THE CIRCULATION

Heart
Lungs

BY

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AUTHOR OF

GROWTH IN SILENCE
SELF SUFFICIENCY
THE VITAL ORGANS
POISE AND SYMMETRY OF FIGURE
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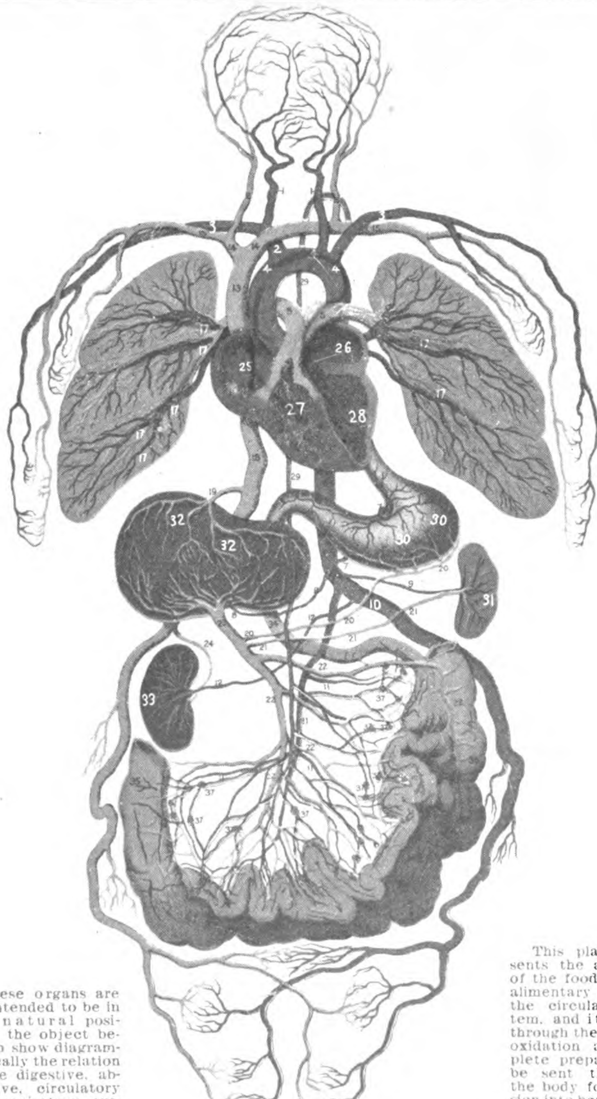

These organs are not intended to be in their natural positions, the object being to show diagrammatically the relation of the digestive, absorptive, circulatory and respiratory systems.

This plate represents the absorption of the food from the alimentary tract into the circulatory system, and its route through the lungs for oxidation and complete preparation to be sent throughout the body for conversion into bone, muscle and other tissues.

BLOOD FORMATION & CIRCULATION.

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An invariable law of nature requires action for strength, movement for growth, unity of movement for equal strength of all parts. The wind exercises the trees of the forest; every bush, tree and shrub is kept in almost constant motion—though the wind at night is tempered for rest, giving relaxation after movement. The fox must hunt his prey, the bird must catch the worm—always effort for reward, activity for strength. The crippled beast is fed by his mates; yet, inactive too long, he loses strength and power of motion.

This is entirely true in man's kingdom; inactivity of an organ or tissue means weakness, ultimate shriveling up of the tissue, atrophy, or decay. Sluggish circulation, or inadequate use of any part, means incomplete growth of that part, means disproportionate strength or disuse.

Complete freedom and uniform strength of every organ is the natural state of the human body,—it is the state of perfect health, and *it is the sacred duty of every human being to keep in health.*

The idea that sickness is sent to "try the spirit as by fire, to chasten, and to purify" is an unhealthy and unnatural thought. Sickness, in the majority of cases, is simply the result of ignorance of the natural requirements, or of negligence in allowing the system to so lose its vitality that it becomes an easy prey to disease. In a large percentage of cases, it is caused by sluggish or disturbed circulation, due to a lack of all-around exercise and a consequent failure of the system to eliminate its waste;—the waste clogs and weakens.

To retain the body in its natural state, every capillary, nerve and muscle tissue, and every sinew, must be kept uniformly strong; there must be a free action of each lung cell, a flexibility of every muscle and cartilage, and a corresponding strength of every nerve and brain cell.

It is not work which kills,—the brain, when untrammeled by bodily restrictions, is capable of an almost limitless amount of work. It is lack of uniform work of every part—incomplete circulation— a wearing out or a clogging of one part of the body, by reason of the failure to exercise each part uniformly, thus calling undue blood pressure to the part which is being most strongly used. The surest way to insure this uniformity is to take a few well directed exercises night and morning in one's room, free from clothing.

The Circulatory System consists of the:

Heart, which forces the blood on its entire circuit through the body; the

Arteries, which convey the blood, carrying the food products from the digestive organs, and oxygen from the lungs, to every tissue; the

Veins, which begin at the ends of the small arteries in the capillaries, and return the impure blood to the heart; and the

Lymphatics, which begin in the spaces about the capillaries, where the nutriment is distributed to all tissues, carrying both nutriment and waste from the tissues back into the blood.

The Lungs are not properly a part of the circulatory system, but they play an important part in purifying the blood, and are, therefore, discussed with the circulation.

THE HEART

The heart is about as large as the clenched fist of its owner. It is shaped like a pear, and is fixed in a slanting position inside the chest, with its larger end upward. It lies just above the diaphragm, behind the lower two-thirds of the breast bone, its upper end projecting a little to the right of that bone, and its lower end, or apex, a little to the left. The membranous tissue surrounding the heart is called the pericardium.

When cut open, the heart is found to be hollow. It is divided into a right and left chamber by a wall which runs through it from base to apex, and each of these chambers is divided into an upper and lower part by a valve. The upper part of each chamber is known as the auricle, and the lower part as the ventricle. There is no direct opening from the right chamber of the heart to the left, but the valve dividing either side into its auricle and ventricle leaves a large opening between these two.

By referring to the Blood Formation and Circulation Plate in the frontispiece, these divisions of the heart may easily be distinguished, as follows,—right auricle (25), left auricle (26), right ventricle (27), and left ventricle (28).

The heart is the pump for the circulatory system. When the heart contracts, the venous blood, in the right ventricle, is driven into the pulmonary artery (5), through which it is forced, by successive heart contractions, to the lungs; here it comes in immediate relation with the oxygen in the air cells.

The right and left ventricles each hold about four ounces of blood. When the heart contracts, both ventricles are emptied at the same time, and when it dilates, the ventricles are both filled at the same time, each from its own auricle. The right ventricle is filled with impure, venous blood, the left with pure arterial blood.

The carbonic acid gas and other impurities, which have been collected by the blood in its circulation through all parts of the body, are cast out of the lungs in the breath, and the blood is loaded with fresh oxygen. The pure, aerated blood is then passed on into the pulmonary veins (17) and is emptied by them through the pulmonary artery (not shown on plate) into the left auricle; from the left auricle it passes into the left ventricle. When the left ventricle contracts, it drives its four or more ounces of aerated blood into the aorta (4), which is furnished with strong valves to keep each charge of blood from returning. Successive heart contractions force the blood through the branching arteries, arterioles and capillaries to all parts of the system.

The apex of the heart rests against the chest at the fourth or fifth intercostal space, and the heart beat may be seen and felt in consequence of a slight protrusion of the wall, occasioned by the contraction of the apex. To feel it beat, press with the fingers between the cartilages of the fifth and sixth ribs.

In keeping up the force of the heart action, the return of the blood through the veins is of the utmost importance. The large vein, through which the blood is returned to the heart from the body, is the vena cava containing impure blood. The pulmonary vein, returning the blood from the lungs, contains pure blood. The return flow through the vena cava forces the right auricle open, which, in turn, forces the opening into the right ventricle, and the force of the returning blood, together with the muscular contraction of the heart, forces it out again into the pulmonary artery. It is in this return flow to the heart that the strength of the muscles, which lie along the course of the veins and the lymphatics, plays so vital a part.

In people in normal health, the heart contracts, or "beats", about seventy-two times per minute. What we designate as a "heart beat" begins with the simultaneous contraction of the two ventricles; then there is a pause during which the whole heart is at rest and is filling with blood.

The contraction of the heart is designated as *systole,* its relaxation or rest period, as *diastole.*

An interesting and important feature of the heart beat is the regular occurrence of the sounds. Two sounds are apparent—one at the beginning and the other at the end of the contraction of the ventricles. These sounds are readily heard by applying the ear to the thorax, over the heart. It is supposed that the sounds are due to the vibrations set up by the closure of the heart's semi-lunar valves. They are thence transmitted to the column of blood in the pulmonary artery and to the chest walls.

The cause of the rhythmic contraction of the heart muscles is not definitely known, but the initial force of action is made in the muscular walls. There are three theories now given weight.

One theory holds that it is caused by contact of chemical properties in the blood with the serous lining. The heart of a frog, as demonstrated by Ringer, can be kept beating many hours upon a mixture of sodium chloride, potassium chloride, and calcium phosphate or chloride being supplied to the heart through the veins. A solution composed of these three salts in proper proportions is known as Ringer's mixture. It is evident that these salts play some important part in the cause of the rhythmic heart beats.

Volkmann's theory, known as the "Neurogenic Theory", is, that the regular, rhythmic movements of the heart are dependent upon the nerve cells contained within its muscular walls.

Another, known as the "Myogenic Theory", is, that the muscular tissue of the heart itself possesses the property of automatic, rhythmic movement.

Either the myogenic theory of contained muscular control, or the neurogenic, or nerve theory, is given precedent today, yet the real cause is not known and the theories shift their standpoint from generation to generation.

The heart beat is regulated, to a certain extent, and influenced constantly, by the central nervous system; but, as was definitely established by Haller (1757), while the activity of the heart is regulated by the central nervous system, it has nothing to do with its rhythmic beat, for the heart continues to beat when connection with the central nervous system is severed. In other words, the heart is an automatic organ. By "automatic" is meant that the stimulus which incites it to activity arises within the organ itself. It is assumed that a stimulus is continually being produced in the heart.

It is a general law of physics that "an object set in motion tends to keep in motion," and the heart of each individual is started with life in a certain rhythm, which determines, to a degree, the rhythm of thought and of movement through life. The heart works stronger in its natural rhythm, just as the brain works better in an even, mental poise.

It will be readily seen, also, that the heart, as well as the lungs, must have adequate room for movement. Upon comparing the spaces through the upper and middle zones of Figures I and II on page 68, it will be noted that, where one stands as far out of poise as Figure II indicates, the room for the heart, stomach and lung action is decreased about one-half. The attitude indicated is all too common. (See also Figures 2 and 3 of the Body Manikin of this series of books.)

Any outward influence, such as pressure of the ribs, or pressure of the stomach upon the heart, interferes with its action. A disturbed state of mind, affecting the condition of the nerves, also tends to disturb the heart action. Such influences naturally compress and retard its freedom and tend to weakness. For strong heart action, its natural movement must not be disturbed.

The belief that a person with a weak heart should not exercise is erroneous; the exercises should be slow and not too strenuous, until the muscle tissue and nerves of the heart are strengthened, but exercise, which gradually works away impediments and unifies circulation, relieves pressure and strengthens the heart action. In case of valvular trouble or heart leakage, however, exercise should be given very cautiously, if at all. Usually, in such cases, rest is indicated.

By regularly increasing the action of the lymphatics and veins, through regulated exercise and breathing or by a nerve stimulant, the return flow of blood is accelerated and the action of the heart is aided.

All exercise occasions alternate contraction and relaxation of the muscles, and the veins which lie between the muscles are thus alternately compressed and relaxed. As the muscles contract, since the valves in the veins prevent the return flow of blood, the venous circulation toward the heart is accelerated by exercise.

Clogging of the circulation at any point calls for more strength of the heart to force the blood past the obstruction. The retarding of the circulation, and the overcrowding of the arteries and congestion of the veins caused by the obstruction, tends to weaken the heart action and to produce a state known as "arterial tension."

Much heart palpitation and irregularities of action are caused by dilated stomachs, indigestion, and by weakened or "over-strenuous" nerves. Anything, therefore, which tends to put the stomach and the nerves in a natural condition relieves the pressure or tension interfering with the heart action.

Heart palpitation frequently results from constant, excessive exertion, such as violent exercise, straining at the stool, the reception of depressing news, or an irritable state of the cardiac nerves. Other irregularities of the heart accompany a deranged condition of the kidneys known as Bright's Disease.

In numbers of cases of both women and men, but more especially in women, the heart is so packed about with adipose tissue, that it cannot move freely and often degeneration of the tissue results.

As shown above, the rhythmic action of the heart is not under the direct control of the will, but in the walls of the auricles and ventricles are numerous small nerve ganglia and nerve cells from the sympathetic nervous system. These control, to a degree, the heart's action, and they are wonderfully affected by thought and emotion. A full description of the causes of nervous heart cannot be given here, but emotions such as worry, fright, etc., or an anaemic state of the blood, will cause them.

It is a wise provision that the regular, rhythmic beat of the heart is not controlled by the nervous system, or fright, worry, or depression would cause suspension of action, or death.

Fainting

Fainting, or syncope, is chiefly due to a strain or to other conditions causing a partial suspension of the heart's action, accompanied by low breathing and a loss of sensation and voluntary motion. Valvular heart difficulty, or a diseased condition of the large arteries, tends to produce this suspension of the heart's action, also. This occurs more frequently in women than in men.

The heart will regain its normal action

more readily by lying with the head lower than the body.

Where the heart is thus vulnerable, the patient usually complains of a stuffy feeling upon entering a church, a hall or a room where the air is impure.

The heart and the blood vessels form a closed vascular system of tubes containing a certain amount of blood. This blood is kept in endless circulation. The tubes, through which the blood flows, vary greatly in width in different parts of the circuit, and the resistance to the moving blood is very much greater in the capillaries than in the large vessels. It follows, from the irregularities in the size of the channels through which it flows, that the blood stream is not uniform in character throughout the circuit; indeed, just the opposite is true, from point to point in the branching system of vessels, the blood varies in regard to its velocity, its pressure, etc.

ARTERIES

The "arterial system" may be said to begin with the ventricles and end with the capillaries. The office of the arteries is to convey the pure, arterial blood from the heart to every tissue of the body.

The aorta (4), the orifice for the outflow of blood from the heart, is about an inch in diameter; it curves just above its base to bend downward in front of the spinal column. In the pelvis it divides into two chief branches, one for each of the lower extremities .(See [F] the foundation plate of the Body Manikin. The frontispiece does not give the organs and tubes in their exact location.)

The great trunk between the heart and the pelvis is called the abdominal aorta (6 and 10) and gives branches to the lungs, the heart, the diaphragm, the liver, the stomach, the bowels and the pelvic organs. Other branches go out to supply the head, the upper extremities, the framework of the body, the muscles of the trunk, and the skin. These smaller branches, which are called arterioles, continue to branch out in the midst of the tissues until they become very minute and are then called capillaries. The frontispiece shows the branchings of arteries and the converging of veins and lymphatics, but the capillaries are too small to be illustrated here.

The aorta is much like the trunk of a luxurious tree,—the artery branches are like the limbs, the arterioles the stems of the leaves, and the capillaries may be regarded as the cells in the leaves. As the limbs of a tree grow smaller and smaller, the farther they extend from the trunk, so the arteries become smaller and smaller the farther they extend from the aorta, until the tubes are of a microscopic size when they reach the capillaries.

The capillaries are the smallest part of the circulatory system and are so small that a pin point will crush several, being not more than one-fiftieth of an inch in diameter.

The entire circulation channel is continuously open, without block or break,—along the arteries, arterioles, capillaries, back through the venules, veins, the right auricle of the heart, the right ventricle, the pulmonary arteries, pulmonary veins, the left auricle, and back again to the left ventricle.

Arteries are distinguished from veins by their thicker walls, due to a greater development of smooth, muscular and elastic tissue. They consist of three walls, the middle coat being the thickest.

One of the most important properties of the arteries is their contractility, in virtue of which the caliber of the vessel can be varied, and, therefore, the supply of blood to a part can be altered. The degree and tensity of the contraction depends upon the development of the muscular tissue. If an artery be exposed, it soon contracts under the stimulus of the atmosphere acting upon the muscular fibres. It may also be made to contract by the application of electric currents.

The vaso-motor nerves govern the muscular fibres of the arteries and the nerve centers controlling them are in the medulla oblongata.

The blood vessels are elastic and can be distended or elongated, but they rapidly regain their original size and form, after the force which causes the distension is removed. When cut across, the walls of the arteries do not collapse, as is the case with the thin-walled veins.

Arterio-Sclerosis

Arterio-sclerosis is a peculiar change in the small vessels throughout the body, consisting in a thickening of the external and innermost coats of the vessels by a deposit of a fibroid material which diminishes the fibre of the vessel, increases the arterial tension, and gives rise to the undue size of the heart present in this condition.

Aneurysm

An aneurysm is a tumor or dilated artery, caused by rupture, wounding, disease or weakness of the arterial wall, or by increased blood pressure following over-exertion;—gout and alcohol act as predisposing causes. Pressure of a growing aneurysm upon adjacent organs often gives rise to secondary troubles as pain, difficult or labored breathing or swallowing, paralysis or spasms.

VEINS

The venous system begins, as the leaves of the trees, as venules; they are the continuation of the capillaries which serve as a connecting link between the arterioles and the venules. As the leaves and branches of a tree are continuously converging, until finally they form the trunk, similarly the venules become veins, the veins the ascending and descending venae cavae and later, the right auricle of the heart—just one open tube.

The veins consist of three coats, or layers, which are somewhat elastic, but not sufficiently so to make any resistance to pressure upon them. When cut across, they completely collapse.

The walls of the veins have but little power to press the blood forward; to keep it from flowing back, there are valves at various points in their course toward the heart. The portal veins from the abdominal cavity have no valves.

It is of the utmost importance that the muscles about the veins be kept strong, so that the flow of blood through them be not retarded by muscular pressure. The portal veins (22 and 23) containing no valves, should be especially free from pressure; hence the necessity of maintaining correct poise, so that the organs may be in proper position and not interfere with the portal circulation. There is more or less pressure of the veins in the abdomen, from the "straight-front" corsets.

Any compression of the liver interferes with the flow of blood through the portal veins and tends to produce, by retrogressive action, congestion of the lining of the stomach and of the intestines. The liver contains about one-fourth of the blood of the system, and the importance of keeping these liver cells free and active will be readily seen.

The heart being situated in the upper part of the body, most of the venous blood must flow upward, and must, therefore, be affected by the force of gravity, which would retard the emptying of the ascending veins. This force of gravity is regulated somewhat by the valves in the veins. If a leg be propped up, so that the foot is higher than the thigh, it will aid in the return of blood through the veins to the heart. For this reason, if the circulation be disturbed in the ankle, the foot, or the knee, the leg is often suspended so as to aid the return flow; also in the aged where the heart action is weak, the return of blood is aided by slightly elevating the legs.

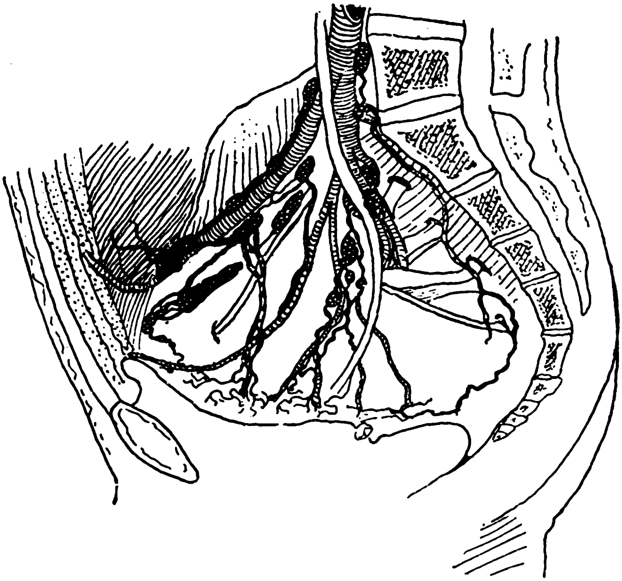
Varicose Veins

Swollen or knotted veins occur in those who have more than normal venous blood pressure, caused by some obstruction to the blood flow in the veins; the walls of the veins yield and dilate, causing them to enlarge to such an extent as to distinctly show the venous color of the blood along the whole of the dilated course. The obstruction to the venous circulation often occurs in the abdomen or pelvis, caused by a growth or by displacement or enlargement of an organ pressing upon the veins. Incorrect poise, which causes displacement of the abdominal viscera, is a frequent cause.

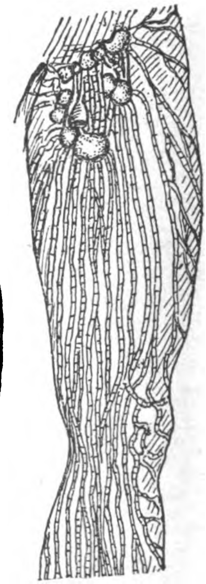
LYMPH AND LYMPHATICS

From the blood capillaries, there oozes out into the intercellular spaces about the tissues, called lymph spaces, a part of the watery, colorless portion of the blood, which contains the nutriment and is known as plasma. When it has escaped from the blood stream into the intercellular spaces about the tissues, the blood plasma is called lymph.

From the lymph spaces proceed minute capillaries, which unite to form tubes or lymph channels. These channels unite or converge, somewhat as the veins, the smaller ones uniting to form larger ones, and these again uniting until they finally converge into two trunks, known as the thoracic duct and the right lymphatic duct. These ducts ascend on either side of the spine and empty into the veins at the base of the neck, at the junction of the jugular and subclavian veins. The thoracic duct, which is on the left of the spine, is the larger of the two (29).



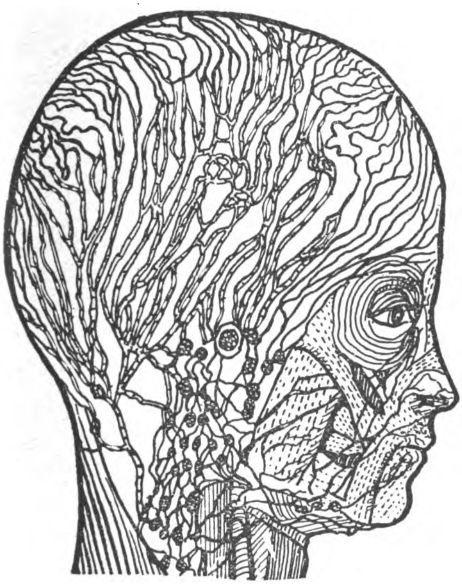
Lymphatics of the bladder.



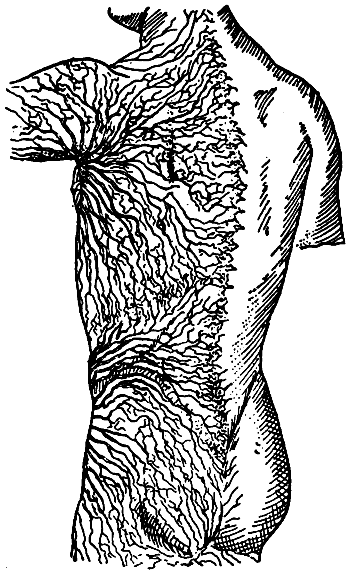
Superficial lymphatics and glands of the internal surface of the leg.

In their courses the lymph channels pass through, or rather empty into and begin anew, numerous lymphatic glands, which are a collection of lymph follicles. (See accompanying illustrations). A large number of these lymphatic glands are microscopic; others are of fair size, some of them as large as a bean.

In structure the lymph vessels resemble veins and have many valves.



Lymphatics of the head and neck.



Lymphatics of the skin.

The lymphatics from the intestines (37) are called lacteals. These lacteals of the intestinal villi absorb the fats, but the other products of digestion are absorbed by the rootlets of the portal veins in the bowels and carried to the liver, thence, through the hepatic vein (19) into the blood current.

During digestion, the contents of the lacteals is called chyle, due to the whitish appearance of the fats, thus it is distinguished from the clear, watery contents of other lymphatics. It is this whitish appearance which has given rise to the term lacteal, meaning "milky."

All of the tissues of the body are moistened or bathed in lymph. It is constantly present in all structures, excepting the epidermis, the hair and the nails.

The lymph contains the nutrient elements of the blood necessary to nourish the tissues, and, as must be inferred from its origin, it contains the same elements as the blood plasma,—the three blood proteids, the extractives, (urea, fat, lecithin, cholesterin, sugar), and inorganic salts. The salts are in the same proportion as in the plasma. Once within the intercellular spaces, the lymph is in easy reach of the substance of the cells.

It carries to the tissues, not only nutrition, but also the inspired oxygen and the raw material or elements, which the glandular cells use in the preparation of such secretions as the milk in the breasts and the ova in the ovaries.

The quantity of lymph present in the different glands and tissues of the body is variable, the flow in the liver and bowels being most abundant; indeed, they produce nearly all of the lymph that flows through both lymphatic ducts.

Besides conveying nutrition and oxygen to the tissues, the lymph spaces are also the receptacles for the waste elements of the tissues liberated in the metabolic work of the body, and the excess of unused lymph, together with the waste, is carried away by the lymph channels.

The flow of lymph is from the tissues to the veins, and is regulated chiefly by the pressure of lymph in the lymph spaces, where it is being continuously forced through the lymph channels into the veins by the blood pressure from the capillaries. The blood pressure in the capillaries is regulated by the pressure in the arteries.

Upon entering the cells, the lymph takes the place left vacant by the removal of the waste.

Just how the lymph filters or oozes out of the capillary walls is not fully known, but in explaining the difference in the quantity of lymph in the different tissues, Starling holds that, since lymph passes with ease through some capillaries and with difficulty through others, there is probably a difference of permeability of the cells of the capillaries in the different areas of the blood-vascular system. A continual interchange is taking place, by means of which the nutrition of the tissues is affected, each according to its needs.

As previously stated, the excess of lymph, over and above the needs of the cells, as well as the waste of the cells themselves, are finally emptied into the venous stream at the base of the neck. The lymph channels are, therefore, the irrigating system, also the great drainage system of the body, and it is of utmost importance that these channels be unobstructed and free for the elimination of waste. This elimination is aided by exercise, by massage, and by a thoroughly forceful circulation of blood. More lymph gets into the spaces when there is a high pressure of blood in the capillaries; therefore exercise which quickens the circulation sufficiently to create a warmth of the capillaries, favors the filtration of lymph by increasing capillary pressure and thus freeing the blood plasma and causing a larger quantity of nourishment to pass into the spaces about the tissues.

The changing process in the lymph cells continues during sleep, though not as actively as during waking hours; the muscles relax and lymph pours out along their fibres for assimilation, hence, the origin of the terse saying: "He who sleeps, dines."

Whether the lymph be scanty or abundant, it is the fountain head of life, for it always has in it the nutriment, or life-giving elements for the body; but it has also to do with the death and decay, holding, in its solution, the toxins, or poisons, of the body, and if not relieved, the hoarded poisons are offered to the cells for nutrition. Should the toxins, for any reason, fail of free elimination, septicemia or blood poisoning may ensue.

Melancholia, tuberculosis, neurasthenia and similar maladies are dependent upon the quality of the lymph, and anything which creates a normal flow of the lymph, together with the free feeding of nutritious foods, tends to a relief of these maladies.

In a normal state the lymph is drained off as it is formed, while in an abnormal state, or when the circulation is sluggish, it may become congested and oedema, or swelling result.

Wherever the nerves are habitually kept tense the muscles are also tense and there is an undue contraction of the rootlets of the lymph channels; the toxins, as well as the lymph, are then hoarded, and this also results in oedema, or swelling. This can often be regulated by exercise relieving the contraction.

The lymph spaces may be compared to cisterns, each of which is provided with supply pipes—the arteries and the capillaries—while there are two exit pipes—the veins and the lymphatic ducts. In health, the balance between the inflow and the outflow is such that the spaces are merely moistened with fluid, the lymph being drained off as it is formed. Where there is an undue accumulation of fluid, more or less like serum, in the lymph spaces, we have the condition termed dropsy, which is a form of lymph congestion.

If the efferent veins and lymphatics of an organ be ligated, or a resistance be offered to the outflow of the blood, congestion and a copious outflow of lymph into the tissues takes place. These are most marked in the skin and the subcutaneous cellular tissue. The soft parts swell up without pain or redness and a doughy swelling, which pits, on being pressed with the fingers, results. These are also signs of lymph congestion.

The relief from above difficulties is not in applying lotions to the skin, but in quickening the circulation.

The failure to carry away the lymph sometimes results, also, in local inflammation, such as the hardened structure at the base of a boil or the swelling of the lower extremities in deep seated erysipelas.

The result of a prolonged retention of waste matter in the lymph spaces not infrequently expresses itself in an abscess; the excess of waste, being more than the small lymph channels can carry away, is finally broken down by bacteria into pus, and many of the cells of the tissues involved in the diseased parts, break down.

Where there is a general surfeit of the lymph, rich in proteids, as in gout, the oxygen taken in by the lungs is not sufficient to reduce the abundant waste to a fit state for elimination, therefore combustion is retarded and incomplete. By virtue of this failure in the combustion process, uric acids and other sub-oxidized products accumulate in the blood stream, hence, there appear, sooner or later, diseases that are very largely due to a too strenuous outpouring of lymph in all persons who are overfed, or who are fed more than they eliminate or burn up through exercise.

Since the flow or exchange of lymph in the intercellular spaces is dependent upon the blood pressure in the capillaries, the forcing of more lymph through the capillary walls by regular exercise to promote a strong circulation, and free breathing of sufficient oxygen, so that the waste matter may be readily oxygenized and then eliminated, cannot be over-estimated, especially for all persons who are over-fed and inclined to gouty conditions.

It would seem that physicians have not, in times past, given sufficient importance to the free action of lymphatics as agents in the elimination of waste. They are now emphasizing the importance of exercise of every muscle and tissue, that the circulation through arteries, veins and lymphatics may be quickened and all waste of the system be thrown off.

THE BLOOD

The composition of the blood is highly complex. It is produced by the digestive organs operating upon the solid and liquid food taken into the system, together with the oxygen absorbed in the lungs and through the pores of the skin.

The blood is the medium of exchange between the outer world and the tissues of the body, since it carries the digested food to all parts.

It is also an oxygen-carrier and it contains new substances, but, in its passage through the tissues, it gives up some of these new substances and receives in exchange waste products, which are removed from the tissues and carried by the blood to the lungs, kidneys, intestines and skin for elimination.

As the composition of the organs, through which the blood passes varies, the elements in the blood stream must vary in different parts of the individual, under different conditions.

The food, after being acted upon by the gastric juices of the stomach, is passed on into the intestines by muscular contraction waves. It undergoes most of the digestive changes in the intestines, only a very small part of the food being put into a state to be absorbed through the walls of the stomach.

The intestinal digestion begins as soon as the food enters the duodenum (about the first twelve inches of the intestines). It is acted upon in the intestines by the pancreatic juice from the pancreas, the secretions from the walls of the intestines and the bile from the liver.* These juices are mixed with the food, putting it into soluble state, ready to be sucked in by the villi in the lining of the intestines and from there carried by the portal veins to the liver, where the blood-making process is

* See "The Vital Organs, their Use and Abuse" by Susanna Cocroft.

continued; it is thence carried into the general circulation through the ascending vena cava.

The mucous membrane of the entire intestinal tract is adapted to absorption, but undoubtedly the greatest part of the food is absorbed in the small intestine, especially its upper half. It is here that nearly all of the fats are absorbed.

The offices of the blood may be briefly stated as follows:

To the tissues it carries food-stuffs after they have been put into condition for absorption by the digestive organs:

It carries oxygen from the lungs to the tissues;

It carries the waste products from the various tissues to the organs of elimination;

It carries the secretions from certain glands;

It aids in equalizing the temperature and water contents of the body.

The blood is composed of plasma, (containing the nutrient elements), corpuscles (red and white), and blood plates—little is known of the origin and function of these plates.

In the rabbit, at rest, it is estimated that about one-fourth of the blood is in the heart, lungs and great blood vessels, one-fourth in the liver, one-fourth in the resting muscles, and one-fourth in the remaining organs.

Red Corpuscles Blood flowing from a wound seems, to the naked eye, to be a uniformly red liquid; however, when seen under a microscope, it is found to consist of a colorless liquid called "blood plasma" in which float millions of minute solid particles called the "blood corpuscles." Some of these are colorless and irregular in shape and are known as the "white corpuscles." The colored, or "red corpuscles," which give the bright, red color to arterial blood, are of a definite shape.—If you should make a little round cake of dough, an inch in diameter and a quarter of an inch in thickness, and then press it between the thumb and the forefinger, so as to cause a little depression in each side, it would be the shape of a red corpuscle. However, it would be thirty-two hundred times wider and thicker.

The red corpuscles, however, are constantly undergoing disintegration in the blood stream. It has been commonly held that this disintegration occurs in the spleen, but this theory has not been satisfactorily demonstrated and it is more probable that they are not destroyed by any special organ, but are dissolved in any part of the blood stream.

The liberated hemoglobin, or pigment coloring matter of the corpuscle, is thrown off by the liver in the bile.

Of course, as the red corpuscles are constantly being disintegrated and thrown off, new ones are constantly forming and it has been satisfactorily proven that the organ for the reproduction of red corpuscles is the red marrow of the bones,—hence, in cases of lack of red corpuscles (anaemia), a solution of red bone marrow is prescribed.

It is interesting, also, to note that a change to a high altitude causes a marked increase in the proportion of red corpuscles, but it is not known whether the number actually increases or whether it is simply a proportionate increase, due to the diminution of water in the blood and a consequent blood concentration. The blood circulates more rapidly in high altitudes thus increasing its oxygen-carrying power.

In a normal state, the red corpuscles constitute 45 per cent of the solid matter of the blood. They get into the blood stream through the open mouths of the blood vessels from the spaces between the bone cells.

Exercise which increases circulation and brings more blood to the periosteum, or covering of the bone, fosters the formation of red blood corpuscles, providing the right foods which produce these corpuscles are fed to the system. Gentle currents of electricity are also regarded as useful means in promoting the formation of both red marrow and bone.

The life of the red blood corpuscles is not known, but it is supposedly very short. The chief function is to convey oxygen from the lungs to the tissues, the oxygen being required to put the waste matter into a state of solution necessary for elimination.

The estimated number of these corpuscles in one small drop of blood in man is 5,000,000, so that in ten pounds of blood there are about twenty-five billions of corpuscles. This proportion varies, however, with the time of day, altitude, nutrition, manner of life, and age, being greatest in the new born babe.

In both arteries and veins the red corpuscles form a solid column in the middle of the stream, and, between them and the wall of the vessel, there is a layer of plasma containing, under normal conditions, only an occasional leucocyte. Physical experiments show that, where a liquid, flowing rapidly, consists of elements of different specific gravities, the heavier ones take the axis of the stream. The reason, then, for the red corpuscles being drawn to the center of the stream is because they are heavier than the plasma and the plasma meets with more resistance along the walls of the vessel.

The red and the white blood corpuscles play no direct part in nutrition and, in a normal state, it is only through the capillaries that there is any chance for the watery or nutrient portion of the blood to pass out from the circulation tube, so that this small part (capillary) of the tube is of great importance in the skin, tissues and mucous lining of the intestinal tract.

In the adult, the blood constitutes about one-thirteenth part of the weight of the body; in the new born infant, about one-nineteenth part.

Life is endangered by hemorrhage in proportion to the quantity and rapidity of the bleeding. In the adult, when one-half of the total blood is lost suddenly, death is apt to result, and in the new-born child, when a few ounces are lost. The old, the young, and the adipose bear the loss of blood badly.

To restore the loss of red corpuscles occasioned by excessive hemorrhage, the most important thing first to be done is to supply some fluid, either salt water or milk. After the blood vessels have received their normal quantity of fluid again, the structure of the blood must wait for the production of the corpuscles in the usual way from the food.

Anaemia The condition known as anaemia is a deficiency of blood or a deficiency in the relative number of red blood corpuscles; the latter is the generally understood use of the term. In this condition, the vehicles for carrying oxygen are not adequate and in consequence, the combustion of the waste of the tissues is not completed as rapidly as necessary in health;—the waste not being fully carried away, the system becomes poisoned.

Where there is a deficiency in the number of red corpuscles the importance of the free breathing of pure air, that all the oxygen possible may be offered as the blood passes through the lungs, will be readily seen. The circulation must also be kept forceful that the blood may circulate freely, for the lessened number of corpuscles must do double duty.

White Corpuscles The white corpuscles are divided into two classes,—lympocytes, produced in the lymph glands and forming about 20 to 25 per cent of the white corpuscles, and leucocytes, forming 60 to 75 per cent.

The leucocytes are seemingly the most important, yet their function is not definitely known. They are supposed to:

Aid in the absorption of fats from the intestines;

Aid in the absorption of peptone from the intestines;

Take some part in the coagulation of blood;

Aid in keeping up the normal supply of proteids in the blood; and

Protect the body from bacteria, either by destroying them directly or by forming defensive proteids which destroy them.

The white blood corpuscles consist of transparent granular-looking protoplasm containing one, two or more nuclei; these nuclei have the power of sending out finger-shaped or filamentous parts of their own substances with which they grapple with foreign bacteria, e. g.: If the tubercular bacilli enter the blood though the lungs, the white blood corpuscles send out their fingers and grapple with them; if the corpuscles be stronger than the bacilli, or bacteria, they entirely conquer them; if the bacteria be the stronger they gain the ascendency over the corpuscles.

The white blood corpuscles have been called the fighters or guards for the system, to ward off all foreign bacteria; hence the necessity of keeping up a good vitality and pure blood with a strong current, to enable one to resist disease.

In a normal state the blood makes a complete circuit of the body in forty-five to fifty seconds.

In the arteries and veins, the flow is very rapid and in the arteries more or less intermittent—it is accelerated with each heart beat. In the capillaries, the flow is relatively slow, showing no pulse beats, as in the arteries, and the flow may be more or less irregular; in fact, the flow may nearly cease in some capillaries at times, while again, it shows a constant, regular flow.

In the veins, as they gather the blood from the venules, the flow accelerates so that the larger the vein the more rapid the flow, but there is no intermittence or pulse in the flow through the veins,—the velocity is uniform.

THE LUNGS

The lungs consist of a light, spongy tissue, which is highly elastic. When the chest is fully opened by dissection, the lungs collapse, expelling most of the air; but so much air remains, even after they are removed from the body, that a healthy lung floats in water.

In a little child, the color of the lungs is rose pink, but they become darker with age, especially in persons living in a smoky atmosphere.

The thorax, containing the lungs, is conical in shape, with the small end upward. The ribs spring out from the sides of the spinal column, the "true ribs" curving around to join in front with the sternum or breast bone. The floor of the thorax is the upper surface of the diaphragm.

The function of the lungs is to convey oxygen to the blood, and to remove therefrom carbonic acid gas.

As the oxygen comes in contact with the waste or dead tissues, on its circuit through the body, its office is to attack this waste within the cells causing combustion. This combustion liberates carbonic acid gas from the dead and waste parts, bringing them to a state necessary for elimination through the blood, as it passes through the lungs. Besides passing into the capillaries to eliminate carbonic acid gas, it also oxygenizes other substances,—such as uric acid—putting it into condition for elimination. Where the system contains too much uric acid, it is lessened in proportion to the quantity of oxygen taken into the system.

The chemical action of combustion, occasioned by the union of oxygen with the fats and carbohydrates, creates the body heat; thus, when the body is cold, heat is engendered within by breathing in more air and by exercise which frees the waste.

With each inhalation oxygen passes

through the walls of the vesicles and through the walls of the capillaries, where it at once forms a loose union with the iron or coloring matter of the red blood corpuscles, changing the livid hue of the venous blood to a bright, arterial scarlet. This is carried by the pulmonary veins from the lungs to the heart, from which it is sent out through the arteries as oxygenated or pure material, to liberate the waste from the body as described above. Thus the lungs effect the exchange of one gas for another, carbonic acid gas for new, pure oxygen.

The lungs are the only organs of the body which may be said to be both receptive and excretory, taking in oxygen and eliminating carbonic acid gas. In view of this double function, the importance of their free and vigorous action for the maintenance of health, may be readily understood.

Since forty-five per cent of the blood, in a normal state, is made up of red corpuscles, and since these corpuscles must freely circulate through the lungs in order to come in contact with the oxygen here and free the blood of the gases, it will be readily seen how necessary both the red corpuscles and the habits of full deep breathing are for the removal of waste from the system.

The volume of air taken in at one inhalation, by a person of average size, is about thirty cubic inches. With a deep and forceful inspiration the same person takes in from one hundred to one hundred twenty cubic inches. The first or easy intake is called tidal air; the second, where great effort is made, is called complemental air. When one makes a violent effort at expiration, there will remain in the lungs about one hundred cubic inches, which is called residual air.

The two hundred and thirty cubic inches represent the vital capacity of the lungs.

The amount of air, equal to about one hundred cubic inches which can be forcefully breathed out from the lungs is known as supplemental air; so that one hundred cubic inches of residual air and one hundred cubic inches of supplemental air represent about the quantity of air always present in the lungs during life. The presumption is that the thirty cubic inches going out with each exhalation are from the residual air that has been longest in the air vessels, and, as each inhalation occurs, the air in the outermost tubes is pushed nearer to the air vesicles.

This orderly movement of the air in the bronchial tubes, together with its probable prolonged stay in the millions of air vesicles, makes it easy for the oxygen to get into all red blood corpuscles.

When the air of a room has in it more than seven per cent of carbonic acid gas, its value for the combustion of tissue waste is greatly impaired. It is commonly stated that each person needs, for proper breathing, a room that has a capacity of about two thousand cubic feet. Pure air, circulating through a sleeping room, is most necessary, as the oxygen is soon consumed from the air by the body, and the poisonous carbonic acid gas thrown off should not be again breathed into the lungs. The air in the sleeping room should be kept, nearly as possible, as pure as the air outside. This necessitates circulating air, which may be gained by two opposite windows being opened, an open window and door, or a window lowered from the top as well as raised from the bottom.

The highest oxygen pressure is in the lungs and its lowest is in the tissues, where it is used up in burning the waste of the cells. The highest pressure of carbonic acid gas is in the tissues where combustion and work is going on, and the least is in the lungs. These two gases move along the lines of least resistance,—the oxygen, with the red corpuscles down to the capillaries, where it escapes into the lymph; the carbonic acid gas from the muscles (for it is in them the great bulk of the oxygen is chemically united with the waste) is carried, with the venous blood, to the lungs.

As stated above, with a full, complemental breath, the intake of the lungs is doubled. Put a tape line around the body (over the shoulder blades, under the arms) and expel as much air as possible from the lungs, noting the measurement; next expand the lungs, keeping the tape in the same position; the difference between the circumference of the contracted and expanded measurements, in a person of average size, will be from three and one half to four inches. If a tape line be placed around the body about four inches above the waist and the air expelled from the lungs, then the lungs filled to their fullest capacity (the tape line remaining in the same position), the difference between the contracted and expanded diaphragm will be the same as the difference between the contracted and expanded chest measurements,—three and one half to four inches.

In the manner of breathing of the average woman, instead of the measurement about the diaphragm increasing with inhalation, the shoulders are raised, the chest lifted, the back drawn in (as shown by the dotted lines of Figure II), and the diaphragm drawn still farther upward; as the chest lifts, the measurement about the diaphragm, in the inhalation, is smaller than in relaxation. It will be noted that this manner of breathing does not exercise the vital organs properly.

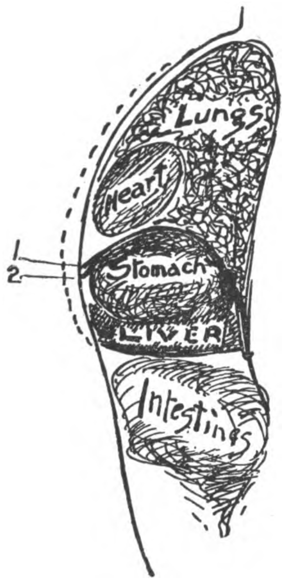


Figure I.

(1) Normal position of diaphragm.

(2) Position of diaphragm in inhalation in diaphragmatic breathing.

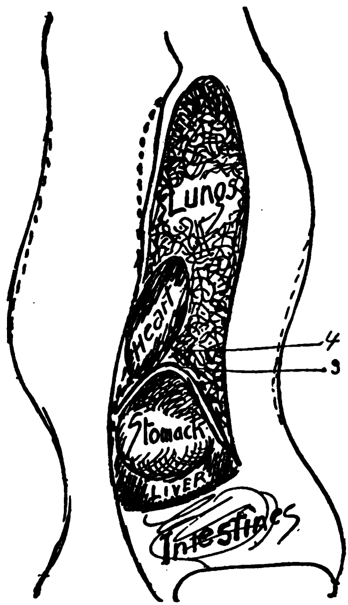


Figure II.

(3) Habitual position of diaphragm in a figure who stands in this attitude.

(4) Position of diaphragm during inhalation in intercostal breathing.

This breathing habit has doubtless come from restrictions of dress and of incorrect habits of standing and sitting. *The effort of inhalation should be to increase the capacity of the entire rib cavity* and the breathing should be diaphragmatic, rather than intercostal.

Each movement of the diaphragm is a natural and required physical exercise for the stomach, liver, kidneys, spleen and pancreas, and, when lungs and diaphragm are not rightly used, these organs are not fully and constantly exercised. In the normal inhalation, the diaphragm contracts and strongly presses downward against the stomach, liver, pancreas, spleen, etc., flattening and broadening them; these organs in turn press upon the intestines. As the diaphragm relaxes, the above organs relax and assume the relative position illustrated in Fig. I. So that every breath regularly relaxes and compresses every vital organ; the exercise of breathing keeps up the normal blood supply and tends to keep them strong.

The average woman has little or no control of the muscles about the diaphragm. These muscles should be as strong as those of the arms or the legs. In taking long breaths, as a breathing exercise, if the hands be placed upon the hips there will be less interference with the expansion of the rib cage.

In inhalation, the mouth should be closed and the air drawn in through the nostrils. The hairs in the nostrils ensnare particles of dust; the membranes of the nostrils detect noxious odors and warm and moisten the air before it enters the lungs.

That one may breathe fully and deeply the nasal passages must be kept free and open.

Catarrh is the most frequent cause of mouth breathing. It is apt to result in adenoids, or enlargement of the septum or turbinates, thus partially closing the passages so that in order to get the proper amount of air into the lungs, to relieve the system of the waste, it becomes necessary to breathe through the mouth. The air is not warmed in passing through the mouth, as in its channel through the nasal passages, neither are the small particles of dirt and dust sifted as by the hairs in the nostrils. In blowing the nose after being out in the dust, one realizes how much dirt must be taken into the lungs by mouth breathers.

The cold air passing into the throat often causes trouble with the tonsils.

In intercostal breathing, it is impossible to expand the lungs to their fullest extent and to take in the necessary quantity of oxygen. The effort of Nature to supply the necessary oxygen to make up for these inadequate breaths, especially where too much fat is packed about the lungs and heart, causes quick, short breaths, the average woman breathing about twenty-two times a minute. By creating a habit of deep breathing, this can be retarded to from twelve to sixteen times a minute.

The frequency of respiration, however, depends upon age, sex, and the state of the emotions. In youth, we breathe more frequently than in middle age. In emotion, we breathe shallowly, then deeply, as in sobbing.

Physiologists have gathered, from various sources, the rates of breathing in several species of animals. The horse breaths from six to ten times per minute, the rat one hundred to two hundred times per minute, man from sixteen to twenty, the pig, (next to man) fifteen to twenty, and the next nearest is the sheep, from twelve to twenty times per minute. The new-born babe breathes, in some cases, as high as seventy times per minute, while, from one year to five, the child breathes thirty-two times.

Coughing is a violent expiratory act. We first take a deep inspiration and then, by suddenly contracting the accessory respiratory muscles, the diaphragm being relaxed, the air is expelled through the glottis with great force.

A hiccough is a sudden contraction (depression) of the diaphragm with the glottis closed by the epiglottis being clapped down upon it. When the in-rush of air strikes the epiglottis, the characteristic sound is the result.

Because of sluggish circulation and lack of free use of the lungs, occasioned by weakened or cramped muscles, lung cells become weakened and sometimes the extremities of the lungs become entirely closed. The breathing muscles should be kept strong; the rib cage, which in the average person is allowed to settle, should be expanded, lifted and kept flexible, so that each lung cell may fully inflate—then the lung tissue, by constant exercise, will be strong.

To a limited degree, the skin acts as a respiratory agent, in as much as it eliminates carbonic acid gas through the sweat glands. It is supposed by some, to absorb oxygen, also, but this theory has not been fully substantiated.

From the fact that the skin does eliminate carbonic acid gas and other waste from the system, it is absolutely necessary to keep it clean and the pores free, not only for the health and clearness of the skin itself, but for the general health; one is never in perfect physical condition unless all poisons are normally and constantly thrown from the system.

Where there is an undue odor to the skin, the chances are that the lungs, kidneys or intestines are not eliminating their normal amount of poisons and the skin is throwing off more than is intended for it to do, in its effort to discharge the waste.

Tuberculosis

Tuberculosis is not inherited. In all cases where the lung capacity is diminished, either by compression of the rib cage or by habits of incorrect and incomplete breathing, there is a diminution in the capacity of the bronchial arteries (the arteries that pass from the arch of the aorta to the two bronchi for the purpose of furnishing the lungs themselves with nutritional blood). It is now believed that the incurability of consumption is largely due to the inadequacy of the bronchial arteries, so that sufficient nutriment is not carried to the lungs themselves, as well as to the failure of the white corpuscles of the blood to destroy the tubercular bacilli.

The tubercular germ multiplies slowly, and, if the blood be strengthened, so that there is a sufficient number of white corpuscles, the breathing regulated, and plenty of pure air taken into the system, tuberculosis, if taken before the bacteria have gained the ascendency, can be cured. Thus, physicians rely most upon building up the general vitality of the individual. The blood must be kept pure, the rib cage flexible, so as to admit of full, regular breathing, the circulation must be strong, especially through the lungs, in order to fully nourish the tissues of the lungs themselves. If all of the lung tissues be kept fully exercised by deep breathing, and the blood be kept in a normal state, there is little danger of contracting consumption.

One may possibly inherit a *tendency* to weak lungs, so that the tubercular bacilli upon entering the system, find slight resistance, but the lungs can be strengthened and the blood be kept in condition to resist the disease.

Owing to the difficulty of accelerating the circulation of the blood in the bronchial arteries, when sluggish or retarded, or when too forceful, physicians are also becoming very pessimistic as to the value of drugs in the treatment of pneumonia.

In order, also, to keep the strength of the lungs, as of every other vital organ, the nerve centers controlling the lungs must be kept strong. While the medulla oblongata, which is the seat of these nerve centers and has been called the "vital knot", cannot be definitely reached by the fingers in massage, it *is* reached by free exercise of the spinal cord. These nerves also respond to the general toning of the system.

Rhythmical Breathing

The rhythmical action of respiration, as determined by Flourens, is dependent upon the respiratory center in the medulla oblongata, from which the impulse is sent to the motor centers in the spinal cord, or, in case of the nose and larynx, to the motor centers of the vagus and facial nerves.

It is a generally accepted theory that the rhythmic breathing is due to automatic centers, as in the heart, but that the stimuli which excite these nerve centers to act are the gases in the blood.

The activity of the respiratory centers is increased by an excess of carbonic acid gas. When this is in excess, the respiratory efforts are excessive, and when not, they are regular, e. g.; any unusual muscular exertion such as running or climbing stairs, generates more carbonic acid gas, and Nature makes the effort to throw off the excess by quick breaths.

Lehmann and some others hold that the cause of rapid breathing during exercise is due to acid products, lactic acid and acid phosphates, known to be found in muscle during contraction and given off to the blood.

The dizziness, faintness and labored breathing, due to holding the breath, is due to the air in the lungs not being changed. There is a consequent excess of carbonic acid gas in the lungs and in the blood, which affects the respiratory nerve centers.

The nerves in the medulla oblongata that conduct the commands of the breathing centers to increase respiratory activity, are the two pneumogastrics, otherwise known as the tenth pair of cranial nerves. The most important of the motor nerves directing the movements, are the phrenic nerves, which supply the diaphragm. They center in the fourth or fifth spinal nerves, a few fibres in the pneumogastrics, and certain of the spinal nerves go to accessory muscles of respiration.

Until birth, or until the placental connection is severed, the mother breathes for her child.

SUMMARY

Let us again trace the circulation of the blood from the heart back to the heart, following its course on the Blood Formation and Circulation plate of the frontispiece, tracing it to the intestines and back to the heart through the lymphatics and veins. In studying this cut it must be borne in mind that it is simply a diagram illustrating the course of the blood. The organs are not in proper position; this correct position of all organs is illustrated in the Body Manikin of this series of books. The cut of the frontispiece is also illustrated in the Manikin in colors, clearly differentiating the venous, arterial and lymph circulation.

From the left ventricle of the heart (28) the purified aerated blood enters the aorta

(4) where the large branch curves downward (6 and 10) in front of the spine. Let us follow one branch (11) to the intestines and the further smaller branches (11) or arterioles, to the capillaries, which are at the very extremities of the arterioles and are too small to be shown on the chart. Blood plasma, containing the nourishing qualities, oozes out through the capillaries and enters the lymph spaces where it nourishes all tissues.

At the capillaries the blood channels divide, the lymph passes through the lymph glands (37), up through the lymphatic duct (29), to enter the venous system at the juncture of the jugular vein (16), and the sub-clavian vein (15), where both the waste of the tissues and the excess of lymph, over and above the needs of the tissues, are again poured into the circulation tube and enter the right auricle of the heart (25.)

The impure blood returns to the heart through the veins (22 and 23), through the liver (32), and the veins (19-18), back into the right auricle of the heart (25).

The nourishment from the digestive

system is absorbed by the rootlets of the portal veins and carried by the portal veins (20, 22, 23), into the liver (32), and thence through the hepatic vein (19), into the ascending vena cava (18), and into the right auricle of the heart (25); from the right auricle of the heart the blood passes into the right ventricle (27), and is sent out to the lungs to be purified through the pulmonary arteries (5), into the capillaries; it is again returned through the pulmonary veins (17), to the left auricle of the heart (26), from which it passes again into the left ventricle (28). The nutrition is thus carried through the course described above, to all tissues and the waste is carried to the lungs, kidneys, intestines and skin, for elimination.

The circulation of the blood can be traced to the extremities in the same way, as shown on the Blood Formation and Circulation Plate, excepting that the lymphatic channels and glands from the extremities are not shown on this plate. They are shown however under the chapter "Lymph and Lymphatics."

Exercise

Having shown that the arteries are connected with the veins and the lymphatics, by means of the capillaries, the combined capacities of which are about 300 times greater than the arteries—and that all of the blood vessels are continuously open and unlocked through the complete circuit,—it remains to show how dependent every part of the body is upon a full and free circulation of the blood, and how intimately this tubular system is associated with every tissue of the body. So close is this relation and so deep the sympathy between the tissues, the blood, and its tubes, it is scarcely possible for disease to exist anywhere in the body without causing some disturbance in the blood vessels. This fact has led physicians to examine the pulse, for by the force and quality of the pulse, the degree of vital stamina, or want of it, in any given case, is estimated.

In fact every secreting organ, in an abnormal state, presents some degree of obstruction to the circulation, such, for instance as torpor of the liver, or a congestion in the venous circulation of the intestines by pressure of any kind.

By understanding the physiological relations of the secreting organs, each to the other, it will be readily seen how the obstruction in one will act injuriously on several, if not on all of the others. When the venous circulation is impeded in the stomach, liver or spleen, or the arterial in the kidneys and the skin, to attempt to restore the general circulation without restoring it in these important organs, would be illogical. It is impossible to restore a free and equable circulation while the stomach is sluggish, or the liver is congested and obstructs the vena cava, or the sweat glands are occluded, etc.

It is needless to say that, without the normal volume of blood, the tissues restricted will be underfed, and the full action of secreting glands cannot be maintained; neither can waste be regularly removed, nor can repair of the tissues be accomplished as in health.

Real health demands constant normal action in the several parts of the body in a harmonious and concreted plan.

For growth and strength, it is necessary not only to give the body sufficient exercise to keep all of the forces freely active, but also to feed it a sufficient quantity of the right food, pure air, sunshine and pure water to replenish the waste. It is simply a matter of using intelligence in forming correct habits of eating, drinking, bathing, and regular exercise.

The patient will not, as a rule, obey the physician's directions for exercise; he therefore, realizes that whatever is done *he* must do; the doctor has consequently relied almost entirely upon medicine as an artificial stimulus to quicken the heart action, so as to create a more forceful circulation, and to open up clogged veins or lymphatics, also to thin the blood, that it may more easily pass through its channels.

The world is now turning to scientific exercise and massage, directed definitely to strengthening and unifying the circulation throughout the entire body, thus calling undue pressure from the weakened parts and to establishing habits of full breathing that the blood may be fully purified.

Man is realizing that, for retention of health he can do more for himself than medicines can do.

We are marvelously made;—if surrounded with fresh air and sunshine and untrammelled by too many clothes, the body will do its work of wasting and rebuilding automatically, leaving the mind and spirit free for development and direction, and the fact that it will do so imperfectly, even though some nerves and muscles be overstrained, while others are cramped and their actions impeded, just as a tree will go on growing though it be bent and scarred, has misled us, or caused us to grow careless.

Before reaching maturity, each individual should be able to determine the quantity of food necessary to re-supply the waste from the daily chemical changes and to furnish sufficient for energy, and he should give to the body no more actual food than necessary for this energy and re-supply.

One's meals should be alternated with sufficient exercise to keep up a thoroughly good circulation in the vital organs so that they may act strongly in the digestive process.*

If the vital organs be strong and the eliminating and absorbing cells be active, so that the juices which aid digestion be secreted in natural quantities, and if judicious care be used in the selection of the proper food in right proportion, the organs will stand much abuse and be strong to throw off waste;—it is long continued abuse, or continued weakness of nerves and muscles of vital organs which makes chronic invalids.

A few minutes of intelligent care and thought to Nature's requirements each day will save weeks of suffering, and each effort will be more effective. So many drag through the day missing the strong enjoyment of life, while a strong current of good blood, bounding through the veins and ar-

* See "Foods" by Susanna Cocroft.

teries, would give vibrant life and jubilant spirits.

Too much emphasis cannot be laid upon the necessity for a complete, forceful circulation. In speaking of sluggish circulation, reference is usually made to cold hands and feet, but forceful circulation through the vital organs is far more important. The average individual puts forth no definite effort to create a good circulation through the stomach, liver, and intestines, and it is necessary, especially in women, to keep good blood, muscular strength and a good circulation about the pelvic organs. A woman thinks she has done her duty by taking a walk, but she can control the circulation of the blood more systematically by five minutes' exercise in her own room, free from the restriction of clothing, than in a five mile walk. Walking, especially when restricted by clothing, gives very little exercise to the vital organs and to the special nerves. The average woman in her daily work, exercises the legs and arms for more than the trunk. Thus there is no real need of going out for a walk if one will briskly exercise the vital organs in one's room, untrammelled by clothing.

The daily work of many people brings into continual use the arms and legs, calling the blood to the extremities, while with others the work is more mental than physical, and the constant mental concentration calls for an abnormal supply of blood in the brain; this causes a dilation of capillaries here; the pressure caused by these dilated cells and the effect upon the nerves, results in the sensation we call "fatigue." The relief, in both cases, is in unifying the circulation by calling the excess of blood from the brain, or the extremities, to all parts of the body. As a rule, we wait for Time to unify the circulation, but the blood can just as well be called uniformly to each muscle and tissue in 15 minutes as to suffer for a number of hours waiting for it to adjust itself.

The effect of exercise upon the stomach, intestines, liver, kidneys and pelvic organs is to strengthen the muscles of the organs themselves, to awaken a forceful circulation through the mucous linings and to open and strengthen the cells of the mucous linings of the stomach and intestines, that the juices which aid in digestion may be freely secreted and the nourishment be absorbed and assimilated.

All exercise sets in motion the molecules and cells of both the tissues and the liquids of the body, so that the oxygen may more freely circulate about them and liberate the carbonic acid gas, that it may be carried to the lungs for elimination; it creates heat, which aids in the combustion of these molecules; it quickens the circulation so that oxygen and nutriment are more freely carried to the tissues for better nourishment and their waste is more freely eliminated.

Exercise, which definitely reaches the vital organs, creates a massage of these organs; it reaches them more effectively than the human hand can do. Every person who would keep in vibrant health, with a feeling of cleanliness of all of the inner organs, should put regular exercise, working and massaging each vital organ, into the daily program; should know that all waste is freely eliminated from the inner parts of the body just as surely as all dust and dirt are washed from the surface. Daily exercise for this cleanliness is as necessary as the daily friction bath is necessary to keep the pores of the skin clean and open. Too many persons who are cleanly to a nicety in the care of the surface of the body, neglect utterly the elimination of waste within.

Every housekeeper knows that, if she would attend to the healthful condition of her family, she must keep the drainage system to her house thoroughly open and clean. Just so, if she would attend to her health, she must keep the drainage system of her body, including the entire Circulatory system, and the intestines, kidneys, lungs and skin in thorough activity, with no pores clogged and all waste entirely removed; water trickling slowly through a clogged drain or sieve does not move with sufficient force to cleanse it, and deposits, further accumulating, often entirely stop up the drain.

The tissues of the walls of the arteries and of the veins also need exercise for their own strength and growth, that they may throw off their own waste.

One writer says: "The body may be likened to an engine. It must be fed with clear water and this water passed out again in the form of steam—in the changing process from water to steam, energy or power is created and the exhaust pipes must be freely open or, in the chemical expanding process of change, the pipes weaken and then burst. If water containing dirt or sediment is poured into the engine, the valves become clogged, too much pressure is brought to bear upon the parts leading to the valves, thus weakening them;—if mineral water be used, the pipes become corroded and possibly the linings eaten through. Pure water, fed in just sufficient quantity for the machine to handle, offers least resistance, will manufacture regular power and force off its own waste. It is when the engine is over-crowded or the waste is not fully eliminated that the mischief begins.

"The difference between the steam engine and the human body is that the body itself is constantly changing, and aside from the waste of the foods taken in, it must eliminate its own waste.

"Scientists prove that nine-tenths of the diseases of the flesh are caused by the failure of the system to eliminate its waste."

If the body be given food or medicine, which eats into the linings of the digestive organs or clogs the system with useless waste, or more than it can eliminate, as in the case of feeding the steam engine, the parts of the system preceding the point at which the clogging or disturbance occurs, are weakened because of overwork. If, in the arteries, at any of the points e. g., (11) on the Blood Formation and Circulation plate, there be any impediment, the large artery and all of the branch arteries and capillaries preceding the point (11), at (6), will be overstrained and weakened because of the effort to dispose of the blood which should pass the natural channels at (11).

Unless the blood is forced through the tissues with sufficient vigor, the tissues in the arteries and capillaries beyond the point (11), will not be thoroughly nourished and will become still further clogged and weakened.

The circulation through the venules and veins at (22), (23) and (18) will also be sluggish because not forced past the obstruction at (11) with sufficient strength to collect the waste, to cleanse the walls and to keep open the cells.

Aside from forceful circulation and good blood, health depends largely upon the strength of the nerves. A nervous difficulty rarely originates in the nerves themselves. It is rather the result of impoverished blood, spinal dislocation and consequent nerve pressure, or of undue blood in the brain, occasioned by excess of mental over physical activity, or of constant pressure of some enlarged organ or tissue upon a particular set of nerves. It will thus be seen how important a part the circulation plays in the strength of the nervous system.*

In the beginning, exercise should not be too rapid; all quick movements call for a too rapid action of the heart to supply the blood to the tissues, and the breathlessness, which many people experience in beginning exercise, or in doing too vigorous work, is due to the effort of the heart to supply the tissues with sufficient blood for the rapid movement and the effort of the lungs to supply them with sufficient oxygen. The average person is inclined, in beginning to exercise, to be more or less nervous and to hold the breath, which causes a gasping in the effort of the system to supply the oxygen—every muscular effort liberates a certain quantity of carbonic acid gas and requires a proportionate amount of oxygen for combustion and elimination. One should always rest from this breathless condition before proceeding with the exercise.

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* Publishers' Note: See "The Nervous System," by Susanna Cocroft.

Since the *plasma of the blood oozes* out of the capillaries *into the lymph spaces more freely after exercise, it is of utmost importance that exercise be followed by complete relaxation that the tissues may be thoroughly fed; they dine sumptuously upon the nourishment in relaxation after exercise,—the brain as well as the muscles should let go.*

All exercise should be so arranged that in one practice period the circulation of blood to every part of the body be quickened.

It is especially important that thin people, whose tissues are underfed completely relax after exercise; for this reason it is particularly desirable to exercise just before retiring.

In the primitive woman exercise was a necessary part of her daily life. So-called civilization has reversed and transposed the relation between the physical and the mental being; formerly she was an animal with an intellect, which modern civilization has made her a soul and an intellect, with an animal residence—indeed some sects even go so far as to deny the reality of the physical. In this transposition of the intellect and the effort to cram the brain, daily exercise and cleanliness of the internal organs are neglected.

Effect of Thought Upon the Blood Vessels

As an illustration of the effect of the nerves upon the manner of breathing, it will be noted that, in a peaceful state of mind, the individual breathes slowly, deeply and rhythmically; in excessive joy, more rapidly, while in fear, the breathing becomes rapid and short and sometimes almost stops. If one is in an agitated, disturbed state of mind and goes into the open air, practicing deep, slow, rhythmic breathing, this rhythm reacts upon the mind and tends to produce the state of mind of which the manner of breathing is expressive. Ancients, realizing this relation and the reflex action of the body upon the mind, gave definite, dynamic breathing exercises to reinstate a normal mental poise.

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* See "Habit—The Nervous System" by Susanna Cocroft.

From a consideration of the above facts, one readily sees how the mental poise directly affects the health. Let us take, for example, the habit of worry. Worry tenses the nerves so that the capillaries and other blood vessels are contracted; being contracted, they do not contain sufficient blood to feed the tissues with the amount of plasma necessary for their nourishment. In the contracted capillaries, the plasma will not ooze through the walls, hence the tissues are underfed; neither is there sufficient oxygen carried to the tissues to put the waste in the dissoluable state necessary for it to be picked up by the lymphatics and the blood stream.

The effect of worry soon expresses itself in a pale, sallow complexion, showing an undernourished skin and poison in the system. If the skin, is undernourished and full of poison, it is easy to realize that all of the tissues and linings of the vital organs, nerves, and blood vessels are in the same condition.

It is also easy to realize that the more oxygen one takes into the system to relieve this waste, the more rapidly the poison will be thrown off, provided, also, that the circulation be quickened.

We have shown above how worry affects the health through the nerve tension; fear, and disagreeable, pessimistic thoughts, by contracting the capillaries, affect it in a similar way.

Good will and kindly thoughts tend to put the nerves in a normal condition, relaxing the tissues so that there is no obstruction to Nature's forces. Joy stimulates the nerves and tends to a quickened circulation and an expansion of the tissues.

It will be readily seen that any religious belief which puts the mind in a kindly or exhilarated poise, affects the health through the nerves and the vascular system and is to be accounted for on a scientific basis—we do not need to go to the mystical or the mythical for an explanation.

Cold and "Colds"

Fire or heat are occasioned by the rapid combustion of carbon in contact with oxygen. If a fire in the stove seems to be "dying down", we "turn on the draught"—in other words, we cause more air to pass through the stove, that more oxygen may increase the combustion. If we wish to shut off a fire, we close the damper, or draught, to keep out the air.

The same principle causes the heat within the body—the chemical contact of the oxygen causing the combustion of the body fat (carbon). When the body is cold it can almost always be warmed by the free breathing of pure air, creating a free combustion or heat; this is particularly true where there is much adipose tissue. If the free breathing be accompanied by exercise to free the waste, the body is quickly heated, because of more combustion.

Very often those who are thin and nervous, are cold because of an over tension of nerve, which does not allow a complete circulation. Thus sufficient oxygen is not carried to the fat about the tissues.

A cold is merely the closing of the pores of the skin, causing the moisture, which normally comes through the pores, to be turned inward. This moisture usually forces itself through the most vulnerable or weakest part of the mucous lining of some vital organ, or through the nasal passages or lungs, causing a disturbance there. We commonly say a "cold has settled" in such and such an organ.

When the pores of the skin are closed, the poisons which should be continuously thrown from them, are hoarded in the system, it thus becomes poisoned.

The relief from a cold lies in the correction of the cause, or the opening of the pores that the skin may throw off its share of the moisture and the toxins. The hoarded waste is assisted in its elimination by the free drinking of water and by a laxative to encourage the kidneys and intestines to freely relieve the waste.

Our grandmother's prescription of a cathartic, a hot mustard bath, and a hot drink just before retiring, has a sound physiological basis; as, indeed, have many of the "old fashioned" remedies. The free perspiration corrects the cause (the closing of the pores of the skin), and this unusual freedom, together with the activity of the intestines and kidneys, helps to relieve the excess of toxins, or poisons, which have accumulated.

But,—better than the *relief*, is the "ounce of *prevention.*" When the pores *begin* to close, one can almost always reopen them by taking deep, full breaths and holding the breath as long as possible. Continue this, taking in all the air you can, until the "fires" are started up and the body becomes warm, opening the pores. Also, drink all of the cold water you can to assist in the free action of the kidneys and of the pores of the skin. Almost anyone in good vitality, with plenty of red blood corpuscles, "oxygen carriers", and a good circulation, can throw off a cold within twenty-four hours.

If the circulation is sluggish, or the blood is not in condition to throw off a cold readily, it is a warning signal of grave importance and it means that one is in condition to become a ready prey to any disease. The building up of the system through proper, regular exercise, diet, and deep breathing is imperative and will save many dollars in doctors' bills. The up-to-date physician tells a patient this, but does she follow his suggestions? Does she realize that she can do for herself, in building up her vitality, more than any physician can do without her help (and physicians welcome her assistance)? Or, is it the old story, which Charles Dickens makes so very strong in the case of Mrs. Dombey and which causes her husband to be out of patience,—because she will not *"make the effort?"*

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