, as bread and pastry, than the Irish, and are greatly inferior both in health, activity, duration of life, and in temper and disposition. Although the same external conditions, fresh air and exercise, and much better clothing and lodging, are enjoyed by the English, they are more bony, rigid, clumsy, and stupid than the Irish."

I think the *fine flour*, with the greater portion of *beer*, *beef*, and *plum-pudding*, accessible to the English peasantry, explain these phenomena perfectly.

Occupation as Affecting Longevity.—The industrial relations of individuals, though important, are less so than domestic conditions and circumstances, as influencing the duration of life. The acknowledged theories and the collected statistics of physiologists exhibit some discrepancies, with regard to the connection between occupation and longevity; and medical men have been utterly unable to explain or reconcile these discrepancies. Thus, while agriculture is universally allowed to be the most healthful occupation known, the average lives of farmers, though comparing favorably with mechanics, tradesmen, laborers, factory operatives, etc., is lower in the scale of longevity than that of several other classes. In some parts of England, where this subject has been investigated, particularly in Manchester and Rutlandshire, the "upper classes," or "gentry" were found to be nearly twice as long-lived as the "lower classes," or "workers." These facts require a thorough analysis, or we shall be led into the monstrous absurdity that idleness and dissipation are more conducive to health than industry and temperance.

With regard to a farmer's life, it must be remarked that, although accompanied with good air, early rising, out-door exercise, and regular habits, these advantages are in a great measure counterbalanced by bad water and bad food. It is true that farmers *ought* to be the healthiest people in the world; but, unfortunately, they are very ignorant or negligent of the *means* of health which are so abundantly at their disposal. With ample facilities for enjoying the best possible diet, they generally employ the very worst. Hard water is usually drank, and, in this country particularly, stale salted meats, superfine flour, greasy compounds of all kinds, and butter and cheese, constitute the essentials of their dietary system; fruits and the more watery vegetables being regarded almost entirely in the light of luxuries or seasonings, which may be dispensed with or sent to market, or, if employed at all, are so saturated with sugar, butter, vinegar, salt, pepper etc., as to be really worse than none.

Cities are universally reputed to be unhealthful residences; and this fact puts the inhabitants on their guard—*compels* them to study, in some degree, the laws of life and health. Their greater exposure to danger becomes the means of rendering them more intelligent; and the caution they exercise in the selection of the articles and qualities of their foods, very nearly balances the natural advantages of the rural districts. The difference between fresh meat and salted, as an article of diet, is very great; and in this respect the inhabitant of the city has a vast advantage, because in cities fresh meat is the staple article of animal food, and salted the exception; the reverse being true in the country. It is not easy to convince the farmer that he can labor without old pork, bacon, or salted beef; but these articles are nevertheless among the principal causes of his rigid muscles, stiff gait, numerous infirmities, and premature old age.

The "upper classes" have the advantages of selected locations for their dwellings, plenty of room, clean yards, well-ventilated sleeping apartments, and favorable external circumstances generally. The poorer classes generally occupy the insalubrious localities because they are cheaper, rear buildings, garrets, cellars, etc., circumstances which will always very materially abridge the period of existence. It is true that laborers are not generally fairly dealt with by capitalists, but it is equally true that laborers have all the means requisite to improve their condition, and become completely independent. Their misfortune is, they know not how to use those means. Their great error, and the grand source of their slavery from generation to generation, is in their dietetic habits. Three or four times as much money is expended on articles of food which give them imperfect nourishment, and render them liable to diseases, with loss of time, and doctors', nurses', and apothecaries' bills accumulating, as is necessary to afford them healthful sustenance, if rightly applied. The money saved by a correct regimen would procure them better residences, and admit of an annual deposit in some savings' bank, in view of a future homestead. It is a fact that, in the United States, and indeed in almost any other country, perhaps in all, wages are sufficient to emancipate the laborers from the thralldom of capital in a very few years, if the "toiling millions" would but make a judicious application of their earnings.

There are some occupations necessarily unwholesome, and requiring special precautions on the part of those who pursue them. Millers, cotton-spinners, tea and coffee-roasters, paper and machine-makers, iron and brass-filers, glue and size-boilers, tallow chandlers, etc., are exposed to an atmosphere loaded with powders or gases which exert a deleterious influence on the lungs. Thorough ventilation, and a position "to windward" of the current of floating particles, are indispensable considerations. Plumbing, painting, and the arts of the operative chemist, potter, and coppersmith, are deleterious, to some extent, from the substances which are volatilized by various processes being inhaled. Experiments in relation to lead-poisoning, however, have shown that workmen in smelting establishments, house-painters, etc., are injured far more from the metallic particles which adhere to their hands and clothes, thence finding their way into the stomach, than from absorption through the skin, or inhalation into the lungs. The proper precautions consist in changing the clothes before going to meals, and thoroughly washing the hands, carefully removing every particle of paint or metallic matter from under the finger-nails. Gold-finders are exposed to sulphureted hydrogen gas, which is exceedingly poisonous.

Severe mental exercise, or close application to study, has usually been considered as unfavorable to long life. This is undoubtedly true as relates to childhood and early youth. The bodily powers are often stunted, the mental functions blunted, and the whole constitution ruined by too early confinement to study. But there is another evil of immense magnitude connected with this view of our subject. Children and youth require much, varied, and regular muscular exercise during the period of bodily development. If the natural instinct for abundance of out-door exercise is repressed, the whole system becomes morbidly sensitive and irritable, and this condition, under the usual stimulating and enervating habits to which youth are so generally the subjects and the *victims*, such as tea and coffee, flesh eating, excessive clothing, feather beds, etc., is aggravated and intensified, until inflammatory secretions and ungovernable passions disorder the whole body, and unbalance the mind. In this state young persons are easily led into any habits of dissipation and debauchery which their associates or superiors are addicted to. The numerous examples of self-pollution or masturbation among studious young men and boarding-school girls, surely undermining the constitution, and laying the foundation for a brief life of infirmity and suffering, are melancholy evidences of misdirected educational enterprises. The duty, therefore, of bringing every child up to some useful business pursuit, in which the surplus animal energies may be profitably and regularly expended, seems absolutely indispensable to its safety as well as to the good of society; a duty, the neglect of which has caused so many sons of wealthy parents, who were so mistaught as to look with contempt upon honest toil, to turn out debauchees and vagabonds.

But intellectual pursuits, or avocations which severely tax the moral powers and higher propensities, do not seem tc be inimical to high health and great longevity, when followed with a consistent regard to general hygienic precepts. Dr. Madden, in his "Infirmities of Genius," has given us tabular statements which go to show that those literary pursuits in which the imagination is vigorously exerted are more inimical to longevity than scientific and philosophical avocations. He also thinks that "the earlier the mental powers are developed, the sooner do the bodily powers begin to fail;" a remark which is correct only so far as it applies to the prevalent method of forcing the intellect into premature and precocious exertion, at the expense of the body. Poets and artists aro rather noted for early deaths, but they have usually been irregular and dissipated in their habits. Eminent theologians, philosophers, physicians, lawyers, jurists, etc., have died very frequently of apoplexy or palsy; but they were frequently addicted in the later periods of life to "luxurious feeding." Many individuals are designated by historians as "victims of excessive mental application," who were truly victims of intemperance. Dr. James Johnson, mistaking the *abuse* of the body for the *use* of the mind, has expressed the absurd opinion that "a high range of health is probably incompatible with the most vigorous exertion of the mind, and that this last both requires and induces a standard of health somewhat below par." This error of Dr. Johnson has arisen from observing that certain intellectual geniuses—Virgil, Horace, Pope, and others—were of feeble bodily health. It is much more rational to suppose that if "men of genius" would take better care of their bodies, they would manifest still more vigorous and enduring minds, than to impute what mental talent they do possess to bodily infirmity.

Sad examples of the same mistake may be seen at all our seminaries of learning, where bodily infirmity and mental genius *appear*, to the superficial observer, to stand in the relation of cause and effect. But, however satisfied and gratified teachers and parents may be with the "highest prizes" won by haggard faces, contracted chests, gaunt abdomens, and dreamy slumbers, the true physiologist can only see, in the not distant future, sure-wasting consumption, hydra-headed dyspepsia, crippling palsy, or nameless debility, as the probable consequence of this working of the machinery of mind out of all proportion to the bodily development; *he* must lament, while short-sighted friends rejoice at the prospect.

PART IV.

DIETETICS.

Preliminary Remarks.—All intelligent physicians of all schools of medicine agree in the general proposition that plain, simple, natural food is most conducive to the recovery or preservation of health; but when we come to the details as to what constitutes plain, simple, and natural food, these same physicians are at all points of the compass. Even hydropathic writers, who are singularly harmonious on every other subject in relation to their system of the healing art, are somewhat discordant on this. The fact, however, may not result so much from differences of opinion as to what is intrinsically true in theory, as from different views as to what is expedient to attempt in practice.

One remark of the author of the "Science of Human Life," all true hydropaths will have abundant opportunity to verify, viz.: "The more the practice of the physician conforms to the appetites of his patients, the more cheerfully and generously is he rewarded." Two dollars a day is not regarded as extravagant at a "first-class hotel," where the guests are provided with "every comfort" which renders them invalids; but one dollar a day at a hydropathic establishment, where they are forced to bear with all the privations that are necessary to restore them to health, is considered exorbitant; so difficult is it for the majority of people to reason against the current of their appetites, and understand in opposition to the impulses of passion and habit. This consideration, too, which all persons who practice a reform system in opposition to the acquired desires and immediate pleasures of their customers must be frequently reminded of, may not be without its influence in determining the general character of many hydropathic tables, and possibly of biasing the opinions of hydropathic practitioners; for that man must be ignorant of human nature who does not know how easily judgment is warped by interest.

I do not know that it is practicable or possible, amid the prevailing ignorance and error, to sustain a hydropathic establishment, or any other public institution, on a dietary system strictly physiological. A majority who are compelled to resort to the water-cures, of course, have been more or less mistaught; nor can their errors be wholly educated out of them at a single interview. "Line upon line, and precept upon precept," even when commended and enforced by personal example, are necessary to change the current of deeply-rooted habits and ever-craving propensities.

A large proportion of patients who for the first time visit these "cures" for the purpose of treatment, expect a change from their accustomed habits of eating and drinking to something more healthful. But *such* a change! Many of them are startled with astonishment on their first appearance at a hydropathic table. They had *heard* of the beautiful brown bread, the exhilarating *cold* water, the substantial hominy, the admirable rice, the tempting fruits, the dainty baked potatoes, the delicious *greens*, and the keen appetites; but while it was, perhaps, "*distance* that lent enchantment to the view," they were pampering the artificial appetite with rich dishes, and condiments, and seasonings. When, therefore, the matter is submitted to the evidences of the senses, the wheaten grits scratch the throat, the beef-steak is too dry to swallow without gravy, the bread will not go down smoothly without butter, spinach is insipid without vinegar, pudding is flat without wine-sauce, pea-soup is uninviting without pepper, pumpkin pie is odious without ginger, pastry has no relish without the accompaniment of cheese, and the biscuits are too tough to "melt in the mouth" without shortening. If perchance an article finds its way to the table by accident, or by the carelessness or connivance of the cook, in all respects what it should not be, it is morally certain to receive a warm eulogium; while the articles selected with the greatest care, and prepared with the utmost pains-taking, and in every way precisely adapted to cure their maladies in the shortest possible period of time, are as certainly treated with dignified neglect or open ridicule.

This I know is an extreme view, but not an uncommon reality, and these circumstances may justify, if they do not compel, hydropathic tables to be, to some extent, compromises with custom. Many patients, with a full understanding of the subject, prefer to have a greater indulgence in matters of appetite, and submit to the severer water-processes such indulgence renders indispensable, in order to effect a cure. But the evil is not wholly on the side of the inveterate errors and perverse appetites of patients. Some persons who undertake to get up a hydropathic table are entirely ignorant of the whole subject of diet; some pretended establishments are merely "watering places," the table being wholly on the ordinary hotel plan. There is, too, some difficulty always attending the preparation and maintenance of a well-regulated table for invalids, for the reason that competent help is not easily found; and again, the commercial adulterations of the materials of food, and the bad qualities so profusely furnished to our markets, require the closest attention and the most careful scrutiny.

But all of these difficulties are surmountable; errors of education are not necessarily fatal, morbid appetites are not absolutely incorrigible, and a clear understanding of the causes, sources, nature, and remedies of all of them, is the pre-requisite for introducing a better order of things. The aim of the enlightened hydropath in directing the dietetic practices of his patients, will be not only to cure their present infirmities, but to teach them "the way of life" in relation to eating as well as to all other voluntary habits. And to this end he should for himself well understand, and for others ever hold out to view, correct physiological principles, although he may rightfully exercise a wide range of discretion in the particular manner of conforming and reforming the habits and appetites of his patients, so as to induce them intelligently to love and permanently to practice "the better way."

CHAPTER I.

DIETETIC CHARACTER OF MAN.

The arguments involved in the question whether man is by nature best adapted to subsist on a vegetable diet exclusively, or on a mixed diet of vegetable and animal food, can hardly fail to be interesting and profitable to all, although all may not draw the same inferences from the facts presented. Those who will attentively study Sylvester Graham's work on the Science of Human Life, will find this whole subject critically investigated and philosophically demonstrated. In the present work it is impossible to give more than a brief abstract of the positions and evidences bearing on the general proposition.

The Bible Evidence.—We learn from the first chapter of Genesis that, as soon as man was created, and placed on the earth, to "multiply, and replenish, and subdue it," his food was appointed in the following words: "And God said, Behold, I have given you every herb bearing seed, which is upon the face of all the earth, and every tree in the which is the fruit of a tree yielding seed; TO YOU IT SHALL BE FOR MEAT." Certainly nothing can be more clear and explicit than this declaration, that the vegetable kingdom is the ordained source of man's sustenance.

But after the flood it is said that animal food was *permitted*. It seems to me a very strange moral hallucination that arrays a *permission* to do one thing against a *command* to do the contrary! Those who prefer to make a permission instead of a command their rule of action will find, on a careful examination of the Scriptures, that wars, murders, polygamy, pestilences, famines, and many other vices and evils, have been permitted, "for the hardness of men's hearts." This doctrine of permission is derived from Genesis ix. 2, 3, 4: "And the fear of you, and the dread of you, shall be upon every beast of the earth, and upon every fowl of the air, upon all that moveth upon the earth, and upon all the fishes of the sea; into your hand are they delivered. Every moving thing that liveth shall be meat for you; even as the green herb have I given you all things. But flesh with the life thereof, which is the blood thereof, shall ye not eat."

To my understanding this permission only more strongly enforces the prior commandment. If we may suppose that man, after the earth had been peopled for several centuries, by reason of some set of circumstances we cannot now ascertain, resorted to flesh-eating, in consequence of which he became so brutal, and ferocious, and depraved, and wicked, and filled the land with so much violence, that it was found necessary to wash the whole surface of the earth clear of his polluting presence, saving only a single family to preserve the race from utter extinction; and if then Jehovah had seen fit to reaffirm His original law in the appointment of man's food, the language employed, it seems to me, is admirably adapted to the purpose.

The *fear* and the *dread* of man was stamped upon the whole animal creation. This implies that man's *supremacy* above the lower animals was again pointed out. It did not ordain man to be a predaceous animal himself, but affirmed his *superiority*. But into man's hands was the whole animal kingdom *delivered*. Well, for what purpose? To eat? Not to *devour*, but to *protect*. To rule and hold dominion over, not to ravage and prey upon. Or even if man were ordained to destroy and exterminate the animal kingdom, it would not follow that it was his duty to eat and digest it. God constituted man the *lord* of creation; was it not an egregious blunder in man to mistake himself for the *tyrant* of all?

The inferior races of men fear and dread the superior; in fact, for all practical purposes, the weaker are "delivered" into the hands of the stronger. But would it not be a perversion of privilege for the more powerful to *eat* the more feeble, especially when there was abundance of good wholesome food obtainable otherwise? If man is placed at the head of creation, formed and fashioned but little lower than the angels, and so much *above* the animal kingdom as to have dominion over it, his duty seems to be to protect and govern it, not sensualize and riot upon it. The fear of God and the dread of the Almighty is upon every human being who walks the earth; but human beings look up to that Deity whom they both fear and dread, as the best of protectors, the most merciful of rulers, the kindest of fathers. If Queen Victoria has dominion over thirty millions of her fellow-creatures, she would be a very cannibal to eat a single one of them; and if a hundred millions of semi-civilized human beings are delivered into the hands of Nicholas of Russia, it does not imply his right to maltreat or destroy, much less devour them!

No one pretends to say that all sorts of *dead* animals were meant by the phrase, "every thing that *liveth;*" and if it does not include *all* animals, why does it mean *any?* Surely the language is as broad as creation itself. But mark! Vegetable food is, indeed, a "living thing," after harvest, and even when prepared for the table. The grains, and fruits, and roots still retain the living seed, the germ of vitality, even at the moment when they are ready for man's repast True, their germinating property may be destroyed by a process of cooking, but this militates nothing against our position.

Now, animal food (save those trifling exceptions, raw fresh eggs and raw fresh oysters) of whatever kind, is not "living;" and it immediately commences putrefying the moment it is deprived of life; and this process of decomposition can only be arrested by powerful antiseptics, as salt, vinegar, sugar, alcohol, nitre, arsenic, etc.

Again, while man's dominion was to be over *all that moveth upon the earth*, his ordained food was to be *every moving thing that liveth.* Those things that *move upon* the earth are most indubitably the animals that creep, crawl, walk, run, jump, climb, fly, and swim. The *moving* things that *live*, when gathered and preserved for food, as well as when growing in the fields and woods, are the waving grains, the spreading vines, the branching roots, the swelling fruits, etc.

Lastly, those who contend for flesh-eating on Bible authority admit that blood is peremptorily forbidden. This admission on their part completely refutes all the appearance of force they draw from their own interpretation of the doctrine of permission, for they never eat a particle of flesh, and *would not eat it*, without a large admixture of blood. A piece of flesh deprived of its blood is a dry, fibrous, stringy unsavory mass; no one would eat it sooner than he would eat a piece of sponge or India-rubber. Yet who does not know that "steaks" and "roasts" rare-done, so as to bleed a little when carved, are considered by Christian epicures generally as the sweetest, daintiest cuts? Even blood-puddings are considered a famous luxury by some of those good Christians who profess to be, and no doubt really imagine they are, obeying the commands of holy writ in the use of animal food.

It is admitted that both the Old and the New Testaments furnish examples of good men, and inspired men, who ate flesh; but good and inspired men were neither all-wise in intelligence, nor all-virtuous in conduct. Though good and inspired, they were still the subjects of ignorance and error—they were human. Nothing, however, is more apparent than the superiority which the whole tenor of Scripture teaching assigns to vegetable food. The history of Daniel, and John the Baptist, and Elijah the Prophet, are striking illustrations. Whether our Saviour ate the animal fish is a question perhaps not easily solved, nor is its solution material to our purpose. But it is worthy of notice that the lotus plant of the Egyptians is, even at this day, made into an edible preparation called fish. The Greek word *opsarion*, it is said by some lexicographers, does not signify fish, but some other delicate preparation eaten with bread. James and John were fishermen, with Zebedee their father, yet Calmet says that they never ate fish or flesh. Ezekiel speaks of an abundance of fishers who should live on the borders of the Dead Sea, yet Josephus says no animal fish will live in it. The balance of testimony is certainly strongly against the supposition that fishermen were fishers of animals in those days, or that the fish employed as food was not a vegetable production.

The Mosaic regulations in relation to animal food were evidently intended to restrain its employment, as far as the sensual people he had to deal with could be controlled, and to restrict those who would persist in its use to the best or least injurious kinds. But, stranger truth than the strangest fiction, many of our good modern Bible-professing Christians, who devoutly believe in "Moses and the prophets," make their dainty delicacies and luxuries on the very kinds of animals and parts of animals which Moses, with the authority of "thus saith the Lord," peremptorily prohibited.

THE ANATOMICAL EVIDENCE.—To the Bible testimony in favor of vegetable diet, may be added that of comparative anatomy. Natural history alone solves the problem beyond all controversy. Medical writers are constantly asserting, and newspaper scribblers are continually reiterating the statement, that the conformation of the human body shows that man is intended to live on a mixed diet of animal and vegetable food; but neither of them support the position with a particle of evidence which can bear criticism. On the contrary, all the eminent naturalists the world has ever produced, as far as I know, are unanimous in the opinion that the anatomical structure of the human body, as compared with other animals, places man among the frugivorous or herbivorous animals, and affords no testimony whatever of his carnivorous or omnivorous character.

Baron Cuvier, whose name stands at the very head of comparative anatomists, says: "The natural food of man, therefore, judging from his structure, appears to consist of fruits, roots, and other succulent parts of vegetables, and his hands offer him every facility for gathering them. His short and moderately strong jaws, on the one hand, and his cuspidati being equal in length to the remaining teeth, and his tubercular molares on the other, would allow him neither to feed on grass nor devour flesh, were not these aliments previously prepared by cooking."

Professor Lawrence states that "the teeth of man have not the slightest resemblance to those of carnivorous animals, except their external enamel, and that the whole human structure most closely resembles those animals which are naturally frugivorous—the *simiæ*, or monkeys."

Thomas Bell, surgeon-dentist to Guy's Hospital, declares that "every fact connected with the human organization goes to prove that man was originally formed a frugivorous animal."

Linnæus asserts that "the organization of man, compared with that of other animals, shows that fruits and esculent vegetables constitute his most suitable food."

Sir Everard Home admits that "while mankind remained in a state of innocence, their only food was the produce of the vegetable kingdom."

Lord Monboddo, also a celebrated naturalist, says: "It appears to me that by nature, and in his original state, man is a frugivorous animal, and that he only becomes an animal of prey by acquired habits."

Dr. William Lambe, of London, after a critical examination of the question, came to the conclusion that "man is herbivorous in his structure," and his conclusion has been verified by more than forty years of personal vegetarian experience. He declares that "the adherence to the use of animal food is no more than a persistence in the gross customs of savage life, and evinces an insensibility to the progress of reason, and to the operation of intellectual improvement."

Sylvester Graham, of Northampton, Mass., with a mind singularly constituted to grasp first principles, has carefully examined the whole organization of the human body, and minutely investigated all its complicated parts, with direct reference to this question, more thoroughly probably than any other person who has ever lived. His theoretical conclusion corresponds with that of all other naturalists whose attention has been directed to the subject, and the experience of hundreds who have adopted the vegetarian system, partially or wholly, in consequence of his teachings, singularly exemplifies its truth.

Against such testimony we have nothing but the bare assumption of medical and dietetical writers who have never examined the subject at all, and who are as profoundly ignorant in relation to it as are those for whose edification they write. It is common and customary for such persons, whenever they make a book on any subject pertaining to medicine or hygiene, to repeat the stereotyped phrase that the *teeth* of the human animal combine the characters of both herbivorous and carnivorous animals, and constitute him an omnivorous, or all-devouring animal. This makes him one of the connecting links between the two, and places him dietetically in the same dignified rank in the scale of being as the bear, hog, etc. The manner in which the omnivorous side of the question is supported is much more amusing than convincing. Dr. Dickson, the author of Chrono-Thermalism, *modestly* observes: "The most cursory examination of the human teeth, stripped of every other consideration, should convince any body *with the least pretensions to brains*, that the food of man was never intended to be restricted to vegetables exclusively."

Dr. Carpenter *(Principles of Human Physiology)*, in allusion to the carnivora and herbivora, remarks: "Now, the condition of man may be regarded as intermediate between these two extremes. The construction of his digestive apparatus, as well as his own instinctive propensities, point to a mixed diet as that which is best suited to his wants."

Dr. Dunglison (*Human Health)* makes the following singularly ridiculous assertion: "There is no doubt whatever, that if, from infancy, man, in the temperate regions, were confined to an animal banquet, it would be entirely in accordance with his nature, and would probably develop his mental and corporeal energies to as great a degree as the mixed nutriment on which he usually subsists."

Professor Lee, who has a happy talent for "coinciding" in the opinions of others, fully endorses the "very judicious remarks" of Dr. Dunglison, and also remarks, on his own responsibility: "The physical organization of man proves that he is destined for a mixed kind of aliment."

A volume of similar quotations could be extracted from the medical authors of the allopathic school; but all alike are deficient in argument or evidence. When an attempt at argument is made, it always turns on the teeth and masticatory organs. These are said to be in man a little different from both carnivorous and herbivorous animals; and hence the inference is drawn that man, because he is *unlike either*, is actually *both*. There is, indeed, a resemblance between the teeth of man and the teeth of both the carnivora and herbivora, as well as those of the omnivora; but there is, too, a difference, and the difference is just as significant as the resemblance. The truth is, that there is a *very wide* difference between the teeth, masticatory organs, and whole digestive apparatus of man and carnivorous animals; a *great* difference between man and omnivorous animals in these respects; a *lesser* difference between man and the *herbivorous* or graminivorous animals; and an *exact resemblance* between man and those animals known to be frugivorous. The single fact that man possesses the *lateral* or *grinding motion* of the lower jaw, peculiar to frugivorous and graminivorous animals, while he is destitute of the pointed, projecting, irregular, and tearing teeth, belonging to carnivorous and omnivorous animals, is perfectly conclusive, in my estimation, as far as anatomy is concerned, that man is by nature in no sense or degree associated, dietetically, with the latter classes of animals.

But for the satisfaction of those who desire to *see* as well as hear the discussion of this subject, the following ocular demonstration is submitted:

Fig. 152.

TIGER'S UNDER JAW.

Fig. 152 exhibits the masticatory organs of the carnivorous tiger. There is a *resemblance* between these teeth and those of the human animal; yet no one will dispute that the *difference* is more striking than the resemblance.

Occasionally the human teeth exhibit those deviations from the ordinary form which are denominated *tushes*; but such deviations are universally regarded as deformities, and such deformities always give a carnivorous and ferocious expression to the countenance. How little do human beings suspect the intimate connection that exists between mental impressions and exercises and bodily conformation. Those tribes of the human family whose minds are most associated with animal food, and whose teeth are most frequently employed in masticating it, are most distinguished for a structure of teeth peculiarly *inhuman.*

Fig. 153.

JAWS AND TEETH OF A PANTHER.

In Fig. 153 we have a representation of the jaws and teeth of another purely carnivorous animal. It affords a good idea of the manner in which the jaws of the carnivora open and shut, like a pair of shears, being wholly incapable of the least grinding or rotary motion.

Fig. 154.

JAWS AND TEETH OF A MINK.

Fig. 154 represents another modification of carnivorous masticators. The teeth are nearly closed, and the dagger-like tusks are seen to be very different from those teeth which, in the human jaw, have received the appellation of *canine.*

Fig. 155.

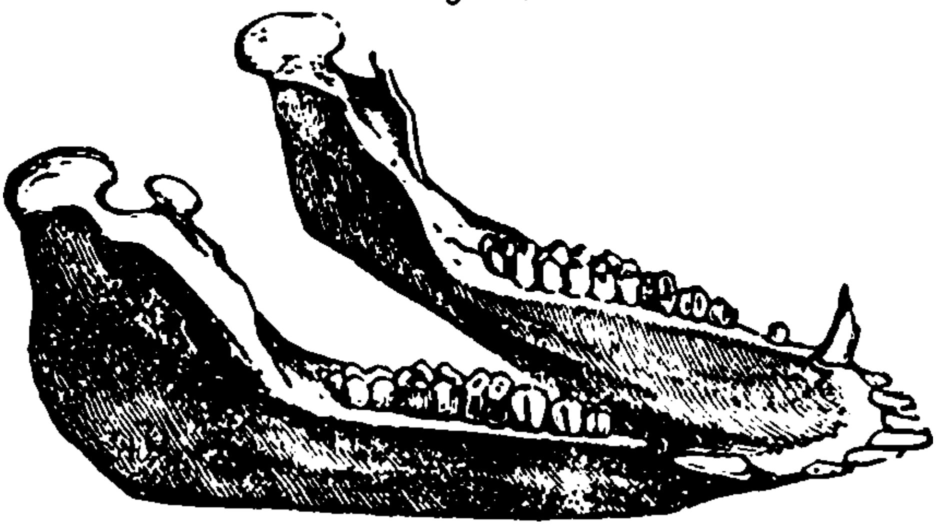
YOUNG LION.

The face of the young lion, Fig. 155, does not make any very near approach to humanity, in the conformation of the teeth or jaws. A *resemblance,* of course, must be acknowledged; yet, when the general contour and expression of the human face approximates to that of a carnivorous animal, it is by common consent denominated "savage," "ruffianly," etc.

The poets and painters who undertake to represent to us their ideal of humanity invariably divest the features and expression of every trace characteristic of the ascendency of the lower range of animal propensities. How would the "Portrait of a Gentleman," the "Flower Girl," "The Bride," or "The Cavalier," appear in the gallery of the American Art

Union, with the angles of the mouth drawn down to the carnivorous range, and the canine teeth projecting omnivorously beyond the rest?

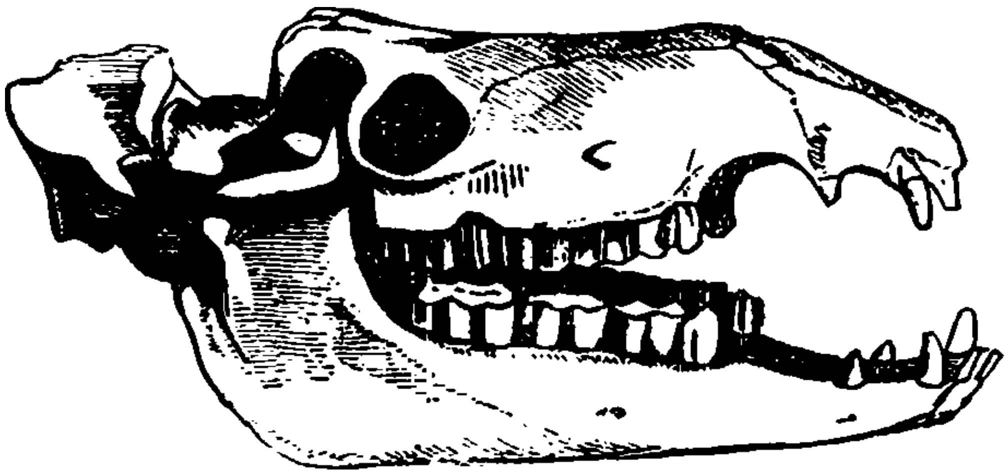
Fig. 156.



UNDER JAW AND TEETH OF THE HOG.

We may now examine the intermediate class—the omnivora. The back teeth of the hog, Fig. 156, resemble exactly those of herbivorous, and the front teeth those of carnivorous animals. But if there is any thing peculiarly human about the masticatory apparatus of the swine, I am unable to perceive it.

Fig. 157.

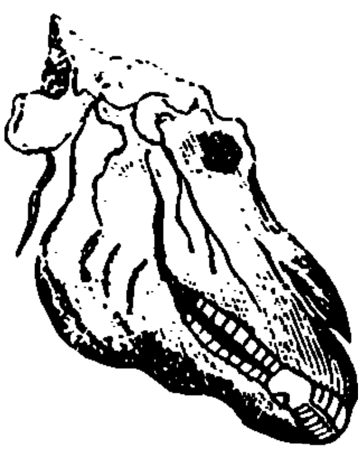


JAW AND TEETH OF THE CAMEL.

The masticatory organs of the camel, Fig. 157, particularly the cuspid or canine teeth, show a much stronger resemblance to those of carnivorous animals than do those of the human animal; hence man, judging from the point of comparative anatomy alone, would be removed further from the carnivora than even the camel, which subsists on the coarsest herbage.

The irregular arrangement of teeth are here peculiarly fitted for clinching and breaking up the sprouts, stalks, branches, etc., which constitute a large proportion of this animal's food.

Fig. 158.



SKULL OF THE HORSE.

In the jaw of the horse, Fig. 158, another herbivorous animal, the incisors, or cutting teeth, are placed in front to crop the grass or other herbage; and the grinding teeth for mashing and comminuting the food occupy the back part. There is no appearance of tearing or carnivorous teeth.

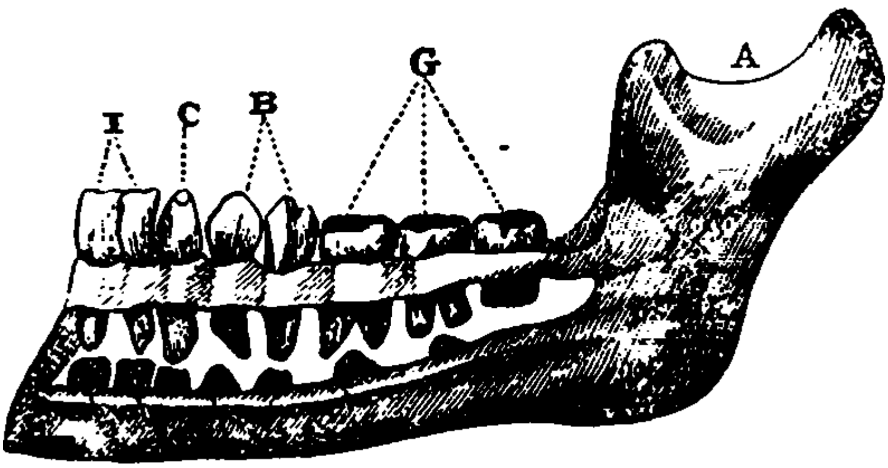
Ascending the scale of the animal creation, we may next look at the masticatory apparatus of a purely frugivorous animal. In the orang-outang, Fig. 159, the articulations of the jaw, as with all herbivorous animals and with man, are adapted to the rotary or grinding motion. The teeth of the ape, or monkey

Fig. 159.

JAWS AND TEETH OF AN ORANG-OUTANG.

tribe, have a nearer resemblance to those of carnivorous animals than have human teeth, which fact would place men, if possible, at even a greater distance than the orang-outang from the carnivora It should be noticed, however, that in some species of monkeys—the baboon for example—the cuspids do resemble the corresponding teeth of carnivorous animals, an arrangement which serves them for weapons of offense and defense, but not for cutting and tearing flesh.

Fig. 160.



HUMAN JAW AND TEETH.

It will be observed at a glance that the masticatory organs of the human animal, Fig. 160, are still further removed from all resemblance to those of carnivorous or omnivorous animals than are those of the purely frugivorous orang-outang, or the purely herbivorous animals. The incisors (I) are evidently intended for biting and cutting the fruits, grains, roots, or other vegetables designed for his subsistence; the cuspid, corner, or canine tooth (C) enables him to grasp more firmly and retain more securely the alimentary substance; and the bicuspids (B) and molares (G), or small and large grinders, are fitted to mash and grind all dry, solid, or hard articles of food.

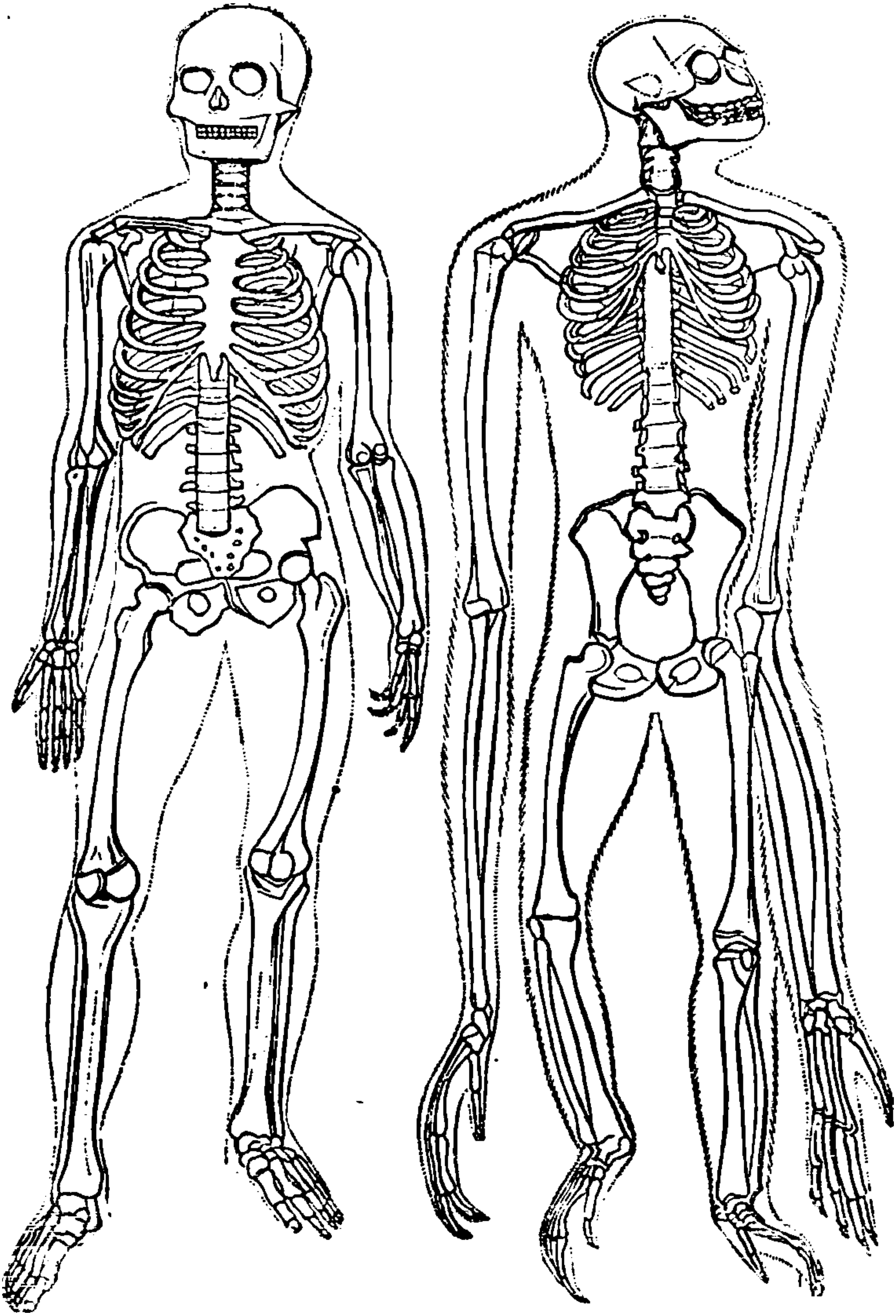
The human masticatory organs, on the whole, exhibit no evidence of any structural arrangement which is not precisely fitted for and exclusively adapted to a vegetable diet. The human teeth can, however, cut and tear flesh to some extent; and so can carnivorous animals break and mash fruits and seeds to some extent. Experiments have also proved that each class of animals may be made to approximate the other, to some extent, in character and disposition, by changing their dietetic habits. Young tigers and young lions have been restricted to vegetable food, during which time they remained docile and governable; but on tasting raw meat, the dormant propensity to tear the warm, quivering flesh, and drink the red blood of other animals, was immediately aroused, and all the ferocity and cruelty of a carnivorous nature was again in the ascendant.

"Just as the twig is bent the tree is inclined," physiologically as well as morally. Those mothers who *force* their little children, even before they are capable of masticating a particle of it, to swallow flesh, and thus develop an early appetite for it, are little aware how seriously they are injuring the organizations and corrupting the whole nature of the future men and women.

Lastly, we have, in Fig. 161, a view of the entire skeleton of man, compared with that of a purely frugivorous animal. Not only is the agreement perfect with respect to the masticatory organs, but the whole digestive apparatuses of both are precisely alike; and even the entire conformation of the body of the orang-outang, considered dietetically or physiologically, resembles the human animal, incomparably more nearly than any other animal does. How, then, can we draw from the structure of man, as compared with other animals, any inferences at war with the divine commandment recorded in the Scriptures?

THE PHYSIOLOGICAL EVIDENCE.—Physiologists have noticed that the blood of flesh-eating animals undergoes putrefaction much sooner than that of a vegetable-eating animal. The chyle of flesh-eating men, when taken out of the body, decomposes and becomes putrescent in less than a quarter of the time required for that of the vegetarian to undergo the same process. All the secretions of vegetarians are more pure, bland, and copious, and the excretions—the sweat, urine, fecal matters, etc.—are less offensive to the senses, and less injurious in their exhalations, than are those of persons who subsist on a mixed diet. The teeth of vegetarians are less affected with tartarous incrustations, and their breath is mostly or entirely free from the rank, cadaverous, pestilent odor so common to flesh-eaters. Medical authorities generally agree that flesh diet makes the blood *prone*, and the whole body disposed to, the inflammatory and putrid diatheses. Some few medical writers have, however, *asserted* that an exclusively vegetable diet predisposes to *scurvy;* but as they have not sustained the assertion with any sort of evidence, it is hardly worth refuting. The vegetarian can always endure hunger and thirst longer without loss of strength, and sustain entire privation of food with much less suffering than flesh-eaters. The appetite of vegetable-eaters is invariably good, and food has always a keen relish, while it often fails with flesh-eaters requiring frequent changes of dishes, or a variety of seasonings, to render it palatable. Digestion with the vegetarian is unattended with that disturbance, heat, irritation, oppression of the stomach, and dullness or drowsiness of the head, which flesh-eaters generally experience after dinner, and which some physiologists, on the mistaken supposition that it was natural, have called the "fever of digestion." Drowsiness, sleepiness, and mental stupidity, so common after a full meal with flesh-eaters, are wholly unknown to vegetarians, when their other habits are correct. These can resume any bodily or mental labor immediately after a meal, with incomparably less discomfort, and greater immunity from evil consequences, than can flesh-eaters.

Fig. 161.



THE HUMAN SKELETON COMPARED WITH THAT OF THE ORANG-OUTANG

All the mental passions of the vegetarian are more governable and better balanced, more easily regulated by the judgment and controlled by the will, less violent, but more enduring than those of flesh-eaters. The firmest and most vigorous structures of body are found among vegetable-eaters, in proof of which we need only refer to the toiling millions of Europe and the Eastern nations. Vegetable-eaters possess an elasticity and flexibility of moving fibres, and a tenuity and purity of circulating fluids, which enable them to work their bodies and brains more severely, more constantly, with greater ease and facility, and with less "wear and tear," than flesh-eaters can; and when fatigued by excessive exertion of body or mind, they will recover, by resting, in a much less period of time.

Extremes of heat and cold, and exposures to atmospheric vicissitudes, are better endured by vegetable-eaters. When in ordinary health, those who subsist on an exclusively vegetable diet are never very fat nor extremely lean. All the senses of the vegetable-eater—tasting, smelling, hearing, seeing, and feeling—are more healthfully acute, and less morbidly sensitive than are those of flesh-eaters. Bodily symmetry and personal beauty have always distinguished those who have subsisted mainly on vegetable food from those whose principal diet has been animal food, other circumstances being equal.

The Medical Evidence.—That vegetable-eaters are not only less liable to epidemical and infectious diseases of all kinds, but much more easily cured of them, either by the efforts of nature or ordinary remedial means, is a fact pretty well established by the observations of medical men. Wounds, bruises, burns, and scalds are also more easily and more perfectly cured. The united testimony of the English Vegetarian Societies, many of whose members have abstained from flesh for thirty or forty years, and some during their whole lives, is in favor of its superior healthfulness. The American Vegetarian Society, instituted in the city of New York in April, 1850, contains in its ranks old men who have for an ordinary lifetime enjoyed almost uninterrupted health, and several who have almost regenerated broken-down constitutions on an exclusively vegetable diet. The Bible Christians, of Philadelphia, who have adopted vegetable diet on religious convictions, have always, as a society, been remarkably exempt from epidemics, which have frequently prevailed around them. During the cholera seasons in New York—1832, 1834, and 1849—no persons whose habits of living approximated very nearly to the "Graham system" died of the disease; and no one who lived strictly according to his teachings had an attack. Missionaries and teachers have, within a few years, gone from the

United States to the sickly parts of Africa, and, by adopting an exclusively vegetable diet, escaped all the attacks of disease which others have experienced, and which are usually considered as incidental to the climate. The same is true of Northern men who, in removing to or traveling through the Southern states, have adopted the vegetable system of diet.

But more striking and, to many minds, more convincing evidence, is furnished in the numerous examples of chronic diseases and malignant ulcers, which have resisted all remedial agencies under a mixed diet, yet have been readily healed under a vegetable regimen. Dr. Lambe succeeded, in cases of cancer, scrofula, consumption, and other maladies which had progressed to the incurable stage, in arresting the ravages of the diseases, and protracting the period of life for many years, by a strict vegetable regimen, and the use of distilled water for drink. The celebrated Dr. Twichell, of New England, has recently cured himself of a malignant tumor of the eye, which has troubled him for ten years, and which had been once excised and once cauterized, with but temporary benefit, by adopting a diet of bread and cream. I have now a patient under treatment for a tubercular affection of the lungs, who, two years ago, was afflicted with a foul and malignant ulcer of the cheek, deeply involving the upper maxillary bone. After trying the ordinary medication in vain, and submitting to the operations of cutting and cauterization without avail, the patient, against the remonstrances of friends and physicians, abandoned flesh-eating, after which the ulcer healed rapidly.

THE CHEMICAL EVIDENCE.—All the light which chemistry is able to throw on the subject of diet is in favor of vegetable food exclusively. Nothing is more common than for medical books and writers to tell us that animal food is more *nutritious*, more *concentrated*, and more *digestible* than vegetable. But these terms are generally employed without any very precise meaning. The truth is, some kinds of vegetable food, as the cereal grains, are more nutritive, pound for pound, than any kind of animal substance; other kinds, as fruits and most esculent roots, are less nutritive. The term concentration has scarcely any meaning applied to animal food, for although some kinds of animal food are more nutritive than others, there is, except in the separation of the curdy and oily matters of milk from the watery part, no method known of separating the nutritious from the innutritious element; and such an invention, should it ever be produced, would tend powerfully to bring animal food into disuse. Some vegetables, and some kinds of fruit, digest, or rather *dissolve* in the stomach sooner than some kinds of animal food, but not as rapidly as other kinds; but the length of time necessary for the digestion of an article of food proves nothing for or against it.

If we determine the value of foods strictly by the rule of chemical analysis, according to the Liebig school, we shall find that good wheaten bread, rice, and lentils, contain four times as much nutritive virtue as the best flesh-meat, while potatoes contain at least an equal amount. If we admit Liebig's theory of the combustion of carbon to sustain the animal temperature, we shall find abundance of carbon, *and the best kind of carbon*, in vegetable food. And if we accede to the doctrine of the *nitrogenous* and *non-nitrogenous* distinctions of alimentary principles, we find nitrogen supplied in nearly all kinds of vegetation, and an inexhaustible resource, in case of accidental scarcity in the vegetable kingdom, in the atmosphere which surrounds us.

The Experimental Evidence.—We have no account that Adam and Eve ever departed from the commandment of God in their dietetic habits, and in the absence of all evidence to the contrary, we are bound to believe they were consistent vegetarians. Although the children of men went astray in an early period of the world's history, "by dipping their tongues in gore," and a large proportion of the human family has continued in the trangression ever since, yet there have been, at all times, men of superior intelligence and high-toned morality, who have rigidly abstained from flesh-eating. Among them we find poets, philosophers, and prophets, distinguished alike for "temperance in all things," purity of life, rectitude of deportment, and length of years.

Pythagoras raised up a society of vegetarians 550 years before Christ. Josephus testifies that the Essenes, a sect of the ancient Jews, numbering several thousands, were long-lived because of their regular course of life and simplicity of diet, which Pliny tells us consisted of the fruit of the palm-tree. It is certain, however, that they were vegetarians after the Pythagorean philosophy. The Bramin priests, who are a very numerous sect, are all strict vegetarians. Sanchoniathan, a Phœnician historian, Hesiod, the Greek poet, Pythagoras, the philosopher, Herodotus, a celebrated ancient historian, Hippocrates, the father of medicine, Diodorus Sicculus, the historian, Ovid, the poet, Ætianus, a Greek historian, and Pliny, the Roman naturalist, all testify that the primitive inhabitants of the earth subsisted on a vegetable diet alone.

Pliny, Plutarch, Galen, and Porphyry, testify to the good effects of vegetable diet in developing bodily vigor, and enabling men to bear hunger, thirst, heat, or cold.

Among the modern names of distinguished individuals who have borne testimony in favor of vegetable diet as conducive to the highest physiological and psychological interests of man, derived from observation, reflection, and in most instances from personal experience, we may notice the celebrated Dr. Cheyne, of England; Sir John Sinclair, an eminent British surgeon; Dr. Cullen, of Edinburg; Dr. R. Jackson and Gen. Elliot, of the British army; Sir William Temple; Professor Adam Ferguson; Rosseau; Newton; Dr. Whitlaw; Lord Bacon; Sir Richard Phillips; Howard, the philanthropist; Dr. Hufeland; Peter Gassendi, a famous French philosopher; Dr. Taylor; Dr. Abernethy; Lord Kaims; Professor Dick; Shelley, the poet; Mr..Shillitoe; Rev. John Wesley; Lamartine; the Abbe Gallani; Benjamin Franklin; Dr. Muzzey, of Cincinnati; Dr. Jennings, of Oberlin; "Father Sewall, of Maine; Dr. S. Graham, of Northampton; Dr. Alcott, of West Newtown; Rev. William Metcalf, of Philadelphia; Dr. James, of Wisconsin; Dr. Grindrod, author of Bacchus; O. S. Fowler, the phrenologist; and a host of others who could be named.

But all human experience, rightly apprehended, is in favor of vegetarianism. It is a fact which no intelligent historian will dispute, that the most robust and enduring laborers of all ages and countries ever have been, and still are, in the main, vegetable-eaters. The peasantry of England, Scotland, Ireland, Italy, Turkey, Greece, Germany, Switzerland, France, Spain, Portugal, Norway, Sweden, Denmark, Poland, and many parts of Russia, subsist principally, and many of them entirely, on vegetable food; and the finest specimens of health, strength, and activity are found among that portion of the peasantry of several of the above countries, who use no animal food at all. The greater portion of the inhabitants of Asia and Africa use but an insignificant trifle of animal food. The millions of Hindostan and China use so little animal food that it may be regarded as a seasoning rather than a substantial part of their diet. The Greek and Russian laborers, and the lazzaroni of Naples, subsist on a diet principally of coarse, farinaceous food, and they are as athletic and powerful a race as can be found. The Irish immigrants, whose brawny arms and powerful sinews perform the hard work of excavating our canals and constructing our railroads, which our flesh-bred American laborers have not strength to do, have generally acquired good, vigorous constitutions on the coarse, vegetable, potato diet of the old country. The Georgians and Circassians, the natives of the Otaheite, Sandwich, and Pitcairn's Islands, the people of the Marquesas and Washington Islands, the Indians of Mexico, on the Tobasco, the Polish and Hungarian peasants from the Carpathian Mountains, the Spaniards of Rio Salado, in South

America, and the Peruvians, subsist mostly on coarse, plain, vegetable food, and they are among the most beautiful as well as the most hardy and enduring people on earth. The slaves of Brazil, the laborers of Laguira, the Moorish porters at Gibraltar, and the porters at Terceria and Smyrna, subsist on a spare, simple, vegetable diet, scarcely ever partaking of animal food; they possess a most powerful muscular development, and are able to carry burdens of from two hundred to eight hundred pounds.

A glance at those nations and tribes whose inhabitants subsist mostly on animal food, will set the argument in a stronger light by the contrast. The Laplanders, Ostiacs, Samoides, Tungooses, Burats, Kamtschatdales, and Esquimaux, in the north of Europe, Asia, and America; the inhabitants of Terra del Fuego, in Southern America; the people of Andeman's Island in the Pacific, the natives of New Holland and Van Diemen's Land, and the Calmuck Tartars, all possess a low, deformed, and demi-brutal organization; some of them are stunted and dwarfish, others are coarse, rough, and hideous. Their principal food is fish, flesh, and all kinds of animal fats and oils which they are able to procure. It should be remarked, too, that the intellectual and moral constitution of these inferior races of men is as degraded and depraved as is their bodily organization.

But it will be readily admitted by most persons that a diet nearly all vegetable is better than a diet nearly all animal, while they will contend that a due admixture of animal and vegetable substances is the golden mean between the two extremes; and in support of this position we shall be referred to the well-fed of the Anglo-Saxon race, and particularly the better classes of Europe and America. But this objection is easily met. We have but to compare flesh-eating Englishmen, Irishmen, Scotchmen, Americans, etc., with vegetable-eating Englishmen, Irishmen, Scotchmen, Americans, etc., of the same class, and of the same general habits in other respects, and the problem is solved. The contrast ever has been, and I am fully persuaded ever will be, in favor of the superiority of an exclusively vegetable diet.

If, however, the past experience of the whole human family for six thousand years, and the coincident testimony of all respectable scientific authors who have ever investigated the subject is not satisfactory, we can furnish living, acting, moving, practicing demonstrations in the present tense. James Simpson, Esq., president of the English Vegetarian Society, stated at a public meeting held at Glasgow, June 17, 1851, that of the individuals belonging to the society, numbering between 600 and 700 adult members, 203 have abstained from all kinds of flesh for upward of ten years; 153 for more than twenty years;

91 for thirty years; 29 for forty years; and 85 have abstained the whole of their lives. These vegetarians belong indiscriminately to all trades and professions, and have, as a body, always a much higher and more uniform standard of health than flesh-eaters under similar general circumstances, and many of them have experienced a wonderful improvement in bodily vigor and mental vivacity.

But we have equally interesting facts in the United States. The American Vegetarian Society, though of more recent date and fewer numbers, has in its ranks full-grown men and women who have never tasted "flesh, fish, or fowl." Rev. Mr. Metcalfe, who is the corresponding secretary of the society, and also pastor of the Society of Bible Christians, who have adopted vegetarianism from religious motives, has practiced the vegetarian system for more than forty-one years, as has also his wife. In a late number of the Vegetarian Advocate he says: "We have raised a family of five children, none of whom have ever eaten flesh. They are all married to vegetarians; they all have children, none of whom have ever used animal food; they are healthy, vigorous, and intellectual." In this society there are now fifty-one persons who have never eaten flesh, nor tasted intoxicating drinks.

CHAPTER II.

HYDROPATHIC COOKERY.

Practical Considerations.—Though I am most thoroughly convinced of the superiority of a properly-regulated vegetable over the best plan of a mixed diet, yet I am equally well aware of the many difficulties in the way of the practical application of this truth. The greatest difficulty of all is the fact that any considerable change of dietetic habits, whether it be to better or worse, usually produces more or less disturbance of the digestive apparatus; and if the change be from a more concentrated and stimulating to a more simple, coarse, watery, and unirritating diet, the change will be attended with a degree of languor, depression, and sense of debility, proportioned very nearly to the extent that the individual has been injured by stimulation and concentration. This is an exceedingly important principle in hydro-therapeutics, as well as the most difficult point to manage successfully in the whole Water-Cure system; hence it ought to be well understood by both practitioner and patient.

It may be stated as a general rule, that *the greater the necessity for a change of dietetic habits, the more will the individual suffer temporarily in making such change;* the worse the physiological condition produced by dietetic errors, the more will the feelings rebel against a removal of the cause. This perverted sensibility is the rock on which so many have been wrecked in their attempts to reform their dietetic habits. Reason points in one direction, but feeling impels another way, and usually the latter triumphs.

All persons know *how* they feel; but all do not apprehend the true sources of their good or bad feelings, and the majority mistake the sense of mere stimulation for the condition of actual strength; they do not distinguish between the feeling of strength and vital power; they do not consider that strength or power is only shown in its waste or expenditure, not in its accumulation or possession. To illustrate: A man who has long been accustomed to the habitual use of intoxicating liquor of any kind, will experience a great degree of prostration, sometimes amounting to *delirium tremens*, on abstaining from it. The apparent exhaustion will be in the exact ratio that his system has been morbidly affected by the alcohol. The habitual tobacco-chewer, on abandoning the use of that narcotic, feels himself to be but the wreck of a man; his limbs tremble, his brain reels, and "horrors on horror's head accumulate." His perverted instincts cry out, as it were, for more tobacco, and his *feelings* tell him that the weed is the true "elixir of life," and if he takes another quid he is at once happy within himself, and at peace with all the world again. Those who have stimulated freely on tea and coffee will often suffer intense headache, giddiness, and nervous debility for several days, sometimes for weeks, on discontinuing them, before the system will recover its normal balance, and feel *natural* without artificial aid. Here we discover the law of conformity. The human organism has a wide range of adaptability; it conforms itself as well as possible to every thing brought in contact with or forced upon it. This principle of adaptability is essential to its existence; for if every succeeding dose of spirituous liquor, tobacco, tea, coffee, or other injurious agent, produced an effect equal to the first, the body would very soon be destroyed. The vital powers may have the ability to defend themselves against deleterious stimulants for half a century, more or less, and have natural ability to sustain existence two or three times as long, if not wasted in this unnatural warfare. Let us apply these considerations to the employment of food.

A person long accustomed to the use of animal food two or three times a day, or of several kinds at a meal, will feel usually a great sense of weakness, or rather a disagreeable craving and want of satisfaction, in the region of the stomach, on the adoption of an exclusive vegetable diet; so, too, one accustomed to the employment of nearly all concentrated preparations, as fine or superfine flour, for the farinaceous part of his diet, will find the first employment of coarse, unbolted meal, and many kinds of watery vegetables and fruits, attended with unpleasant distension of the stomach, flatulence, acidity, etc., also, those accustomed to stimulating condiments, as pepper and mustard, generally find nearly all sorts of food to feel heavy and sit uneasily on the stomach, on first adopting plain, unseasoned dishes; and even many persons who have used animal food very moderately once a day, experience considerable disquietude in the digestive organs, with a constant craving for some kind of stimulus, on totally abandoning flesh-meat; and this craving may re-occur occasionally for months.

Now if all persons were to follow their feelings as the proper dietetic guide, all persons would forever continue on in whatever dietetic system should once become with them an established habit. It is clear, therefore, that in prescribing a dietetic course for invalids, our reason, and not their feelings, is the better guide. Our aim is not to pamper morbid, but to restore healthy appetites. I have had many patients under treatment whose first meal of wheaten grits and milk, or brown bread and baked apples, raised a tremendous commotion in the stomach, producing distension, nausea, and headache; and yet in a few days the same persons would partake of them with a keen relish, and with perfect satisfaction to the stomach.

But in laboring to introduce better habits of living, and in dealing with invalids, we must take mankind in general, and patients in particular, as we find them, not as we would have them; and in advising a particular course of diet, or in recommending changes in the accustomed regimen of individuals, we must, to be useful, have regard to what is possible in practice, as well as to what is true in theory. Our advice is sought by thousands who have not the means to carry out a well-regulated plan of vegetable diet; and a well-regulated mixed diet is far preferable, therapeutically, to a very bad selection of vegetable food. At ordinary hotels and boarding-houses, the fruits and vegetables are not selected with especial reference to their dietetic qualities, and their attractiveness depends much more on the butter, sugar, vinegar, or spices, with which they are served, than upon their own intrinsic gustatory properties, while nearly all the farinaceous parts of the food are brought from the baker's shop, or prepared according to the recipes of "French" and "domestic" cook-books, which teach little else than the art of compounding dishes so as to produce the greatest possible amount of disease in the human body Here, then, is a predicament.

Many persons find it convenient or necessary to take their meals at these hotels and boarding-houses, where animal food constitutes the best articles of the table. Plain flesh-meat is not liable to the objection of concentration or complication, and if of good quality it contains the proper relations of bulk and nutriment. All the objections to animal food may be summed up in a single word—*impurity;* yet if it be of the best quality and properly cooked, it is an absolute advantage, a corrective to a diet consisting mainly of baker's bread and sweet cakes.

How far, therefore, it is expedient for a Water-Cure patient, who intends remaining at an establishment a few weeks, and then returning to his former boarding place, or usual dietetic habits, to adopt vegetarianism, must be left to the intelligent physician, in view of all the circumstances of each particular case. It is very certain that many patients require, for successful treatment, total abstinence from all animal food, not even excepting milk, and that the majority will obtain more speedy and thorough cures under a well-regulated vegetable diet; yet it is equally certain that a large proportion of invalids can be cured, and can subsequently enjoy, comparatively speaking, very good health, on a plain mixed diet. But the duty of the true hydropath is not limited to being a mere curer of disease. His is a higher, nobler mission. He is, or should be, a reformer in the broadest sense. It may do for the drug-tinkerer who only studies the philosophy of death, who contemplates the machinery of life only in its abnormal manifestations, whose ambition is mainly to silence, scatter, subdue, change, or otherwise modify the phenomena of morbid symptoms, and who is as profoundly ignorant of the philosophy of life as of any other subject he has never studied—it may do for him to medicate the existing maladies of mortals with all his might, while he leaves the causes in operation which produce other maladies as fast as he can modify existing ones. But better things are expected of a hydropathic physician, who claims a knowledge of the laws of life and health, and professes to cure disease by removing the conditions upon which it depends, and preserve health by avoiding the causes which produce disease.

While, therefore, we yield to circumstances we cannot control, until society can be more thoroughly indoctrinated in the true science of life, we should make the best we can of unavoidable evils. We can and should at once reject all the immense variety of complicated dishes of animal food, all unclean and filthy animals, and all the unclean and unwholesome parts of animals, confining our dietetic prescriptions to a few of the very best articles and preparations. That patient or that individual whose appetite cannot be satisfied, as far as flesh, fish, and fowl are concerned, on seven dishes per week, with a change for every day in the week, furnishes an example of a deeply-depraved appetite, and an additional evidence, if any is wanted, that all flesh-eating is a departure from the physiological laws which the Creator has implanted in the constitution of man.

Preparations of Animal Food.—Consistently with the principles advocated in this work, all animal broths, soups, teas, all pickled, salted, and smoked meats, all kinds of shell-fish, all fried dishes, all dishes cooked in butter or other grease, all minced or other meat pies, all very oily or greasy animals or parts of animals, all and every thing pertaining to the swine—pork, bacon, lard, sausages, etc., and all very young or very old animals, are to be considered as among the things prohibited.

Beef-steak, cut from the sirloin, well-pounded and broiled, is probably the very best food that can be obtained from domesticated animals. The pieces called "porter-house steaks" are more tender, but too fatty.

Mutton chops, prepared in the same way, are next in the order of preference. For those who have feeble teeth they are better stewed in water until they are very tender. These chops should be well cleaned of the fatty matters.

Boiled mutton is nearly equal to the former in healthfulness; the leg is the preferable part.

Slightly corned beef, boiled till the fibres cut easily, is admissible. The lean pieces are to be selected; the rump piece, or round, is one of the best.

Roast beef is also an admissible article. The sirloin piece is, on all accounts, to be selected for roasting. As the roasting process of cooking renders the fatty matter particularly obnoxious, this should be carefully trimmed off before cooking.

Beef hash, made by chopping cold corned beef or beef-steak fine, and warming it up with three or four times the quantity of cold boiled potatoes and water, no butter or grease being employed, is not objectionable. The flesh of some wild animals of the herbivorous kind is at least as healthful as that of any domestic animals, as the deer, hare, rabbit, etc., and may be prepared and employed under the same regulations.

White fish, which are not oily nor strong, broiled or boiled, may be occasionally substituted for flesh. The cod, halibut, trout, black-fish, white-fish, and perch, are among the best. Eels, salmon, mackerel, herrings, shad, sprats, etc., are among the greasy varieties. Fish are more dry and unsavory than flesh without gravies. If a gravy is employed, it should be made of water, milk, a little salt, and thickened with a little flour or meal.

The *barn-yard fowl* is the best kind of domestic poultry. The turkey does not differ much in wholesomeness from the common chicken, yet its flesh is not as well relished without gravies or seasonings. Geese and ducks should be ruled away from the table. Chickens may be broiled, boiled, or stewed in water with equal advantage, taking care to skim off the floating particles of oil when cooked in either of the last two methods.

Eggs, rare-boiled, are admissible occasionally They should always be very fresh, and cooked by standing seven minutes in water, which is to be poured upon them at the boiling point, but not allowed to boil afterward. This method deprives them of the raw taste, and yet leaves both the white and yolk soft and digestible. Poached eggs, omelettes, etc., are outrages upon human stomachs.

Here we have a list of the best or least objectionable kinds of animal food, which can be so managed, if desirable, that the same article need not occur but once in two weeks; and surely the appetite that cannot be satisfied on this extent of variety, would still want something more if it had all the beasts of the field, and fishes of the sea, and birds of the air, spread out before it. But the true policy of a dietary system, as far as relates to animal food, is to simplify as much as possible, and to employ as few kinds as may be; therefore the very best articles in our list—beef and mutton—ought to come upon the table much oftener than fish and fowl.

Milk, when employed at all, should always be used moderately by invalids, rather as a seasoning than a part of the food. Very little should be taken at the evening meal, as it is apt to irritate the kidneys, or produce restlessness and uneasy sleep, with feverishness, and dryness or bad taste in the mouth. Sour milk, whey, or buttermilk, are no better in any case than pure water; but many persons are fond of them, and I regard them as entirely harmless. *Boiled milk* is regarded by some as more suitable for dyspeptics. No doubt it will feel more agreeable in cases wherein raw milk produces flatulence; but it is constipating, and in such cases milk had better be avoided entirely.

Pot cheese, *fresh curd*, and very *new pressed cheese* are not objectionable when used moderately as relishes. The former article should never be made in the common brown earthen vessels, as the lead employed in glazing them is acted on by the acid of the milk, and a poison ous salt of the metal produced. Several cases of poisoning from this cause have been lately reported in the newspapers.

Butter should always be as fresh as possible, but moderately salted, and eaten cold. Dr. Johnson *(Domestic Hydropathy)* gives us an excellent rule in relation to bread and butter. He says: "For breakfast and supper there is nothing better than bread and butter. *But the butter should be as small as possible in quantity.*"

PREPARATIONS OF VEGETABLE FOODS.—Vegetarians can prepare an unlimited variety of dishes, and still preserve the characters of simplicity and healthfulness. All pure and undepraved appetences, however, are satisfied with moderation in variety as well as in quantity. Invalids should not study so much to ascertain how many kinds of food they can bear, as to learn what particular combination of articles is most conducive to the recovery of health. But we can easily present an ample variety, so that all can select according to taste, fancy, or convenience, or in reference to personal peculiarities. This part of our subject may be conveniently arranged under the following heads:

a. Breads.—Unquestionably the best bread is that made of coarse-ground, unbolted meal, mixed with pure water, and baked in any convenient way. The earliest bread-makers pounded the grain on a smooth stone or in a mortar, wet it with water, and baked it before the fire or in the ashes. Various savage tribes have made corn-bread in a similar manner, and all who have partaken of it testify to its delicious flavor and excellent quality. The inhabitants of new countries, where flouring-mills are not to be found, frequently resort to this method of bread-making from necessity, and they have a sweet and wholesome article when they do not spoil it with grease, or shortening. Many of the New England housewifes formerly had a method of making bread without raising or fermentation of any kind, and I believe it is still practiced to some extent. It is made generally of a mixture of wheaten and rye flours and Indian meal. Wheat-meal, with a small proportion of Indian, makes a fine unleavened bread. It may, however, be made of wheat-meal alone, or of rye and Indian, or of various other admixtures. Fine wheaten flour alone will not make good bread in this way. Of whatever meal or flour composed, it is to be wet up with water or milk, or both, into a moderately stiff dough, and baked in the old-fashioned iron baking-kettle for several hours. The New England custom was to make the bread in the evening, put it in the kettle, cover it sufficiently with hot ashes and coals, and let it remain until morning, when as good, sweet, and wholesome bread as mortal ever tasted, would be found on the breakfast table.

For making *unleavened* bread, the grain should be thoroughly cleaned, all foreign ingredients removed, the husks of oats and buckwheat and the hulls of corn carefully separated. If ground at an ordinary flouring-mill, the mill-stones should be sharp, so as to cut the seeds into fine particles. If mashed by dull stones, the bran appears in flakes or scales. The meal should never be bolted. Great pains should be taken to procure a plump, sound article of grain, and families would do well to keep a hand-mill, and grind it for themselves, as all kinds of flour and meal are much better and sweeter fresh-ground than when kept a long time. A large coffee-mill will answer very well, although it usually makes the meal rather too coarse and uneven.

Wheat-meal makes the very best unleavened bread. New meal is to be wet with *pure soft* water—it is important that the water be *pure;* then formed into very thin cakes, and well baked in an oven, stove, reflector, or before the fire on a plate or board. Indian meal, managed in the same manner, makes an excellent bread. It may be made thicker than the wheat-meal cakes. It is called in this country, *Johnny-cake*, or *hoe-cake*. The fine Indian meal often found at groceries and provision stores, does not make good bread or cake; it is, when cooked, heavy, sticky, and clammy, whereas the coarse is light, dry, and porous. Oatmeal may be prepared in the same way; it is more pleasant made into extremely thin cakes, or wafers. Rye, buckwheat, millet, and barley may be formed into similar preparations of bread; but they are less agreeable, and, as the other grains are more plentiful and more economical, as well as more pleasant, it is hardly worth while to extend this list. In making any of the above breads, cold or warm water may be employed; some prefer scalding the meal.

The most common as well as the best kinds of unleavened bread made from mixtures of various coarse meals are: 1. Wheat and Indian meals in equal proportions. 2. Two parts of wheat-meal to one of Indian. 3. Three parts of wheat-meal to one of Indian. 4. Four parts of wheat-meal to one of Indian. 5. Equal parts of wheat-meal and oatmeal. 6. Six parts of wheat-meal to one part of soft-boiled rice. 7. Equal parts of rye and Indian meals. 8. Equal parts of rye, Indian and wheat-meals. 9. Two parts of rye-meal to one of Indian. 10. Two parts of Indian to one of rye-meal. 11. Two parts of Indian meal to one of rye-flour.

Very good and wholesome breads can also be made of wheat or other meal, and the addition of some one of a variety of vegetables and fruits. Among the best are: 1. Three parts of wheat-meal to one of soft-boiled beans. 2. Three pounds of wheat-meal to one pound of good mealy potatoes. 3. Seven pounds of wheat-meal to two of soft-boiled split peas. 4. Three or four parts of wheat-meal to one of soft-boiled chestnuts. 5. Two or three parts of wheat-meal to one part of good sweet or moderately tart apples, pared, cored, and stewed or baked. 6. Three or four parts wheat-meal to one of West India pumpkin, or marrow squash, or cream squash. A fair article of bread can also be made of three parts of wheat, corn, or barley-meal, to one of powdered comfrey root; also of three parts of wheat-meal to one of boiled and pounded green corn.

I am satisfied that if our good mothers and intelligent sisters would give their attention less to mixed meat dishes and cake compounding, and more to bread-making, they would improve very much on all the methods of preparing bread-food now in use. For one I am greatly in favor of the combination of meal with roots and fruits; and the few experiments I have been enabled to make in this line have satisfied me that most delicious bread, and more advantageous, considered in reference to the usual dietetic habits of society, than even the best wheat-meal bread, can be made of wheat-meal and good mealy Irish potatoes, or sweet potatoes, or good mealy apples and pears, and probably a variety of other fruits and vegetables; nor can I see any reason why dried or preserved fruits can not be advantageously employed in this way, although I have never seen the experiment tried. I know it may be replied to this, that people may as well eat the clear meal-bread, and a due supply of the less nutritious fruits or vegetables with it. So they may. But if they *will not*, and *will* use the proper proportions of each when compounded into the shape of bread, they had better have the bread. This kind of bread would also be a great convenience, to say the least, to persons who are obliged to travel much, and who desire to "eat to live" while on a journey as well as when at home.

Fermented breads may be made of any or of all the articles or combinations mentioned above. But wheat, from its larger proportion of gluten, is greatly superior to all other grains for making fermented bread. The best *ferment* is good hop yeast or potato yeast. Milk yeast makes a very good bread, but it will not keep well. Distillery yeast, though much used in cities where distilleries and breweries are common, never makes good, sweet bread, but always imparts to it a strong, disagreeable, musty flavor. There are several ways of making good yeast, either of which may be employed, as most convenient. I know no better recipe for *hop yeast* than the following, copied from Graham's Science of Human Life: "Boil a double handful of hops in a gallon of water for fifteen or twenty minutes; strain off the liquor while scalding hot; stir in wheat-meal or flour till a thick batter is formed; let it stand till it becomes about blood-warm, then add a pint of good, lively, fresh yeast, and stir it well, and then let it stand in a place where it will keep at the temperature of about 70° Fah., till it becomes perfectly light." This yeast will keep from one to two weeks, if corked tight in a clean jug, and placed in a cool cellar.

Yeast cakes, which may be kept for weeks or months, are made by stirring good light yeast into Indian meal, until a fine dough is formed, which is to be made into thin cakes and perfectly dried. It is best when dried by exposure to a warm dry current of air, or what is called a drying wind. Sunlight or fire seems to impair its properties. Some persons add a little rye-meal to make the Indian more adhesive. These cakes, which are commonly called *hard yeast*, require to be kept in a cool and dry atmosphere. One of these cakes, an inch thick, two inches wide, and three inches long, is sufficient for four quarts of flour or meal. They are soaked in milk or water until completely dissolved, and then employed like other yeast.

Hard flour yeast, or *rubs*, is preferred by some to the former preparation. It is made by mixing the yeast with wheat-meal or flour so that it will be formed into hard lumps; it is then dried in a warm place, without exposure to the sun. The finer particles are for immediate use, and the larger lumps may be put into a bag, and hung in a dry, cool place. In using these "rubs," about a pint are necessary for six quarts of flour. It is usual to let them soak from noon till night, on the day preceding that for wetting up the bread.

Some persons may desire to know how to make yeast without yeast, in other words, how to procure the *original ferment*. It may be obtained by subjecting any kind of meal or flour to fermentation. Wheaten flour or meal is generally employed. Mix the meal or flour with water or milk into a batter or dough, and let the preparation stand exposed to a temperature of about summer heat—60° to 70° Fah., until it "raises" or ferments; it will then communicate the fermenting property to any other material capable of undergoing a similar process. The ferment can be created more rapidly by the addition of mashed potatoes and molasses.

Potato yeast is a favorite with some domestic bread-makers, and it is certain that excellent bread can be made with it. It will not keep as long as the hop yeast, but it has the advantages of rising quicker, and of not imparting the sharp, harsh taste to bread that the former does, when not carefully managed. Miss Beecher (*Domestic Receipt Book*) gives a good recipe, with the exception of the distillery yeast, which I have substituted by baker's yeast. I have also omitted the salt, which appears to be a kind of *fixture* in every preparation or thing mentioned in her book: "Mash half a dozen peeled boiled potatoes, and mix in a handful of wheaten flour [or meal], and after putting it through a colander, add hot water till it is a batter. When blood-warm, put in a tea-cup of baker's yeast. When raised, keep it corked tight."

Milk yeast, or *risings*, is made by mixing two table-spoonfuls of flour or meal with a quart of new milk, and keeping the preparation at about or a little below blood-heat for an hour or two. It requires nearly twice as much of this as of the ordinary hop yeast for a loaf of bread. For those who are fond of milk, this yeast makes an agreeable bread, to be eaten the next day after being made. In warm weather it soon spoils.

All bread-makers ought to be thoroughly acquainted with the *theory of fermentation*; although many persons acquire, by practice and observation, the tact of managing the fermenting process very well, a knowledge of its theory would enable all to succeed more uniformly, as well as qualify them to detect the errors and correct the mistakes of others. *Panary fermentation*, or, which is the same thing, *vinous fermentation*, is the decomposition of the sugar or saccharine matter of the grain, and the recombination of its elements so as to produce carbonic acid gas and alcohol. The alcohol is mostly dissipated by the heat of the oven, the remainder evaporating subsequently, and the carbonic acid gas, being retained by the tenacious gluten, puffs up or raises the dough. If the yeast is not intimately mixed with every particle of the meal or flour by thorough kneading, the fermentation will be unequal, and some portions of the bread will be compact and heavy, while others are marked with open cavities. If the dough is well kneaded, yet not allowed to raise sufficiently, it will be heavy, raw, and clammy; if fermentation is allowed to proceed too far, the starch and mucilage are, to some extent, destroyed, and the *acetous fermentation* commences, which develops vinegar, rendering the bread disagreeable and sour; and if the fermentation is allowed to proceed still further, the gluten is more or less decomposed, literally *rotted*, and the *putrefactive stage* of fermentation exists; the bread is then exceedingly dry, harsh, and as unpalatable as a dirty chip. It will be seen, therefore, that the management of yeast bread requires the most careful attention, and affords room for the exercise of no small degree of judgment. It is a common error to regard bread as not over-fermented unless it is sensibly acid to the taste. Fermentation may be carried so far as to destroy the richness and sweetness of the loaf, and yet arrested by the heat of the oven at a point just short of developing any appreciable sourness. It is here that the majority of domestic bread-makers fail. If it does not feel sticky and heavy, on the one hand, nor taste sour, on the other, it is pronounced good. But all really good bread must, in addition to these negative qualities, possess the positive recommendation of being in every way delicious to the senses.

Whether fermented bread is made of fine or superfine flour, or unbolted meal, it requires essentially the same management. Wheat-meal, or Graham bread, however, requires, on account of the swelling property of the bran, a somewhat softer or thinner sponge than that of wheaten flour, and it should be baked one half longer; an ordinary loaf should remain in a brick oven about one hour and a half. Although, as already remarked, wheat-meal makes the best fermented bread, yet good rye-meal, or this, coarsely ground, and mixed with Indian-meal, makes a very good article of bread.

Raised bread, or bread made light by means of acids and alkalies, is used to some extent in this country and in England. It has been thought by some that this method of bread-making was an improvement on the fermenting process; but in numerous experiments I could never succeed as well with acids and alkalies as with yeast, nor do I conceive the plan to be as healthful, provided both processes are managed in the best possible way. It is true that a part of the sugar is destroyed by fermentation, and it is true that if the acid and alkali usually employed exactly neutralize each other there is no extraneous ingredient formed and retained in the bread except common salt, while all the natural properties of the grain are left unchanged. The "choice of evils," then, is between the absence of sugar in one case, and the presence of salt in the other. Which is the greatest evil?

For making the best unfermented raised bread the sesquicarbonate of soda and hydrochloric acid are employed, in the proportion of forty grains of alkali to fifty drops of the acid. The alkali is dissolved and diffused through the mass of dough, and then the acid is diluted and worked into the dough as rapidly as possible. The hydrochloric acid combines with the soda of the sesquicarbonate, forming common salt, and the carbonic acid gas is set free to puff up the dough. Those who esteem salt an alimentary article, will reasonably presume that this bread is better than fermented; and those who add a large quantity of salt to their fermented bread, as indeed most commercial and public bakers do, will have an additional argument in favor of the raised as compared with the fermented bread. Besides, the raised bread has the actual advantages that it may be put into the oven as soon as mixed, and eaten when recently from the oven without detriment, which is not the case with the fermented, although most persons do eat it fresh from the oven, and take the consequences. But I do not regard salt as an aliment; in fact I consider breads of all kinds essentially deteriorated, not only in flavor and consistence, but in physiological properties, by the admixture of salt in any quantity. It is the very last place where salt should be used, if employed at all. All the cereal grains, wheat especially, contain considerable quantities, comparatively, of earthy phosphates, principally phosphate of lime, which seem to be appropriate for the sustenance of the bony structure; but any additional and unnecessary admixture of saline or earthy matters in those aliments which are already specially furnished with saline and earthy materials, must be the *very worst* use we could make of them. If salt must be taken, let it be with those articles of food which contain the *least*, instead of the greatest proportions of earthy and saline matters, as grapes, apples, cucumbers, milk, and flesh-meats.

There are a few *general rules* in regard to bread-making which may be conveniently summed up in this place: 1. The best ovens are constructed of an arch of brick, over which is a covering of ashes, and over this a covering of charcoal, with a finishing layer of bricks over all. This arrangement retains the heat so long that cakes, apples, and pies can be baked after the bread is taken out, and custards and other light articles after them. 2. A new oven should be heated at least half of the day previous to baking in it, and the lid kept closed after the fire is out until heated for baking. 3. The fire should be made nearly on the back side of the oven. 4. The oven must be heated till all the bricks look red, and are free of all black spots, but not hot enough to burn flour *quickly* when sprinkled on the bottom. A better test is the thermometer. 5. Bread is light enough for the oven as soon as it looks porous and full of holes, like sponge; it will also exhale a brisk, pungent, but not in the least degree acid, odor. 6. When bread becomes light enough before the oven is ready, it should be kneaded a little, and then kept in a cool place. 7. When the loaf does rise too much, the best corrective is to knead in a solution of bicarbonate of soda, about a tea-spoonful for every three quarts of flour. 8. When taken from the oven bread should always be taken out of the pans or tins and placed endwise, and if the crust is very thick and hard, the loaf should be wrapped in a cloth wrung out of cold water. 9. In making the sponge for fermented bread, the water or milk employed should be about blood-warm. 10. When the dough has been properly kneaded, it should be covered with a napkin or light woolen blanket, and kept at about summer heat, say 60° Fah., until the dough becomes light. 11. In very warm weather the sponge should not stand over night, unless kept in a very cool place; even then better bread can be made by mixing the sponge in the morning, and baking in the afternoon. 12. All bread-makers should remember that the process of fermentation is arrested at a temperature below 30° Fah., that it proceeds slowly at 50°, moderately at 60°, rapidly at 70°, and very rapidly at 80°.

b. Boiled and Roasted Grains and Seeds.—Good clean *wheat*, boiled in pure soft water, and eaten with a little sugar, syrup, cream, or milk, is an excellent dish as part of a dietetic course. It requires boiling nearly all day to become entirely soft, hence the cracked wheat is much more convenient. Those who would have a *tasting* appreciation of the vast difference in the gustatory properties of different samples of the same article, should eat, without any seasoning whatever, boiled wheat which has been raised on a new, fresh, virgin soil, and that raised on an old, worn-out, badly-tilled and viciously-manured farm. The contrast might remind one of pine-apples and pine shavings.

Rye, barley, and *corn* are equally wholesome, prepared in the same way, but not as pleasant. It is difficult to remove the skins of corn, even by a long process of boiling, without the use of ashes, or some other alkali.

Rice is a good food when well boiled, but is too nutritious to eat alone. Those who employ it freely require a good proportion of potatoes, or other vegetables or fruits, with it. When cooking, it should never be stirred so as to break up or mash the kernels. A very pleasant but rather rich dish is made by boiling the rice in water until soft, then stirring in a little milk, and simmering them together about fifteen minutes. Boiled rice is often used as a vegetable with the ordinary dinner, and as a dessert after dinner. For both purposes it is too nutritive, unless the dinner is extremely simple and abstemious.

Boiled *peas* and *beans* are perfectly wholesome at all stages of their growth. Very young peas want cooking but very little. Beans are liable to produce more or less flatulence, except in stomachs long accustomed to a very plain vegetable diet. They are more tough and indigestible when boiled in salted water, as the salt hardens the outside membrane or skin. If salt is employed, it should be added as they are eaten. There are no vegetables that the taste which has been trained to the love of salt, so dislikes without it as rice and beans; hence most cook-books direct that those articles have plenty of salt *cooked through* them. I know individuals, however, who have so overcome the desire for this condiment that they like even rice and beans better without it than with it. The small white bean is an excellent vegetable for winter use. It may be simply boiled in water, and seasoned with a little salt and milk, or afterward baked.

Boiled *green corn* is usually put down as bad food by medical and dietetical writers. I car discover no reason for its condemnation. I have employed it freely for years at a table for invalids, among whom were always a greater or less number of dyspeptics, and I have never seen any evil result from it. On the contrary, I regard it, when tender and milky, as excellent. I suspect the mischief imputed to it is due to the butter and salt with which it is usually eaten. It is also generally cooked in salted water, which has a peculiar effect in rendering it hard and indigestible, much more so than is the case with peas or beans. It is incomparably better when boiled in pure water, and eaten with salt added to it, than when cooked in salt. The sweet corn is the best for boiling when green.

Succotash, which is a mixed dish of boiled green corn and boiled stringed beans, is a delicious and wholesome food, when seasoned with a little milk or sweet cream, with but very little if any salt.

Roasted green corn is not particularly unwholesome, though not as good as boiled. *Parched corn* is a favorite dish and principal food with some semi-barbarous nations, and in some parts of South America. It is perfectly wholesome. *Roasted wheat, rice, buckwheat, oats, barley,* and *chestnuts* are wholesome, but the process of cooking all of them, except the latter, is too inconvenient to deserve much consideration. Rice, when torrefied, is considered more constipating than when boiled, and has hence been prescribed in cases of diarrhea. Those who *must* have some substitute for tea, coffee, cocoa, and chocolate, besides water and milk, will find a pleasant beverage in the infusion of the roasted seeds of wheat, oats, or barley—equal, in fact, to the famous "crust coffee," made by steeping toasted bits of bread-crust in hot water.

c. Mushes.—Wheat, rye, and corn are the only grains much employed in the preparation of mushes; oatmeal is occasionally used. They are all made by boiling in pure, soft water, though in a very few dishes more or less milk is used. *Wheaten grits*, or *cracked wheat*, ranks at the head of the list of mushes. As usually put up at the mills, wheaten grits require to be boiled five or six hours. If the grain is broken up finer, it may be cooked in a much less time. My own plan for several years has been to procure the common grits, made from the best Ohio or Western wheat, and run them through a hand-mill, or large coffee-mill, whenever they are wanted for cooking. This secures the full flavor and freshness of the grain, and grinds the grits fine enough to be well cooked in an hour and a half. The most convenient method of boiling them is by means of a tin or iron vessel surrounded by hot water, and contained within another vessel which comes in contact with the fire. This obviates the necessity of constantly stirring to prevent them from burning on the vessel. They may be managed very well in an iron pot with legs, so that the vessel can stand on the range or stove without coming in direct contact with the fire. Milk, or a moderate quantity of molasses or sugar, are the only admissible seasonings for all kinds of mushes.

Hominy is one of the best mushes. In this market it is prepared from the Southern or white corn. The fine-grained hominy is usually boiled about an hour; it may be very well cooked in half an hour by boiling a few minutes, and then steaming it, without stirring, over as hot a fire as can be borne without burning. The coarse hominy, or *samp*, requires boiling five or six hours. It should be washed several times, and the water poured through a sieve, to separate the hulls. Two quarts of water to one of hominy are necessary.

Rye-meal makes an excellent mush, and is particularly useful in cases of habitual constipation; to those unaccustomed to the grain, its effect on the bowels is decidedly laxative. It is made precisely like cracked-wheat mush.

Indian meal, if coarse-ground, makes a good mush known as *hasty pudding*. White and yellow meal are equally agreeable to most persons in this dish. It should be stirred rather stiff, and cooked about fifteen minutes.

Oatmeal mush is a favorite with some persons, and it makes a pleasant change for all. It is cooked precisely like Indian meal mush. In Scotland it is called *stirabout*.

Graham flour, or wheat-meal, is sometimes cooked in the form of mush; it may do for a change, but is not as good as the coarser preparations of wheat. For infants and young children it is much better than the farina which is so extensively used.

Farina is occasionally made into mush, but I consider it too nutritious and concentrated to be employed in this way as a leading article of food, or as a principal part of a single meal.

d. Gruels and Soups.—Gruels are merely thin mushes; they are usually prescribed to invalids laboring under fevers and acute inflammations, or for the purpose of promoting the action of the bowels. For the latter purpose coarse *Indian meal*, *Graham flour*, or *cracked wheat* gruel are the best. A couple of spoonfuls of flour or meal are sufficient for a quart of water. It need boil only for a few minutes. *Rice* is sometimes made into a thin mush or thick gruel, for the table. It helps to make up a variety.

But few vegetable soups are desirable. *Split peas*, soaked over night, and then boiled until completely diffused in the water, make one of the best dishes of this group. A pound of peas is sufficient for two quarts of water. *Garden beans*, and *common field peas*, and the *marrow fats*, either green or dried, may be made into tolerable soups. Cook-books generally recommend saleratus to be put into all vegetable soups, and indeed into nearly every vegetable preparation that can be named, on the idle supposition that there is something terrible in the shape of an acid in every thing vegetable, which requires to be neutralized. It is a pernicious custom; it is giving the stomach an actual poison to counteract an imaginary one.

c. *Puddings.*—The majority of puddings found at ordinary hotels, boarding-houses, and refectories, are vile compounds. Plain puddings are generally farinaceous mushes, in which sugar and milk are cooked. The addition of eggs renders all puddings indigestible for weak stomachs, and unhealthful for all. The best kinds of plain puddings are not so objectionable in themselves as a part of some of the meals, as they are liable to be swallowed hot, unmasticated, and at the end of a full meal of other things. The very best puddings are made of cracked wheat, rye-meal, hominy, rice, stale brown bread, and Indian meal. Potato and apple puddings are very good, and several other kinds are perfectly admissible.

Cracked-wheat pudding is made by boiling the grits perfectly soft in water, adding a due quantity of clean brown sugar, or good New Orleans molasses, and milk, and baking in a moderate heat.

Rye-meal, hominy, rice, and *Indian meal* puddings may be prepared in precisely the same manner. Hominy and Indian require a hotter oven than the other articles.

Bread pudding may be made by soaking pieces of stale but sweet bread in milk until soft, then sweetening and baking it. A very good method is to cut a hole in a loaf of bread, add as much new milk as it will soak up through the opening, tie it up in a cloth, and boil it an hour.

Potato pudding may be made of Irish or Carolina potatoes. Mix into a stiff paste two parts of boiled and mashed potatoes, and one part of wheat-meal; tie it in a wet cloth dusted with flour, and boil it two hours.

Apple pudding is made in various ways. One good method is to alternate a layer of prepared apples with a layer of wheat-meal dough, until a tin pudding-boiler is filled, then boil three hours. Layers of soft-boiled rice, in lieu of the wheaten dough, make another kind of apple pudding.

Rice and apple pudding is prepared by boiling half a pound of rice in a pint and a half of milk, till it is soft; then fill the pudding-dish half full of apples pared and cored; sweeten with molasses or brown sugar; put the rice over the fruit as a crust, and bake.

Cracker pudding, of Graham or wheat-meal crackers, is made in the same manner as bread pudding.

Tapioca pudding is made by pouring a pint of boiled milk on half that quantity of tapioca; let it stand half an hour, then add another pint of milk, sweeten, and bake. *Sago* pudding is made in the same way. These are very bland, and not very nutritive, and their principal value is to fill the stomach and satisfy the appetite when but little nutrition is desirable or practicable.

Corn starch pudding is prepared by mixing the starch with a sufficient quantity of milk to give it the due consistence, then sweetened and baked. It is rather indifferent as an article of diet, and when made with eggs decidedly bad.

Sweet apple pudding is made by putting a dozen good ripe sweet apples, cut into pieces, into a quart of milk, with a pint of Indian meal, and baking about three hours. If the apples are not very sweet, a little molasses may be added.

Snow-ball pudding is made by paring and coring large apples, and inclosing them in cloths spread over with boiled rice; they are then boiled an hour. They should be dipped in cold water before being turned out of the cloths. They may be eaten with syrup or sugar.

Cottage pudding is one of the best preparations of which eggs form a part: Mix two pounds of pared, boiled, and mashed potatoes with one pint of milk, three eggs, and two ounces of sugar, and bake three quarters of an hour.

Custard pudding is a preparation in which eggs are much more wholesome than they are in other puddings, particularly the farinaceous kind: Mix four eggs, well beaten, with a quart of good milk, and three table-spoonfuls of clean brown sugar; bake in custard cups, or a common pudding-dish about half an hour.

Apple custard is another dish preferable to farinaceous puddings which contain eggs: Pare and core half a dozen good ripe, mealy, tart apples; boil them in a small quantity of water till moderately soft; put them into the pudding-dish, and sugar them over; then add eight eggs which have been beat up with three table-spoonfuls of sugar, and mixed with three pints of milk, and bake half an hour.

Macaroni, vermicelli, and *arrow-root* are sometimes made into puddings; but there are so many better articles they are not worth the trouble.

f. Pastry.—"All pastry is an abomination," says Paris, with whom the majority of dietetical writers coincide. The expression is not too strong in reference to pies, as they usually come to our tables from the bakeries. Nevertheless pies *may* be made very good and wholesome, even much better than the majority of plain puddings. Pies, as they should be made, are but little different from bread and fruit, with an extra quantity of sugar. The crust of a baker's pie is better adapted to kill a hyena than to nourish a human stomach; and the crust of ordinary home-made or domestic pies is too full of meat-drippings, hog's lard, or butter, to be otherwise than pernicious to the stomach. But pie-crust can be made in a healthful manner. I know the majority of appetites will consider it harsh, rough, and tough, and many will turn away from it in disdain, because they cannot swallow it without masticating. But the fault is with the wrongly-educated appetite, not with the healthful article. It seems a sad pity that our fashionable eaters, who are so violently opposed to chewing their own victuals, can not employ servants to perform this necessary duty for them, or invent some labor-saving masticating machine!

Excellent pie-crust can be made of wheat-meal, modified or shortened with good mealy potatoes and fresh sweet cream. Rich new milk answers very well in the place of the cream, and if the fastidious appetite insists on having the crust a little smoother, the coarsest part of the bran may be sifted out. In the absence of cream, the crust may be raised or made light with sour milk and super-carbonate of soda, an alkali much less objectionable than saleratus, and the only one that ought to be employed in cooking. Indian meal may be used in lieu of wheat-meal in forming the crust; equal parts of each may be employed

Nearly all the mild, sub-acid, and sweet fruits may be made into pies; many kinds of pumpkins and squashes make delicious pies; some roots and leaves, as potatoes and sorrels, make very good and wholesome pies. A few specimens of the best kinds will answer the purposes of this work:

Apple pie may be made of green apples cut into thin slices, or of dried apples stewed, or of the fruit which has been preserved in its own inspissated juice. Moderately tart and very juicy apples make the best apple pie. Brown sugar or molasses is the best sweetening for all kinds of pastry.

Pears and *peaches*, when thoroughly ripe, make excellent pies, managed the same way as apples.

Currants, when very young, or when perfectly ripe, are not objectionable. *Gooseberries* and *cranberries* are too acid, in all stages of their growth, for this use, although I do not apprehend a sound stomach, well trained to a vegetable regimen, would experience any difficulty from their employment. Indeed, I know individuals who can and do use them without any apparent disadvantage.

Strawberries, red raspberries, black raspberries, blackberries, whortleberries, black cherries, and *red cherries*, all in their season, when fully ripe, make delicious pies and tarts.

Pumpkins and *squashes* are equally delicious and healthful. They are to be boiled, mashed, strained, mixed with milk or milk and water, moderately sweetened, and baked on a single crust. Of pumpkins, the *West India* is the best our market affords for pie-making, and among the best squashes for this purpose are the *cream* and the *pumpkin*.

Potato pies are not as inviting as the preceding. The sweet potato is the best. It is cut into squares, with a little sliced turnip, covered with milk or cream, and then with a crust.

I have heard *tomato* pies well spoken of, but I have had no experience in their making or tasting.

Rhubarb pie is made by stewing the cut stalks till tender, straining, sweetening, and baking on an under crust. In the usual method of pie-making, eggs are added. This pie is rather too acid for weak stomachs.

Meadow sorrel, stewed and sweetened, is much less acid, and, to my taste, more pleasant than rhubarb, when made into pies or tarts.

Custard pie is one of the best ways of eating eggs, providing the pie is made of nothing but eggs, sugar, and milk, and a crust as herein advocated.

g. Cakes.—But very few kinds of cake are agreeable or desirable to those whose appetites are under the guidance of a reasonable degree of reason; and to all others no extent of variety and complication can give satisfaction. The following list comprises the best preparations of cake I am acquainted with:

Wheat-meal cakes, made of fresh Graham flour, good brown sugar, and sweet cream, raised with sour milk and super-carbonate of soda, and well baked, is a much superior article, as far as health is concerned, to either of several hundreds, the recipes of which are found in common cook-books. Sweet cream makes a much richer and sweeter cake than lard or butter. If the cream is moderately sour, its acid will be sufficient to neutralize the soda without the sour milk. A very fair article can be made without the cream. This kind of cake, if preferred, can be raised with yeast, but it should not, in such case, be eaten till the next day.

Fine flour cake can be managed in the same manner, but it is not as good as the coarse. When fine flour is used, molasses is better than sugar for sweetening.

Indian meal cake, made of coarse yellow Indian meal, is very light and tender made in the same way. It is very good without the cream. It should be sweetened but moderately. Eggs are almost always put in all kinds of Indian cake, but I think it is as pleasant without them, and it is certainly more healthful.

Biscuits of wheat-meal or fine flour, or of wheat and Indian, or rye and Indian, may be made by the first-mentioned process, omitting the sugar

Good *gingerbread*, "with the part of ginger omitted," and also without alum and potash, can be made with rye flour, New Orleans molasses, and sweet cream, raised with yeast, or with sour milk and super-carbonate of soda, and baked in small, thin cakes.

Griddle-cakes are made of buckwheat flour, fine flour and Indian meal, wheat-meal, wheat and Indian meals, wheat-meal and rice, or of rye-meal alone, or with either of the other meals. They may be raised with yeast, or with sour milk and super-carbonate of soda; the latter is the best method, because all fermented food is objectionable when eaten immediately after cooking. They are wet up with milk or water, or both, according to taste, and they may be baked on a soapstone griddle without a particle of grease. Sugar, molasses, or milk, is their proper accompaniment for seasoning.

Wheat-meal, with a very little coarse Indian, and three parts of rye-meal to one of Indian, make the very best, sweetest, and most wholesome kinds of griddle-cakes. Buckwheat is improved by the addition of a small quantity of Indian. All of them, however, are very good alone. Rice griddle-cakes are prepared by mixing soft-boiled rice with a little flour or wheat-meal. Those who are not provided with soapstone griddles are obliged to use a little oil of some kind to prevent the batter from adhering. Olive oil, when perfectly sweet, is much better than lard or butter for this purpose. Good olive oil may also be used as a substitute for butter in oiling bread, cake, and pie pans, or in shortening bread or cakes for those who have not cream, and will have shortening of some kind.

h. Roots.—All of the esculent roots—potatoes, beets, carrots, parsneps, turnips, ground-nuts, artichokes, comfrey, etc., are equally healthful *per se*, but of different degrees of nutritive power, and of very different degrees of adaptability to weak stomachs, or stomachs accustomed to the ordinary concentrated or mixed diet. The potato, ground-nut, comfrey, and artichoke, are called *mealy* roots, the others *watery*.

The potato far exceeds all the rest in amount of nutritive property, and is alone capable of sustaining the prolonged nutrition of the human being.

Boiling is the best method of cooking potatoes; *roasting* in the ashes is the next best process, and *baking*, the next. When boiled, they should be taken out of the water as soon as they can be easily pierced with a fork, and then steamed about five minutes. Some prefer steaming instead of boiling; the difference is very trifling. They are always richer flavored and more nutritious when cooked with their skins on, especially in the fall and early part of winter. A potato should always be pared very thin. Some cooks prepare them by washing and paring, and soaking in cold water over night; others put them, pared or not, as the case may be, into boiling water at first. The former is the best method for new, and the latter for old potatoes.

Cold boiled potatoes, cut into slices, and slightly browned on a griddle, make an excellent relish as a part of the breakfast, and are not to be despised as a whole breakfast. For dyspeptics who have craving appetites, and for all who are liable to eat too much bread, or other very nutritive food, potatoes prepared in this way are peculiarly serviceable.

Boiled potatoes, jammed up with a little milk or sweet cream, and seasoned with a very little salt, make as rich a vegetable dish as any one ought to crave. When cold, they may be warmed up in milk, as a part of either meal.

The Carolina, or sweet potatoes, may be cooked in the same ways precisely as the common potato. They are generally preferred when roasted; they are delicious either baked or boiled. All the other mealy roots may be cooked in the same manner as the potatoes.

The watery roots are of essential service in a dietary system of which farinaceous food or flesh-meat, or both, constitute the leading features. The parsnep, when boiled, is among the most digestible and nutritive of this division. It keeps well through the winter, and is most sweet, tender, and wholesome in the latter part of winter and early in the spring, the very time when most needed, on account of the absence of fresh fruits and the scarcity of green vegetables. A rich and excellent dish may be prepared by cutting the root into thin slices, boiling it in water until soft, and then simmering it a few minutes in milk. The beet requires boiling a long time; it should always be cooked until perfectly soft. The turnip should be thoroughly boiled, but taken from the water as soon as well done. The carrot is more nutritive than the turnip, but less so than the parsnip or beet; it is not usually relished as well without seasonings as the other watery roots. All of these roots may be roasted, baked, or stewed in water or milk.

They are most frequently *fried* at common hotels and boarding-houses, but that is, of course, the worst manner of cooking them. The radish possesses a very little nutriment, but its acrid property is objectionable, and as there are so many better things to eat, it is hardly worth retaining.

In selecting the watery roots, great pains should be taken to get those which are tender, brittle, and juicy. All the tough, dry, fibrous articles should be rejected.

i. Green Vegetables.—Many of the articles known as "greens," or "spinach," are slightly nutritive and perfectly wholesome, and, like the watery roots, they help to make a variety, and also offset the too highly nutritive property of farinaceous food, and the too stimulating property of animal food. Asparagus is one of the blandest, and most delicious and nutritive of the class. It is good enough for any one to eat with no preparation but simple boiling. The weakest and most dyspeptic stomachs can almost always use it with comfort and satisfaction. Water-cress, celery, onions, and lettuce are generally eaten as salads. The first three are too acrid, and the latter is too narcotic. Boiled onions are not objectionable, except from their rank and, to many, disagreeable odor. Boiled mustard leaves, potato tops, cabbages, cowslips, spinach, young beet plants, and a variety of other leaves, leaf-stalks, buds, shoots, flowers, are perfectly healthful to healthy stomachs. When cooked in butter, or boiled with salted meat, or mixed with vinegar, they are objectionable only on account of their accompaniments. Lemon juice makes as pleasant seasoning as vinegar, and this or some other *organic* acid is all the condiment that can be admitted with a consistent regard to physiological truth.

Whenever greens or vegetables are employed, they should be perfectly fresh, not dry, wilted, nor long kept.

j. Fruits.—As a general rule all sweet and sub-acid fruits, when full-grown and perfectly ripe, are most wholesome, if eaten without any preparation or seasoning. If, however, they are too sour, a little sugar may be added, and the very acid fruits, as well as those not perfectly ripe, are improved by stewing and sweetening. I have never found good grapes to disagree or produce even temporary inconvenience in the most delicate stomachs. I regard them as always preferable without cooking. Apples, pears, and peaches always agree with all healthy stomachs, and the worst dyspeptics may soon acquire the habit of eating them, not only with apparent impunity but with absolute advantage, by partaking of a very little at first, and gradually increasing the quantity. Baked apples stand at the head of the class of cooked fruits. Apples, pears, and peaches may be made into an elegant dish by paring, boiling, sweetening with molasses, and serving them whole. This is an excellent method of preparing peaches which are not perfectly ripe, and but few sold in our city markets are so. Pared, and cut into slices, and sprinkled with sugar, is another very common and very good preparation. It is a common prejudice that there is something unwholesome or pernicious in peaches which the skin tends to counteract or correct, hence both ought to be eaten together. The fact I believe to be, that both skin and pulp are perfectly harmless. Tomatoes, when fully ripe, are among our best fruits, and are relished by many persons without cooking. An excellent dish is made by scalding them a few minutes, to loosen their skins, peeling, and then stewing them slowly for an hour, or even two (as they are improved by cooking a long time), and then adding pieces of toasted bread.

Water-melons and musk-melons are liable to produce colic and flatulence in very weak stomachs, but are unobjectionable as a part of the dietary system of those whose digestive powers are not greatly impaired. The variety of musk-melon called *nutmeg* is the richest.

It is the general fault of dried fruits that the poorer qualities are selected for drying. Those who purchase them in reference to their dietetic character, should select such as are of good, rich flavor, and not very acid. Dried raspberries, strawberries, whortleberries, and blackberries, stewed and sweetened, make a good addition to dried apples and peaches. Most of the dried plums which are sold in our markets are too sour for pleasure or profit. Dried cherries are a troublesome article to handle on account of the stones, but they are among the most wholesome articles. French prunes, stewed and moderately sweetened, are excellent. The boiled fig is a good and very nutritious fruit.

Pumpkins and squashes can be readily dried for winter use, by being cut into thin slices, and exposed to the sun, or placed in a heated oven. *Peach leather* and *tomato leather*, are prepared by squeezing out the pulp of the fruits when very ripe, and spreading them half an inch thick on plates or shingles, to dry until quite hard. Ripe tomatoes are sometimes cut into slices without peeling, and dried in an oven. *Tomato figs* are made by scalding and peeling the fruit, then boiling it in one third its weight of sugar. The figs are then flattened, and dried in the sun, occasionally turning them and sprinkling with sugar.

Currants and gooseberries are too acid for the majority of invalid stomachs. They may be preserved in the green state, but are not worth the trouble.

k. Nuts.—These, with the exception of the boiled chestnut, perhaps, are not proper food for invalids, although, as previously remarked, they are adapted to the digestive organs of man, and other frugivorous animals, in a state of nature. The butternut and walnut are too oily, an objection which no cookery I am acquainted with can obviate. The peanut and beechnut are less oily, but so long as the world is full of better things invalids would do well to use them.

l. Condiments.—In relation to condiments or seasonings, I have named milk, sweet cream, sugar in some form, salt, and the vegetable acids, as the only admissible ones. With the exception of salt, they are all more or less nutritive, and are really different forms of food. Although the most perfect nutrition can be secured without the aid of any of them, yet their moderate employment is not especially injurious, but, in reference to the imperfect character of many of our fruits and vegetables, sometimes an actual advantage; and it is a great step in advance if we can induce the highly cultivated and grossly pampered appetites of civilized society to submit to the simplicity here enjoined. The great misfortune of the vast majority of people, and of invalids especially, is that they have stimulated away, or so palsied the organic instincts that they can not appreciate the intrinsic properties of food. Every thing is flat, insipid, and unsatisfactory, save perhaps the best kinds of fruit, unless strongly charged with some extraneous seasoning. If we can induce them to abandon all cooked oils, greasy gravies, strong spices, and the whole list of enervating beverages, we can cure them of their diseases, and when they are restored to such a degree of health and vigor as their remaining constitutional vitality admits of, they may take as many progressive steps as they please in simplifying and improving their whole plan of diet. There is room in this direction for the exercise of the best talent and noblest energies of the human mind.

CHAPTER III.

DIETARIES.

General Rules for Invalids.—Although all kinds of natural food agree equally well with all persons in a pure state of nature, excepting so far as the mere influence of habit is concerned, we have now to deal almost wholly with men in an artificial state. In a great variety of alimentary materials, therefore, all of which are intrinsically wholesome, there is an opportunity for the exercise of considerable skill in adapting them to invalids, and so managing them as to restore the deeply-injured digestive powers and broken-down constitutions to comparative health and strength. The following rules, which are but a summary of the principles indicated in various parts of this work, may serve as a kind of chart to those who are not thoroughly familiar with all the therapeutic adaptations of diet.

1. The general errors in diet are too great *concentration*, improper *combination*, excessive *quantity*, and imperfect *quality* of the alimentary materials. Each of these errors is equally important to guard against.

2. The diet may be equally simple and wholesome whether the number of articles employed be three or three hundred, provided but few articles are eaten at a single meal.

3. Of whatever materials the diet consists, the due relations of nutriment and bulk must be maintained. Thus those whose food is principally preparations of the cereal grains, require the largest proportion of juicy fruits and watery vegetables; those who eat principally animal food and potatoes, require a less proportion of the less nutritious foods; and those who eat potatoes and other less nutritive roots freely, with little bread or meat, require the least of the watery vegetables and fruits, etc.

4. Chronic diseases of the digestive organs are always attended with constipation, diarrhea, or irregularity of action; in ninety-nine cases in a hundred constipation is the primary morbid condition. All these morbid conditions require essentially the same plan of diet, but there are two diseased states not uncommonly met with, where a peculiar modification of the general plan is desirable, if not necessary. One is an inflamed, abraded, or ulcerated condition of the mucous membrane of the duodenum, consequent on the acrid, corroding bile which is emptied into that intestine from a diseased liver; and the other is the same condition of the rectum, or lower bowel, consequent on the existence of hemorrhoids or piles. In these cases unbolted farinaceous food, brown bread, cracked wheat, etc., often irritates and increases the pain and mucous discharges, and as local quiet is important for the healing process, a diet of mealy potatoes, baked apples, or raw grapes, with a *very* little farinaceous food, which may be farina, arrow-root, tapioca, or even wheat-meal, will afford the patient more quiet and facilitate the cure.

5. Invalids whose diseases have been specially produced by particu-

lar articles of food, or a particular plan of diet, will almost invariably be inordinately attached to those articles of food, or that plan of living. Thus gout is often produced by concentrated farinaceous food, and it is very rare to find a gouty subject who has not a strong repugnance to all other kinds of farinaceous food. Those patients, too, whose diseases are attended with an inflammatory diathesis produced by the excessive use of flesh-meat, will almost always manifest a particular horror toward just what they need—strict vegetable diet. No person is more wedded to or more passionately fond of strong green tea and fine tea biscuits, than the female whose stomach is contracted to half its natural size, and whose whole nervous system is completely shattered by their use; and no spoiled child is more crazy after candies and sweet cakes than one rendered feeble, dull, gaunt, and cachectic by them. These facts should be understood by both patient and physician; by the latter that he may prescribe successfully and intelligently, and by the patient, that through the tribulation of denying a morbid appetite, he may work out a salvation from its consequences.

6. Invalids who have lost health under the ordinary way of living, should select a moderate variety of the very best articles of farinaceous food, and the mildest fruits and vegetables, and persevere in their use until health is re-established, gradually proceeding to the use of the coarser articles, or those fruits and vegetables which are called crude and flatulent. By managing carefully in this way, very bad dyspeptics will in due time be able to partake of nearly all healthful articles without discomfort.

7. No rule can be given for weighing or measuring the quantity of food for invalids, as it varies with age, exercise, temperament, and pathological condition; a correct practice is to eat sufficient to satisfy all demands of actual hunger, but not to the extent of producing a sense of oppression in the brain and muscular system. If the appetite be not excessively morbid, the intelligent observer will soon find, in the sense of hunger in the stomach on the one hand, and the feeling of weariness, fullness, oppression, and dullness in both body and mind on the other, where the golden mean of practice lies. But in extremely morbid states of the digestive organs, attended with a craving sensation, instead of natural appetite, the best practice is to apportion out such quantity as the judgment approves in view of all the circumstances of the patient, and adhere to it until a good degree of natural appetite is restored.

8. Above all things let the patient not become a *monomaniac* on the subject of diet. It is infinitely less injurious to eat too much, or too little, or something not strictly physiological, than to be always worrying

for fear some error has been or will be committed. The mind must not be continually directed to the stomach, and on the watch for some new or old feeling or symptoms, to be modified, mitigated, or aggravated after every meal. The judgment should be convinced that the general plan is right, and that Nature has reserved to herself the ability to correct slight deviations.

Therapeutic Divisions of Diet.—The "old school" works on diet and regimen give us eight technical divisions of diet, for medicinal purposes. As truth can always be seen to better advantage when contrasted with its opposite, it may be useful to mention briefly the system we pronounce erroneous.

1. *Full, Common, or Meat Diet.*—This consists of plain animal and vegetable foods, according to the patient's appetite; and generally in indolent diseases, as scrofula, chorea, epilepsy, etc., and during the convalescent stage after fevers, beer, wine, or ardents spirit is recommended with it.

2. *Animal Diet.*—An exclusive diet of animal food is recommended only in the disease called diabetis. Pereira tells us that when patients are limited to animal food, a considerable variety is necessary to prevent him from loathing one kind frequently repeated, and for this variety Dr. Pereira names: "*Butcher's meat, bacon, poultry, game, fish, shell-fish, cheese, eggs, sausages,* and *brawn;* and for *common drink*, to go with it, *water, beef-tea,* or *mutton-broth.*" This is sufficiently *strong*, in all conscience, for any sick person, but we have not a particle of evidence in medical books that a single diabetic patient ever got well upon it.

3. *Vegetable Diet.*—Although a vegetable diet is named among the varieties appropriate in certain cases of disease, an exclusively vegetable diet does not appear to be recognized as orthodox in the allopathic materia medica. Pereira disposes of it in the following summary and contemptuous manner: "The exclusive employment of vegetable food, in conjunction with the use of distilled water, has been recommended by Dr. Lambe, as a remedy for cancer, scrofula, consumption, asthma, and other chronic diseases; but he has, I suspect, gained few, if any proselytes to his opinions and practice."

4. *Spare, or Abstemious Diet.*—This means, in allopathic parlance, a mixed animal and vegetable diet, with the use of fish instead of butcher's meat, because the former is supposed to be less stimulating

and less nutritious than the latter. It is principally recommended in the gouty and apoplectic diatheses, plethora, etc.

5. *Fever Diet.*—This is also called *spoon*, *slop*, or *thin* diet. It consists of teas, toast-water, barley-water, and acidulous drinks, *ad libitum*, with light saccharine and amylaceous preparations.

6. *Low Diet.*—This does not differ much in object from the former, although a different set of preparations are named as constituting it, as gruel, broth, milk, bread or biscuit, and light farinaceous puddings. It is prescribed in cases of accident, injuries, surgical operations, and acute inflammations, with the object in view of depleting the system, or effecting a change in the blood similar to that produced by bleeding.

7. *Milk Diet.*—This includes the free use of cow's milk, and a moderate employment of light farinaceous substances, as bread, arrow-root, tapioca, sago, and even rice, batter or bread puddings. It is advised mostly in consumption, and other pulmonary diseases, and after severe bleedings or hemorrhages, and sometimes for the strumous habit of children.

8. *Dry Diet.*—The object of a dry diet is to lessen the volume of blood, in cases of aneurism, valvular disease of the heart; it has also been recommended in diuresis and diabetis. It consists of the ordinary articles of a mixed diet, excluding fruits and watery vegetables, and taken with little or no drink.

As being more philosophical, as well as hygienic, I propose the following technical divisions of hydropathic diet, some one of which will meet the necessities of all classes of invalids, as well as all classes of well folks:

1. *Full Mixed Diet.*—Bread, mush, butter, cream, milk, potatoes, with some kind of fruit, for breakfast and supper; for dinner, bread, vegetables, fruits, plain pudding or pastry, with flesh, fish, fowl, or eggs. This is calculated for persons in health, and for that class of invalids who have no special or disproportionate disease or derangement of the digestive organs.

2. *Full Vegetable Diet.*—Precisely the same as the preceding, omitting the flesh, fish, fowl, and eggs. Milk, cream, and butter are not included in the term *animal food*, whenever the term occurs without being defined in this work. This diet is to be preferred in all diseases attended with the inflammatory diathesis or great irritability of

the nervous system; in gout and rheumatism, in incipient pulmonary diseases, in scrofula, scurvy, neuralgia, in most of the cachexies, and in nearly all of the ordinary female complaints.

3. *Strict Diet.*—Bread, mush, milk, sweet cream, potatoes, and good grapes or apples, or the equivalent to this set of articles for each meal, the quantity to be as exactly proportioned as possible to the nutritive demands of the bodily structures. This is adapted to nearly all chronic diseases attended with neither corpulency nor emaciation, but with a decided yet not extreme dyspeptic condition of the digestive organs. It is admirably calculated for that common and prevalent condition of body known as "liver complaint," and for a variety of nervous, rheumatic, and neuralgic affections which have been preceded by, and are connected with, a long-standing derangement of the biliary secretion; it is peculiarly appropriate, too, in almost all forms of skin diseases. In chronic catarrhal affections, and severe cases of bronchitis, laryngitis, and ulcerations of the throat, it is indispensable.

4. *Abstemious Diet.*—This is the same as a strict diet, with the exception that the quantity of food should be rather below the point of complete nutrition. It is one of the hydropathic methods of depletion, and is the very "hunger-cure" itself. The especial object of abstemious diet is to favor absorption and depuration. It is hence adapted to glandular enlargements, and protracted cases of chill fever, fever and ague, and what is called "dumb ague," all of which are usually attended with enlarged livers and spleens. In malignant tumors, phagedenic and deep-seated ulcers, and foul skin diseases, it ought to be rigidly enforced, as long as the general strength will permit, or as long as the patient can keep about, unless the disease sooner yields. It is also often indispensable in some cases of mucous dyspepsia, attended with great intolerance of food and extreme tenderness in the epigastric region. In blind, or bleeding piles, when they are inflamed and irritable, and the bowels disposed to griping and diarrhea, it is highly advantageous; and in nearly all forms of female complaints, attended with great local relaxation, prolapsus, or other displacement, it is absolutely necessary to a perfect cure.

5. *Dry Diet.*—The object here is to promote healthy and correct morbid secretions. When the saliva is imperfect, the gastric juice deficient or depraved, the bile acrid and irritating, the gums tender and spongy, etc., very solid food, which secures thorough mastication, distends the stomach gradually, and thus promotes the most perfect

digestion, is an almost indispensable means of cure. It is seldom that it requires to be continued long, although no harm could result from continuing it a lifetime, because it is, or should be, composed of a set of articles capable of sustaining perfect and prolonged nutrition. Crusts of bread, roast potatoes, Graham crackers, and uncooked apples, make a good arrangement of dry diet. Many other selections can be made equally as good. Dyspeptics, who are troubled with excessive flatulency, acrid eructations, water-brash, sick headacne, etc., are benefited by this diet.

6. *Watery Diet.*—The object of this kind of diet is to satisfy the appetite and stomach, as far as may be, while the necessary amount of nutrient material is supplied, and at the same time wash out and deterge from the body, drugs, minerals, alkaline or saline accumulations, and other impurities. It is in some cases a substitute for, and in many an improvement upon the practice of copious water-drinking. Due proportions of milk, grapes, parsneps, and potatoes, are an example of a watery diet. It is adapted to gravel, calculous concretions, biliary obstructions attended with gall-stones, those forms of gout and rheumatism in which chalky deposits are formed in and around the joints, the disease called *fragilitas ossium*, or brittleness of the bony structure, from excess of earthy particles and deficiency of animal matter. It is also advantageous in plethora and obesity, and may be resorted to in other cases wherein free water-drinking is advisable, but when pure soft water can not be procured.

7. *Fever Diet.*—This term is almost a misnomer. Strictly speaking fever and food are antagonistic ideas. No simple fever, if well managed, requires dieting in any way, save the negative one of starvation, until its violence is abated, and then the diet would more properly be called *convalescent.* It is, however, often desirable to satisfy the stomach or act upon the bowels, for which purpose the Indian or wheatmeal gruel may be administered. Toast-water, barley-water, lemonade, etc., are no better than pure water, as fever beverages; yet they are harmless, and very often gratifying to the patient or friends.

Diet for Public Institutions.—A glance at the established dietary systems of a variety of public institutions will enable the reader to see more clearly, by the contrast, the merits or demerits of the proposed innovations. For this purpose I have made such selections as will present a fair exhibition of the leading ideas of the civilized world on this subject.

Diet of the London Hospital

	Common Diet.	Middle Diet.	Low Diet.	Milk Diet.
Per day	12 oz. bread. 1 pint porter, *men*. ½ pint do., *women*.	The same, except that 4 oz. of meat are given instead of 8 oz.	8 oz. bread.	12 oz. bread.
Breakfast	Gruel.		Gruel.	Gruel.
Dinner	8 oz. beef, with potatoes, thrice a week. 8 oz. mutton, with potatoes, twice a week. 8 oz. potatoes, and soup, with vegetables, twice a week.		Broth.	1 pint milk.
Supper	1 pint broth.		Gruel or broth.	1 pint milk.

Diet at St. Bartholomew's Hospital.

	Common Diet.	Broth Diet.	Fever Diet.	Milk Diet.
Daily	Milk porridge. 12 oz. bread. 6 oz. mutton or beef. 1 pint broth, with peas or potatoes, four times a week. 2 pints beer, *men*. 1 pint do., *women*. 1 oz. butter twice a week.	Milk porridge. 12 oz. bread. 2 pints broth. 1 pint beer. 1 oz. butter.	Milk porridge. 12 oz. bread. 1 pint milk, with tapioca, arrow-root, sago, rice, as may be prescribed. Barley-water.	Milk porridge. 12 oz. bread. 2 pints milk, with tapioca, arrow root, sago, or rice, as may be prescribed. Barley-water. 1 oz butter. Bread pudding three times a week when ordered.

In addition to the *beer*, in the foregoing tables, which English physicians, as well as English legislators and people, seem to regard as "bread in another form," wine, spirit, porter, etc., are permitted as extras, whenever prescribed by the medical officers.

Diet at Guy's Hospital.

	Full Diet.	Middle Diet.	Low Diet.	Milk Diet.	Fever Diet.
Daily	14 oz. bread. 1½ oz. butter. 1 quart table beer. 8 oz. meat, when dress'd.	12 oz bread. 1½ oz. butter. 1 pint table beer. 4 oz. meat, when dress'd, and ½ a pint broth.	12 oz. bread. 1 oz. butter. Tea and sugar.	12 oz. bread. 1 oz. butter. 2 pints milk.	6 oz. bread. 1 oz. butter. Tea and sugar.
			Half a pound of beef (for beef tea), or arrow-root or sago, when ordered. For each diet, gruel or barley-water, as required.		

The bread mentioned in all of these tables is undoubtedly common baker's bread; nothing is said of its character in the reports. Under the head of *dry diet*, at St. Thomas's Hospital (England), we find: 14 oz. bread daily; 2 pints of *beer!* and water gruel for breakfast; 4 oz.

of butter four times a week, for dinners; and rice pudding and 4 oz. of butter for dinner the other three days of the week. No supper is allowed.

Among the dietaries of Westminster Hospital (England), we find there is a special diet for the incurables, consisting of the daily rations of ¾ lb. bread, ½ lb. meat, ½ lb. potatoes, ½ pint milk, and one pint of *porter!*

At St. George's Hospital (England), under the head of *Extra Diet*, 2 pints of *beer* are allowed to each man, and 1½ pints to each woman!

Among the dietetic curiosities of Middlesex Hospital (England), is a *Cancer Diet*, consisting of 12 oz. bread, ½ lb. meat. ½ lb. potatoes, and 1 pint milk daily.

Diet at London Lying-in Hospital.

Breakfast.—Tea, and bread and butter, *ad libitum.*
Dinner.—Broth or gruel, until the third day, after which boiled mutton and broth.
Tea.—As breakfast.
Supper.—Gruel, after the ninth day, then bread and cheese and *beer.* Should the patient be delicate, she is allowed wine, fish, light puddings, or any thing she may fancy.

Diet at Bethlehem Insane Hospital.

Breakfast ... Gruel.
Dinner ..... Every day ...... Table beer.
Sunday, Tuesday, Friday .... 8 oz. cooked meat, 8 oz. bread, vegetables.
Monday ...... Baked batter pudding, 4 oz. bread, 1 oz. cheese, or ½ oz. butter.
Wednesday ... Pea soup, with legs and shins of beef, 8 oz. bread. In the summer months, baked rice pudding, 4 oz. bread, 1 oz cheese, or ½ oz. butter.
Thursday ..... Boiled suet puddings, 4 oz. bread, 1 oz. cheese, or ½ oz. butter.
Saturday .... Rice milk, 8 oz. bread, 2 oz. cheese, or 1 oz. butter.
Supper ...... 8 oz. bread, 2 oz. cheese, or 1 oz. butter; table beer.
Extras ...... *For the Sick* ... Mutton broth, beef-tea, puddings, fish, meat, eggs, wine, strong beer, etc., or whatever may be ordered by the medical officer.
Christmas Day. 8 oz. roast beef, 8 oz. bread. (*Mem.* If it fall on a meat day, the patients have a meat dinner on the following day.) A mince pie, 6*d.*
New Year's Day. . Plum puddings, in addition to the ordinary dinner.
Good Friday .... A bun, 1*d.*
Easter Monday .. 8 oz. roast veal, 8 oz. bread, vegetables.
Whit Monday ... 8 oz. roast veal, 8 oz. bread, vegetables.
During the summer, about the month of August, 6 oz. bread, bacon, beans, 8 oz. bread, 1 oz. butter. Fruit, consisting of currants and gooseberries.
In the month of October, apple pies in addition to the ordinary dinner.

The ordinary diet at the Edinburgh Hospital (Scotland), is, for *breakfast* and *supper*—1 mutchin of porridge, 3 gills of milk *or beer*. or 5¼ oz. of fine bread, *milk or beer!* For *dinner*, on Sundays and Thursdays—1 choppin of broth, 8 oz. of butcher's meat boiled in the broth, or beef-steak, and 5¼ oz. of bread. On Monday, Thursday, and Saturday, a choppin of broth made of beef and bones, barley, groats, potatoes, and vegetables, and 5½ oz. of bread. On Tuesdays and Fridays, potato soup, with beef and veal, or bones, and 5½ oz. of bread.

At the Royal Hospital, Phœnix Park (Ireland), the *breakfast* and *supper* are, ordinarily— 1 pint of oatmeal or rice gruel; *dinner*—½ lb. of meat, 12 oz. of bread, and 1 lb. of potatoes. A *full diet* consists of ¾ lb. of meat, 1 lb. of bread, ½ lb. of potatoes, and 1 quart of *beer!*

The dietaries for the prisons in England and Wales differ principally from those of the hospitals in being more plain and simple. The prisoners who are obliged to work are actually fed more healthfully than in the hospitals, where the physicians are endeavoring to cure. In the prisons the *beer* is omitted; there is a less proportion of animal food, and the suet puddings, mince pies, old cheese, etc., are, fortunately for the inmates, left out.

In the English dietary system for paupers, the *beer* is also omitted, except when ordered by the physician. The following table is a fair specimen of the pauper diet of that nation:

Dietary for Able-Bodied Paupers.

		Breakfast.		Dinner.					Supper.	
		Bread.	Gruel.	Pickled Pork or Bacon, with Vegetables.	Soup	Bread.	Meat Pudding, with Vegetables.	Rice or Suet Pudding, with Vegetables.	Bread.	Cheese.
		oz.	pints.	oz	pints.	oz.	oz.	oz.	oz.	oz.
Sunday, Tuesday, Friday	*Men*	8	1½		2	6			6	2
	Women	6	1½		1½	5			5	1½
Monday, Thursday	*Men*	8	1½					12	6	2
	Women	6	1½					10	5	1½
Wednesday	*Men*	8	1½	6					6	2
	Women	6	1½	5					5	1½
Saturday	*Men*	8	1½				12		6	2
	Women	6	1½				10		5	1½

In the above table, vegetables are not included in the weight specified. Old people of sixty and upward are sometimes allowed 1 oz. of tea, 5 oz. of butter, and 7 oz. of sugar per week, in lieu of the gruel, for breakfast. Children above nine are allowed the same quantities as women.

The dietary system of the public institutions of the United States does not differ very materially from those adopted by the similar institutions of Great Britain. Generally tea and coffee take the place of beer and porter, and a greater proportion and variety of animal food and condiments are allowed.

At the New York Hospital the dietary is: For *dinner*, on *Tuesdays, Wednesdays, Thursdays*, and *Saturdays*—Beef soup, with beef and potatoes, and bread. On the alternate days—Mutton soup, with mutton and bread. On Mondays—Boiled rice, with one gill of molasses, is served ordinarily. For *breakfast* and *supper*—Black tea and bread; 1 oz. of tea to every six, and a pint of milk to every eight patients. Special diet, as eggs, oysters, chickens, crackers, porter, wine, coffee, etc., is directed by the attending physician.

Diet of the New York City Prison.

Dinner	Monday	Mush and molasses.
	Tuesday	Beef, with soup and bread.
	Wednesday	Mush and molasses.
	Thursday	Fresh boiled beef, with soup and bread
	Friday	Mush and molasses.
	Saturday	Fresh beef, with soup and bread.
	Sunday	Mush and molasses.
Breakfast	Coffee, with molasses boiled in it, and bread.	

The following dietary table of the New York Protestant Half-Orphan Asylum, furnishes a fair specimen of the diet provided for children in our public institutions:

Dinner	Monday	Bean soup, with bread.
	Tuesday	Mutton soup, with vegetables (potatoes, turnips, carrots), and bread.
	Wednesday	Mutton, hashed with potatoes and rice; clam soup, with rice, during the summer months, with potatoes and rice, or balls of flour boiled.
	Thursday	Beef soup, with vegetables and bread.
	Friday	Beef, hashed with potatoes and rice, and bread.
	Saturday	Cold corned beef and bread; except during the summer months, when crackers and cheese are substituted for salt meat, which was found to produce bowel complaint
Breakfast	Bread and milk for the smaller children; bread, with molasses, or sugar, or honey, for the larger ones.	
Supper	Plain bread, except on Sunday evening, when gingerbread is allowed.	

At the Pennsylvania Hospital (Philadelphia), for *breakfast*—Tea, coffee, or chocolate, with sugar or molasses, and milk, and common baker's bread, are allowed at discretion. For *dinner*—Soup always; meat of two kinds [illegible] generally; pork frequently; vegetables according to the season, potatoes always. For *supper*—Tea and bread; no butter allowed, unless prescribed.

The dietary of the Blockley Alms-house (Philadelphia) is very similar to that of the New York City Prison.

The dietary tables of the Baltimore, Providence, and Albany Alms-houses do not differ greatly from that of the Bellevue Alms-house in this city. The following is the general diet of the paupers at the Baltimore Alms-house, which may serve as a sample of the whole:

Breakfast	Bread, and rye coffee sweetened with molasses.	
Supper	Bread, and tea sweetened with sugar.	
Dinner	Monday	Beef and soup.
	Tuesday	Mush and molasses.
	Wednesday, Thursday	Beef and soup.
	Friday	Herring, mush and molasses, or hominy.
	Saturday	Beef and soup.
	Sunday	Pork and vegetables.

The amount of animal food allowed each pauper is 8 oz. of beef, or 5 oz. of pork; each laborer is allowed 20 oz. of bread per day; and all others over one year old, 16 oz. of bread daily.

At the Manhattanville Lunatic Asylum the diet approaches more nearly to that of an ordinary hotel or boarding-house. All the materials are said to be of first quality, and all the articles are allowed *ad libitum*. The following is the table:

Breakfast	Meat, hashed with potatoes, or cold, with bread and butter, coffee, milk, and sugar.	
Dinner	Monday, Tuesday	Roast meat, beef, mutton, or lamb, with vegetables, rice, flour, bread, or fruit puddings.
	Wednesday, Saturday	Soup, with rice or Indian mush; pastry on Wednesday.
	Thursday	Corned beef, with potatoes, and other vegetables, and puddings.
	Friday	Boiled fish (either fresh or salted cod, fresh halibut, shad, mackerel, etc., in their season).
	Sunday	Cold meat, warm vegetables, pastry, and cheese.
Supper	Bread and butter, tea or milk; molasses gingerbread on Wednesday; sugar cakes and cheese on Sunday evening.	

The intelligent physiologist cannot fail to notice several grave and important errors in the existing dietaries of all our public institutions. In some of them tea or coffee is allowed on some days, and refused on others. It would be an improvement either to refuse it wholly, or allow it daily; for all articles which strongly stimulate the blood-vessels, or excite the nervous system, if administered one day, and withheld the next, keep the whole organism in a constant state of perturbation; one day partially exhilarated and [illegible] unnaturally depressed. Another error is in allowing full solid diet, as meat and bread, one day, and the next restricting the diet to slop food, as soup and mush, or mush and molasses, or both. The solid and nutritive materials, in whatever forms presented, should be nearly equal on each day. Another sad defect is the meager supply of fruits and vegetables. In most instances they seem to be regarded as *mere indulgences*, whereas they ought to be considered and provided as a substantial part of the food itself. Again, when cakes, pastry, and puddings are allowed, they are among the most unhealthful and indigestible preparations. Such an unphysiological, irregular, and disorderly plan of feeding the inmates of prisons, asylums, or pauper-houses, must be exceedingly detrimental as regards the character, health, and well-being of the individuals subjected to their punishments or charities, and as regards the discipline, order and economy in which the public are more especially interested.

Every dictate of true humanity demands, and every consideration of enlightened public policy requires, that all persons, be they wicked, poor, or homeless, be furnished with such food as will be alike conducive to healthy bodies and sound minds. Society has a right to study economy, but not to the extent of depriving a fellow-creature, under the name of authority or alms-giving, of the materials of a pure and perfect nutrition; but the expense of a perfectly wholesome dietary system would not exceed those in general use.

There are so many good things to eat in the world, and so many ways of preparing them, as taste, convenience, fancy, or economy may dictate, that our difficulty consists not in finding sufficient materials, but in making judicious selections.

The following tables are presented, not as being any better than a hundred others which could be constructed, but as landmarks to guide those who are not familiar with all the details of a dietary system founded on physiological principles.

General Dietary for a Water-Cure in Winter

Standing Articles for the Table.—Brown bread, white bread, cold cracked-wheat, hard biscuits or Graham crackers, water, milk, sugar, molasses or syrup, salt.

Monday.....*Breakfast*. Cracked-wheat mush, baked potatoes, green apples stewed.

Dinner... Beef-steak, boiled potatoes, pea-soup, apples. Dessert—Rice pudding.

Supper....Indian cake, stewed prunes.

Tuesday....*Breakfast*. Rye and Indian griddle-cakes, baked potatoes, dried apples stewed.

Tuesday ....*Dinner* ...Mutton chops, mashed potatoes, boiled parsneps, baked tart apples. Dessert—Pumpkin pie.

Supper....Indian mush, dried peaches stewed.

Wednesday..*Breakfast* . Rice gruel, cold potatoes browned, green apples stewed.

Dinner ...Corned beef, potatoes, cabbage, apples. Dessert—Indian pudding.

Supper....Milk toast, boiled apples sweetened.

Thursday ...*Breakfast* Wheat-meal griddle-cakes, baked potatoes, green apple sauce.

Dinner ...Boiled mutton, potatoes, white beans, stewed cranberries. Dessert—Apple pie.

Supper....Dry toast, dried whortleberries stewed.

Friday......*Breakfast* .Water biscuits, boiled potatoes, dried peaches stewed.

Dinner ...Boiled halibut, sweet potatoes, beets, baked apples. Dessert—Custard.

Supper....Stewed figs, hominy.

Saturday ....*Breakfast* .Rye-meal mush, cold sweet potatoes browned, green apple sauce.

Dinner ...Roast beef, potatoes, turnips, dried currants stewed. Dessert—Tapioca pudding.

Supper....Wheat-meal sweet cake, baked apples.

Sunday .....*Breakfast* .Buckwheat griddle-cakes, dried apples and raspberries.

Dinner ...Roast beef, potatoes, Lima beans, baked tart apples. Dessert—Bread pudding, dried squash pie.

Supper....Oatmeal mush, dried apples and prunes stewed.

General Dietary for a Water-Cure in Summer.

Standing Articles —As in the preceding table.

Monday.....*Breakfast* .Indian cake, young currants stewed.

Dinner ...Roast lamb, potatoes, asparagus, grapes Dessert—Tapioca pudding.

Supper....Oatmeal mush, strawberries.

Tuesday ....*Breakfast* .Rye-meal mush, red cherries.

Dinner ...Beef-steak, potatoes, green peas, stewed tomatoes. Dessert—Strawberry pies.

Supper....Dry toast, whortleberries.

Wednesday .. *Breakfast*. Cracked-wheat mush, red raspberries.
Dinner ... Mutton chops, potatoes, beets, string beans, uncooked tomatoes. Dessert—Rice pudding.
Supper.... Water biscuits, boiled peaches.

Thursday ... *Breakfast*. Rice gruel, black raspberries.
Dinner.... Corned beef, potatoes, spinach, green corn, tomatoes. Dessert—Raspberry pie.
Supper.... Milk toast, boiled pears.

Friday ...... *Breakfast*. Rye-meal cakes, black cherries.
Dinner.... Boiled cod, potatoes, succotash, baked apples. Dessert—Custard pudding.
Supper.... Hominy, blackberries.

Saturday .... *Breakfast*. Boiled rice, peaches.
Dinner.... Beef hash, potatoes, squash, green peas, tomatoes stewed. Dessert—Whortleberry pie.
Supper.... Wheat-meal water biscuits, stewed blackberries.

Sunday ..... *Breakfast*. Oatmeal cakes, stewed green apples.
Dinner.... Boiled eggs or chicken, potatoes, succotash, musk-melons. Dessert—Blanc-mange.
Supper.... Wheat-meal sweet cake, baked sweet apples.

I need not say that in the above tables the dry and watery foods, and the proportions of nutriment and bulk, are so arranged that the dietary for either day of the week would do as well for two or three, or even all the days of the week.

There are many cases of indigestion, attended with extreme derangement of the digestive powers, and also various chronic inflammations, complicated with great torpor of all the depurating organs, for which a more strict diet is indispensable. I propose, therefore, the following plan, which is substantially that which I have prescribed for several years.

Particular Dietary for Dyspeptics.

Breakfast ... Brown bread, apples, grapes, peaches, or pears, or other very ripe uncooked fruit, if sweet or subacid. Drink—Water, or a *very little* milk.

Dinner...... Baked or boiled mealy potatoes, baked apples, or grapes, with brown bread. Dessert—Cold cracked-wheat mush, or oatmeal, or plain boiled rice, with a little sweetened milk, or brown sugar, for seasoning; asparagus, or green peas, in their season. Drink—A very little water.

Supper......Brown bread toasted, or Graham crackers, baked sweet apples. No drink, and the whole supper very light. Baked or boiled mealy potatoes may be substituted for the bread or crackers.

Those who reject animal food, either from principle or interest, will find so much of the dietary for Water-Cure establishments, as convenience admits or occasion requires, suitable for them, omitting the flesh part. To show, however, the amplitude of our resources for eatables, without the shedding of blood, let us look at the subject in a tabular form:

Dietary for a Vegetarian Hotel.

Standing Articles.—Brown bread, white bread, rye and Indian bread, butter, pot cheese or fresh curd, sweet cream, milk, water, lemon juice, sugar, syrup or molasses, or honey.

Monday.....*Breakfast*. Wheat and Indian griddle-cakes, rice gruel, baked potatoes, stewed green apples.

Dinner....Mashed boiled potatoes, parsneps, squash, green corn, apples, grapes. Dessert—Rice pudding, custard pie.

Supper....Milk toast, cracked-wheat mush, potatoes, baked apples, stewed figs, blanc-mange.

Tuesday....*Breakfast*. Corn-meal cake, boiled potatoes, stewed peaches, stewed currants.

Dinner....Potatoes, white beans boiled, beets, tomatoes, musk-melons. Dessert—Tapioca pudding, pumpkin pie.

Supper....Dry toast, plain sweet cake, hominy, potatoes, whortleberries, stewed apples.

Wednesday..*Breakfast*. Rice griddle-cakes, wheaten grits, cold boiled potatoes browned.

Dinner....Sweet potatoes, asparagus, cabbage, green peas, tomatoes, green pears, baked apples. Dessert—Custard pudding, apple pie.

Supper....Cracker toast, Indian mush, potatoes, stewed prunes, stewed dried peaches.

Thursday...*Breakfast*. Graham flour hoe-cake, baked potatoes strawberries, apples.

Thursday ... *Dinner*.... Mashed potatoes, baked carrots, spinach, baked white beans, sweet oranges, baked apples, grapes. Dessert—Indian pudding, tomato pie.

Supper.... Oatmeal mush, brown biscuits, potatoes, custard, boiled apples, peaches, or pears.

Friday ...... *Breakfast*. Buckwheat griddle-cakes, baked potatoes, stewed apples, grapes, cherries.

Dinner.... Common potatoes, sweet potatoes, green corn, string beans, baked apples, stewed tomatoes. Dessert—Cracked-wheat pudding, whortleberry pie.

Supper.... Rice gruel, dry toast, potatoes, boiled peaches or pears.

Saturday .... *Breakfast*. Wheat-meal water biscuits, baked potatoes, oranges, figs, bananas, or grapes.

Dinner.... Potatoes, pea-soup, parsneps, boiled cabbage, baked sweet apples. Dessert—Boiled rice, dried apple and green currant pie.

Supper.... Oatmeal cake, cracker toast, potatoes, stewed apples.

Sunday ..... *Breakfast*. Rye-meal griddle-cakes, farina mush, potatoes, boiled peaches, pears, or apples.

Dinner.... Sweet potatoes, common potatoes, turnips, asparagus, stewed tomatoes, baked apples. Dessert—Blanc-mange, pumpkin or squash pie.

Supper.... Plain biscuits or buns, cold hominy, potatoes, green apples stewed.

The dietary for a private family only requires a little simplification in the matter of variety; there is as much room for improvement in this direction as any one is disposed to occupy. Those who see fit to drop off the superfluities or seasonings—salt, butter, cream, etc.—will experience, in due time, a permanent physiological advantage, amply compensating them for the temporary privation of accustomed indulgences. But let me in this place urge what I have before insisted upon, and what is of vastly more importance to invalids, and even to well persons, than most people can be made to understand, that all seasonings or condiments, and especially butter and salt, are incomparably less injurious when added to the article of food after it is cooked, than when cooked into it The sweetness, digestibility, and healthful ness of most of our ordinary vegetables, I repeat, are always very materially impaired by cooking them in salted and greasy water. This is one of the *great errors* of most Water-Cure establishments, which easily can be and ought to be corrected. Let those whose appetites or whose judgments are determined in the employment of these things, put them *on*, not cook them *in*, their vegetable dishes or farinaceous preparations.

The following catalogue of green fruits and vegetables as found in the New York markets, exhibits our ample resources for these articles during each month of the year. The list is a selection of the best articles in their seasons, rather than an enumeration of the whole:

January.—Common potatoes, sweet potatoes, beets, cabbages, white turnips, yellow turnips, preserved green peas, preserved green Lima beans, pumpkins, apples, grapes.

February.—Common potatoes, sweet potatoes, parsneps, beets, cabbages, white turnips, yellow turnips, preserved green peas, preserved Lima beans, apples, grapes.

March.—Common potatoes, sweet potatoes, parsneps, beets, cabbages, white turnips, yellow turnips, preserved green peas, preserved green Lima beans, apples, grapes.

April.—Common potatoes, parsneps, beets, carrots, cabbages, white turnips, yellow turnips, preserved Lima beans, spinach, apples, grapes.

May.—Common potatoes, parsneps, beets, carrots, cabbages, asparagus, spinach, apples, currants, strawberries.

June.—Common potatoes, parsneps, cabbages, asparagus, spinach of various kinds, strawberries, currants, peas, string beans, cherries, gooseberries, apples.

July.—Common potatoes, sweet potatoes, peas, beans, young corn, beets, squashes, strawberries, currants, gooseberries, whortleberries, cherries, raspberries, tomatoes, apples, peaches, apricots, water-melons, musk-melons.

August.—Common potatoes, sweet potatoes, peas, beans, young corn, squashes, currants, raspberries, whortleberries, blackberries, tomatoes, apples, peaches, pears, apricots, water-melons, musk-melons, plums, grapes.

September.—Common potatoes, sweet potatoes, beans, young corn, cabbages, beets, turnips, tomatoes, blackberries, apples, peaches, pears, water-melons, musk-melons, plums, grapes, pumpkins.

October.—Common potatoes, sweet potatoes, beets, turnips, cabbages, squashes, pumpkins, apples, pears, plums, grapes.

November.—Common potatoes, sweet potatoes, beets, turnips, pumpkins, squashes, cabbages, apples, pears, plums, grapes.

December.—Common potatoes, sweet potatoes, beets, turnips, preserved green peas, preserved Lima beans, squashes, pumpkins, apples, grapes.

I cannot, perhaps, better conclude the dietetic department of this work, than by quoting the testimony of two eminent medical scholars and accurate observers, in favor of vegetable diet both as a curative and preventive of disease. The first-named author practiced in his person and prescribed to his patients what he preached; the latter did neither.

Dr. William Lambe (*Water and Vegetable Diet in Consumption, Scrofula, Cancer, Asthma, etc.*) remarks: "It seems, moreover, highly probable that the inherent power of the living body of restoring itself under accident or wounds, is strongest in those who use mostly a vegetable regimen, and who are very sparing in the use of fermented liquors. This has been observed among the Eastern nations. Sir George Staunton says on this subject: 'It is, however, to be remarked that the Chinese recover from all kinds of accidents more rapidly, and with fewer symptoms of any kind of danger, than most people in Europe. The constant and quick recovery from considerable and alarming wounds has been observed likewise to take place among the natives of Hindostan. The European surgeons have been surprised at the easy cure of sepoys in the English service, from accidents accounted extremely formidable.'" This felicity the relator attributes to the causes which I have mentioned. I have received the same accounts from other quarters.

These facts are enough to nduce a suspicion that our diseases are much exasperated by our manner of living, and the full diet of animal food to which we are habituated. One would be apt to imagine, from the common practice of most of our physicians, and still more of our medico-chirurgeons, that excess and intemperance were the regular methods of curing diseases. They have been laboring, during almost the whole of my medical life, to prove to the public that the doctrines of abstemiousness, inculcated by several of our predecessors, are a mere prejudice and error. In almost all chronic diseases, to forbid the use of vegetables is a part of the established routine. If there be a little heart-burn or flatulency, all vegetables are instantly proscribed. Infants, even, are loaded with made dishes, and their breaths smell of wine and strong liquors. Nay, to such an extent are these abominations carried, that when their stomachs revolt against these unnatural compounds, with instinctive horror, and the importunities of nature cannot be wholly resisted, a little fruit is held out to them as a sort of premium, and as a reward for forcing down the nauseous farrago which they loathe.

The English surgeon, John A. Forsyth, somewhat celebrated as an author on medical and dietetical subjects, and a very accurate historical writer, observes, in allusion to the connection between the vegetarian food and the health of the early inhabitants of the earth (*Dictionary of Diet*): "The decays of nature, in the expiring periods of life, were the only infirmities to which men were then liable; and though their limbs sometimes failed to perform their office, their health and appetite continued with them till life was no more. In this rude, but natural state, the food of mankind is said to have continued upward of two thousand years, *during which period the cook and the physician were equally unknown*. It is not easy to say at what period man exchanged vegetable for animal diet; but certain it is, that he no sooner began to feed on flesh, fowl, and fish, than seasonings of some kind became requisite, not only to render such food more pleasing and palatable, but also to help digestion and prevent putrefaction. Of these seasonings, salt was probably the first discovered; though some are inclined to think that savory roots and herbs were first in use; spices, however, as ginger, cinnamon, pepper, cloves, and nutmegs, by degrees came into use, and the whole art of cookery gradually improved, till it reached its present climax of perfection. Eating of animal food was evidently adopted as necessary to guard against famine, the consequence of the scarcity and bad condition of vegetable productions. We find, therefore, that in process of time, and to aid their mutual wants, as well as to protect the weak against the strong, the industrious from the indolent, men, by general consent, began to portion out to each other a certain measure of land, to produce them their supply of vegetables. Reason soon after suggested the expedient of domesticating certain animals, equally to assist them in their labors and to supply them with food. Hogs, it is said, were the first animals of the domestic kind that appeared on their tables, as then they held it to be ungrateful to devour the beasts that assisted them in their labors."

GLOSSARY.

In the following vocabulary will be found a definition of the most important technical terms, not fully explained in the text:

Abnormal, irregular, unnatural.
Acetabulum, saucer-like cavity.
Acute, of short duration, severe.
Adipose, fatty; from *adeps*, fat.
Adynamic, relating to vital debility.
Aëration, arterialization of the blood.
Allopathy, "contraria contrarius curantur," or, the practice of counteracting the symptoms.
Anæsthesia, deprivation of sensibility.
Anastomosis, communication between vessels.
Anhæmia, bloodlessness, with debility.
Anorexia, absence of appetite.
Antiphlogistic, reducing, cooling.
Ant-irritant, soothing, sedative.
Apparatus, set of organs or instruments.
Areolar tissue, cellular substance.
Arterial, relating to arteries.
Articular, relating to joints.
Asphyxia, suspended animation.
Atheroma, pulpous encysted tumor.
Atony, want of tone, debility.
Atrimatrics, medication with foul air.
Basilir, pertaining to the base.
Biceps, a two-headed muscle.
Bicuspids, two-pointed teeth.
Bougie, a flexible dilating tube.
Brachial, belonging to the arm.
Bronchia, branches of the windpipe.
Bursæ mucosa, sacs of viscid fluid.
Calculi, concretions of gravel, stone, etc.
Capillary, small, minute, hair-like.
Cardiac, relating to the heart.
Catamenial, relating to the menses.
Cephalagia, headache of any kind.
Cervical, relating to the neck.
Cervix uteri, neck of the uterus.
Chronic, of long and uncertain duration.
Chylopoietic, chyle-making organs.
Cicatrix—Cicatrization, a scar—scarring.
Cineritious, cortical, ash-colored.
Colliquative, profuse, exhausting discharges
Commissures, points of union between parts.
Condyle, an articular eminence of bone.
Contractility, the vital property of muscle.
Convolutions, undulating windings.
Corpuscules, the globules of various fluids.
Cortical, exterior, belonging to the bark.
Cuticle, the epidermis, or scarf-skin.
Cutis vera, the inner or true skin.
Demulcent, gummy, mucilaginous medicines.
Dermoid, pertaining to the integument.
Diaphoretic, tending to produce sweat.
Diluent, tending to thin the fluids.
Dispensatory, book of medical compositions
Diuretic, increasing the urinary secretion.
Dorsal, pertaining to the back.
Dynamic, in biology, the vital force.
Eclectic, selecting from all sources.
Effluvia, impalpable emanations.
Elasticity, property of areolar tissue.
Elingual, destitute of a tongue.
Elixir vitæ, alcohol and aromatics.
Emmenagogue, promoting menstruation.
Emollient, softening, relaxing, soothing.
Encephalic, situate within the head.
Endemic, prevailing over a neighborhood
Epidemic, prevailing over a country.
Epidermis, the external or scarf-skin.
Epigastric, upon or near the stomach.

Epiploon, the caul or omentum.
Epispastic, blistering the skin.
Episynthetic, accumulative, collective.
Epithem, soft or warm applications.
Eructation, sonorous ejection of wind.
Escharotic, producing a sore or scar.
Expiration, breathing *from* the lungs.
Facette, small, smooth surface of bone.
Facial, belonging to the face.
Fasciculus, a small bundle.
Fæces, excrement of the bowels.
Fauces, the throat, pharynx.
Feculent, relating to the fæces.
Fenestra, window-like.
Filament, a fine thread, fibril.
Foramen—Foramina, a hole—apertures.
Fossa—æ, a depression—cavities.
Frænum, a bridle of fibers
Fumigations, odorous smokes or gases.
Ganglia, convolutions of nervous cords.
Gangrene, death, with putrefaction.
Gastric, relating to the stomach.
Gastrodynia, flatulent colic.
Gastro-enteric, relating to the stomach and bowels.
Glenoid, shallow articular cavity.
Granulations, flesh-shoots of ulcers.
Granule, a small, compact particle.
Grumous, clotted or coagulated.
Gymnastic, relating to bodily exercise.
Hepatic, pertaining to the liver.
Homœopathy, "similia similibus curantur," the doctrine that like cures similar.
Humoral pathology, the doctrine of the fluids being the primary seat of disease.
Hydropathy, hygienic medicine, the system of treating diseases by water, light, air, temperature, exercise, food, etc.
Hygiene, preservation of health.
Hypoglossal, under the tongue.
Idiopathic, primary, original.
Idiosyncrasy, functional peculiarity.
Ingesta, food, drinks, condiments, etc.
Inhalation, breathing into the lungs.
Innominata, nameless, bones of the pelvis.
Inorganic, without distinct organs.
Inosculation, connection, communication.
Inspiration, receiving air in the lungs.
Insufflation, injecting gases or vapors.
Intumescence, enlargement, swelling.
Irritability, susceptibility to external impressions; the ultimate vital property.
Irritant, causing painful excitement.
Irritation, preternatural excitement.
Lachrymal, relating to the tears.
Lamella—æ, thin plate or plates.
Lamina—æ, thin part or parts of bone.
Lentor, viscid or sizy matter.
Lithontriptic, solvent for the stone.
Lobe, small, round, projecting part.
Lobule, diminutive of lobe.
Lumbar, relating to the loins.
Malaria, miasm, noxious gases.
Malignant, dangerous or putrescent.
Mater, mother, membranes.
Materia Medica, medical materials.
Meatus, a canal or passage.
Medulla, the marrow or pith.
Medullary, relating to the marrow.
Membranous, formed of membrane.
Menstruum, a vehicle or solvent.
Metastasis, changing the seat of disease.
Metasyncrisis, changing, making over.
Methodus Medendi, curative method.
Modus operandi, mode of operating.
Molecular, relating to minute portions.
Mucous, pertaining to mucus.
Mucus, animal mucilage.
Narcotic, stupefying, deadening.
Nervine, relating to articles which affect peculiarly the nervous system, either of an exciting or soothing nature.
Neutral salts, salts having excess of neither acid nor alkali.
Neuralgia, nerve-ache, tic dolereaux.
Normal, regular, natural.
Nosology, classification of diseases.
Nuclei—Nucleoli, central points, or primordial particles of matter.
Ophthalmia, inflammation of the eye.
Organic, constituted of organs.
Osseous, relating to bone.
Ova—Ovules, germinal particles, eggs.
Papillæ, nipple-like eminences.
Parenchyma, substance of the lungs.
Parietal, relating to a side or wall.
Pathogenetic, disease-producing.
Pathology, doctrine of diseases.
Petrous, hard, resembling stone.
Pharmaceutic, relating to pharmacy.
Pharmacopœia, book of medical formularies
Pharmacy, preparation of drug-medicine.
Phlegmasia, term for inflammation.
Phlogistic, active inflammation.
Plastic, that which serves to form.
Plexus, net-work of vessels or nerves
Pneumatology, in medicine, the doctrine of spiritual substances.
Præcordia, near the heart, or about the epigastric region.

Preternatural, unnatural.
Process, in anatomy a projection.
Probang, a rod of whalebone.
Prophylactic, preventing disease.
Puerperal, relating to childbirth.
Radicles, germs of the roots.
Regimen, regulated food, drink, etc.
Refrigerant, cooling, reducing.
Renal, relating to the kidneys.
Respiration, pertaining to breathing.
Resolution, removal of disease.
Rubefacient, inflaming the skin
Rugæ, membranous folds or wrinkles.
Sacral, relating to the os sacrum.
Sedative, soothing, anti-irritant.
Semi-animist, half-living and half-dead.
Sensation, cognizance of an impression.
Sensibility, feeling of an impression.
Sero-fibrous, serous and fibrous.
Serous, thin, watery, like serum.
Sialagogue, exciting the salivary flow.
Sigmoid, resembling the Greek S or C.
Speculum, an instrument to dilate cavities, etc.
Spermatozoa, spermatic animalcules.
Stimulant, exciting the circulation.
Spinous, sharp or thorn-like.
Sudorific, producing perspiration.
Suppuration, formation of pus.
Sympathetic, associated in function action, or condition.
Symptomatic, secondarily affected.
System, assemblage of parts or organs.
Temperament, constitutional peculiarity.
Temporal, relating to the temple.
Tenesmus, frequent, painful, and vain attempts to eject from the bowels.
Therapeutics, the application of remedies.
Tic doloreaux, nerve-ache, neuralgia.
Tissue, a distinct structure.
Tone, force, power, stamina.
Tonic, giving strength, corroborant.
Tormina, griping pains in the bowels.
Traction, gradual, steady pulling.
Transpiration, passage of fluid outward.
Tubercle, a tumor within an organ.
Tuberosity, protuberance, projection.
Turgescence, swelling, fullness.
Vascular, composed of vessels.
Venæsection, bleeding with a lancet.
Venous, appertaining to veins.
Ventricular, relating to small cavities.
Vermifuge, a remedy against worms.
Vesicular, consisting of vascular cells
Vesicatory, producing blisters.
Villous, hair-like, velvety.
Vis Medicatrix Naturæ, remedial power of nature.
Viscus—Viscera, organ—organs.
Vitality, inherent principle of life.
Vis vitæ, vital force, irritability.

HYDROPATHIC ENCYCLOPEDIA;

A COMPLETE SYSTEM OF

Hydropathy and Hygiene:

AN ILLUSTRATED WORK,

EMBRACING:

I. OUTLINES OF ANATOMY, ILLUSTRATED.
II. PHYSIOLOGY OF THE HUMAN BODY.
III. HYGIENIC AGENCIES, AND THE PRESERVATION OF HEALTH.
IV. DIETETICS AND HYDROPATHIC COOKERY.
V. THEORY AND PRACTICE OF WATER-TREATMENT.
VI. SPECIAL PATHOLOGY AND HYDRO-THERAPEUTICS, INCLUDING THE NATURE, CAUSES, SYMPTOMS, AND TREATMENT OF ALL KNOWN DISEASES.
VII. APPLICATION TO SURGICAL DISEASES.
VIII. APPLICATION OF HYDROPATHY TO MIDWIFERY AND THE NURSERY.

BY R. T. TRALL, M.D.

THE object of this work is to bring together, in the most condensed and practical form, for public use and professional reference, all the facts and principles in medicine and its collateral sciences, pertaining to the Philosophy of Life and Health, and the Water-Cure Treatment of Diseases. It is therefore designed as a guide to students and families, and a text-book for physicians.

Especial attention will be devoted to the consideration of Hygienic Agencies, each of which constitutes a fundamental principle in the Hydropathic System, and all together forming a perfect and harmonious whole, embracing all the laws of constitution and relation by which Diseases are cured, Health preserved, and Longevity attained.

While the General Rules which govern the application of water as a remedial agent are kept prominently in view, every malady recognized by physicians as a distinct disease will be particularly described and its appropriate treatment specified.

A leading feature in its therapeutical department is the endeavor to supply a bedside adviser for Domestic Practice, or Home Treatment. The experience of a quarter of a century, and the results of many thousands of cases of nearly all forms of acute and chronic diseases, treated hydropathically in different parts of the world, afford ample data upon which to predicate correct and intelligible rules, for the successful management of the great majority of ordinary complaints, by non-professional persons, without the attendance of the practicing physician.

The time will surely come, and the physiological salvation of the Human Race requires that it *soon* come, when all *well* educated persons will understand for themselves, *all* the departments of the Healing Art, and be as competent to take care of their own health, and defend their own lives against morbific causes, as they are to procure their own food, raiment, houses, and lands.

With the hope of being instrumental in hastening a "consummation so devoutly to be wished," the author and publishers have spared neither labor nor expense.

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