A BASIC PHYSIOLOGY FOR YOGIS

This chapter contains a very basic summary of the body's structures and functions. It is important in the practice of yoga to gain an understanding of how the body works. It will enable you to acquire a clearer understanding of why the postures are done from a physical standpoint, along with why they benefit the total body-mind complex. Remember, as the body is affected the mind is also affected. A healthy body brings about a healthy mind. The following is a brief outline of the body systems and the various organs comprising them.

BODY SYSTEMS AND THE ORGANS COMPRISING THEM

Skeletal system	Bones Joints
Muscular system	Muscles
Nervous system	Brain Spinal cord Nerves Ganglia
Circulatory system	Heart Blood vessels Lymphatic vessels Lymph nodes Spleen
Digestive system	Mouth Teeth Tongue Tonsils Salivary glands Pharynx Esophagus Stomach Intestines Appendix Liver Gallblader Pancreas

Respiratory system
- Nose
- Pharynx
- Larynx
- Trachea
- Bronchi
- Lungs

Urinary system
- Kidneys
- Ureters
- Urinary bladder
- Urethra

Reproductive system

Male:	Female:
Testes	Ovaries
Epididymis	Uterine tubes
Vas deferens	Uterus
Seminal vesicles	Vagina
Ejaculatory ducts	Bartholin glands
Urethra	Vulva
Prostate gland	Mammary glands
Bulbourethral glands	
Scrotum	
Penis	
Spermatic cord	

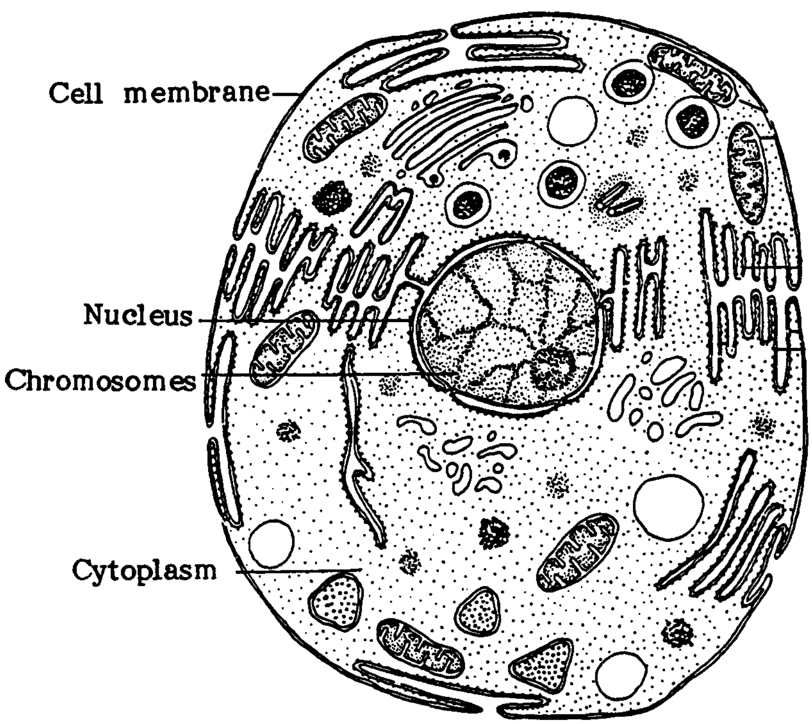
Endocrine system
- Pituitary gland
- Thyroid gland
- Parathyroid glands
- Adrenal glands
- Islands of Langerhans
- Sex glands

Body systems and the organs comprising them.

Section 1

THE CELLS OF THE BODY

The first discoveries of cells were made by Antony van Leeuwenhoek (1632-1723), who made his own simple lens microscope and saw bacteria and protozoa, and by Robert Hooke (1653-1703), who had several lenses in his compound microscope and who first named cells after studying their tiny boxlike structures in cork. Since then it has been shown that all living things are made of cells.



Major parts of a cell.

Size of Cells

Cells are so tiny that they are measured in microns. A micron is a unit of microscopic measurement. There are 1,000 microns in a millimeter (10 mm = 1 cm; 2-1/2 cm = 1 inch). Bacteria are the smallest cells that can be seen with the light microscope. The average are 1-3 microns in size. Most other cells are about 10 microns in size. A nerve cell, however, which is usually microscopic, may extend more than a yard in length; and the yolk of a bird's egg, which is a single cell, may measure several inches across.

Cell Structure

Until quite recently, the structure of plant and animal cells was considered to be relatively simple, as shown in the diagram of the major parts of a cell.

Protoplasm

A cell is a tiny unit of living material called protoplasm. Protoplasm consists of:

1. A nucleus, which is a small, spherical, dense body. It controls the activities of the cell and is made up of a chromatin network of chromosomes which contains the genes. The genes have recently been shown to consist of molecules of DNA (deoxyribonucleic acid). There is usually at least one nucleolus, a tiny dot-like structure, inside the nucleus. It has been found to contain RNA (ribonucleic acid), which helps direct the synthesis of proteins.

2. Cytoplasm, which is a thick, granular, grayish liquid that occupies most of the cell. It appears to be somewhat like the white of a raw egg. It carries on most of the other activities of the cell which include:

   a. Endoplasmic reticulum. This is a network of channels or tubes that extends throughout the cytoplasm. It is thought to function in the transport of materials throughout the cell.
   b. Ribosomes. These are tiny granules that are distributed along the endoplasmic reticulum. They contain RNA.
   c. Mitochondria. These are rod-like structures with inner, folded walls. They act as sites for cellular respiration and contain enzymes that bring about the transformation of food into energy. They contain ATP (adenosine triphosphate) which is the storehouse of energy.

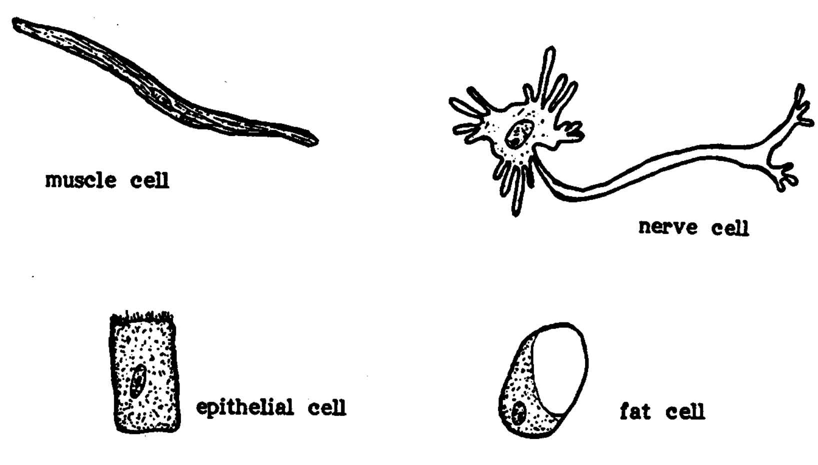
3. Cell membrane, or plasma membrane, which is the outer living layer of cytoplasm. It has a complex porous structure, composed mainly of protein and fatty material. It is semipermeable and controls the passage of dissolved substances into and out of the cell. Some dissolved materials pass through the cell membrane by diffusion.

Because they contain protoplasm, living things are able to carry on the following basic life functions:

1. Ingestion: The taking in of food.
2. Digestion: The breaking down of food to simpler soluble form with the aid of chemicals called enzymes.
3. Secretion: The formation of useful substances, such as enzymes.
4. Absorption: The passage of dissolved materials through the cell membrane, in and out of the cell.
5. Respiration: The release of energy from food.
6. Excretion: The passing out of waste products from the cell through the cell membrane.
7. Transport: The circulation of materials throughout the organism.
8. Synthesis: The chemical formation of complex molecules from simple compounds.
9. Assimilation: The changing of nonliving materials in food into more protoplasm, resulting in growth and repair.

TISSUES AND THEIR FUNCTIONS

A tissue is a group of similar cells performing the same function. The study of tissues is known as histology. Tissues are classified as epithelial, muscle, nerve, connective and supporting, blood, and reproductive.



Types of cells.

Epithelial tissue

This tissue consists of a continuous layer of cells covering the body surfaces and lining the cavities within the body. It is found on the outer layer of skin and in the lining of the digestive tract, the respiratory system, the blood vessels, and also in the glands. In these various parts of the body it may have one or more of the following functions:

1. Protection
2. Absorption
3. Secretion
4. Sensation

Epithelial cells may also differ in appearance, some being flat, some box-like or cuboidal, and others tall and rectangular (columnar). They include:

1. Epidermis of the Skin. This is the outer layer of the skin which protects the underlying cells from:

   a. Injury
   b. Bacteria
   c. Drying out

   There are layers of these cells which are constantly being worn away and replaced from underneath.

2. Flat (squamous) epithelium. These cells are broad and flat, like tiles on a floor. They form a protective membrane that lines the inside of the mouth (mucous membrane) and the esophagus. They have special cells that secrete mucus to lubricate the passages and to trap dust and bacteria. They also line the smallest blood vessels (capillaries) where they allow dissolved materials to pass through them (absorption).

3. Ciliated epithelium. These epithelial cells lining the nasal cavities and the trachea (windpipe) have cilia which are constantly in motion, beating foreign particles upward and outward.

4. Columnar epithelium. These cells line the small intestine where they absorb digested food. They contain special cells called goblet cells which secrete mucus, a sticky fluid that lubricates the interior of the intestine.

5. Glandular epithelium. These include the complex glands of the digestive system

(i.e., salivary glands), the endocrine glands which secrete hormones (i.e., thyroxin), and the tear glands which are all specialized cells whose task is to secrete special liquids for the body's use.

6. Sensory epithelium. These are specialized epithelial cells which receive stimuli (sensations) from the outside of the body. The olfactory cells lining the inside of the nose help us to smell. The cells on the retina of the eye permit us to see.

Muscle Tissue

This tissue has the ability to contract and produce movement. There are three types of muscle tissue:

1. Voluntary or striated muscles contract according to our will. Muscles of our arms and legs are examples of this type of muscle; they are usually attached to the bones of the skeleton and so may also be referred to as skeletal muscles.
2. Smooth muscle is involuntary and is found in the walls of the alimentary canal and the blood vessels. We are rarely aware of the activities of these muscles. Food is moved along and churned in the stomach and intestines by the wavelike contractions and expansions of the smooth muscles in the walls of these organs; this muscular activity is known as peristalsis.
3. Cardiac or heart muscle is also involuntary and is found only in the heart. Its cells have a striated appearance.

Nerve Tissue

Nerve cells are specialized for transmitting messages or impulses through the body. They appear different from other cells in having branched projections which are in close contact with each other.

Connective and Supporting Tissue

This consists of several types of cells quite different from each other, whose function is either to support the body or to connect its parts. The cells secrete a nonliving substance or matrix around them. They include:

1. Bone. "Solid bone" is not as solid as it seems. It consists of cells separated from each other by nonliving intercellular deposits of calcium and phosphorus which are secreted by the cells themselves.

2. Cartilage. The cells of cartilage are contained in a nonliving matrix which is smooth, firm and flexible but not as hard as bone. Cartilage can be felt in the ears, nose and the windpipe.
3. White fibrous connective tissue consists of a very tough matrix of white fibers containing living cells. It is found in tendons which connect muscle to bone, and ligaments which connect bones together forming joints, e.g., the knee, elbow, etc.
4. Yellow elastic connective tissue contains fibers which stretch when necessary and then return to their normal size. This tissue is found in the arteries which expand as each beat of the heart sends spurts of blood through them and then relax before the next beat or pulse. The elastic fibers in the walls of the arteries permit them to expand in this way. Hardening of the arteries results when the elastic fibers lose their elasticity. This tissue is also found in the bronchial tubes of the lungs and between the vertebrae of the backbone.
5. Fat (adipose) tissue has cells that store oil and fat. It is located beneath the skin and around the heart and kidneys. It helps to retain body heat.

Blood Tissue

The cells of this tissue are carried in a liquid called plasma. Plasma is a straw-colored fluid consisting of water and dissolved proteins, salts, nutrients, antibodies, hormones and wastes. It contains three types of cells:

1. Red blood corpuscles, which are round disc cells that lose their nucleus after being manufactured in the marrow of the bones. They contain hemoglobin which unites freely with oxygen. Their function is to bring oxygen to all the cells of the body.
2. White blood corpuscles, which are amoeba-like cells that move through the circulatory system and the body tissues. They engulf and destroy bacteria that may have entered the body.
3. Platelets, which are a very small group of cells that play a role in blood clotting.

ORGANS

Tissues are grouped together to form organs. For example, the stomach is an organ that contains several types of tissues. All of these tissues work together as the stomach performs its function of digestion. Similarly, other organs such as the heart, kidneys and brain are also made of tissues working together.

SYSTEMS

Besides the stomach, there are other organs concerned with digestion such as the mouth, esophagus, small intestine, large intestine, liver and pancreas. All together, they make up the digestive system. There are seven other systems composed of groups of organs working together to perform their particular function. These include the circulatory system, the respiratory system, the excretory system, the nervous system, the reproductive system, the skeletal system, and the muscular system.

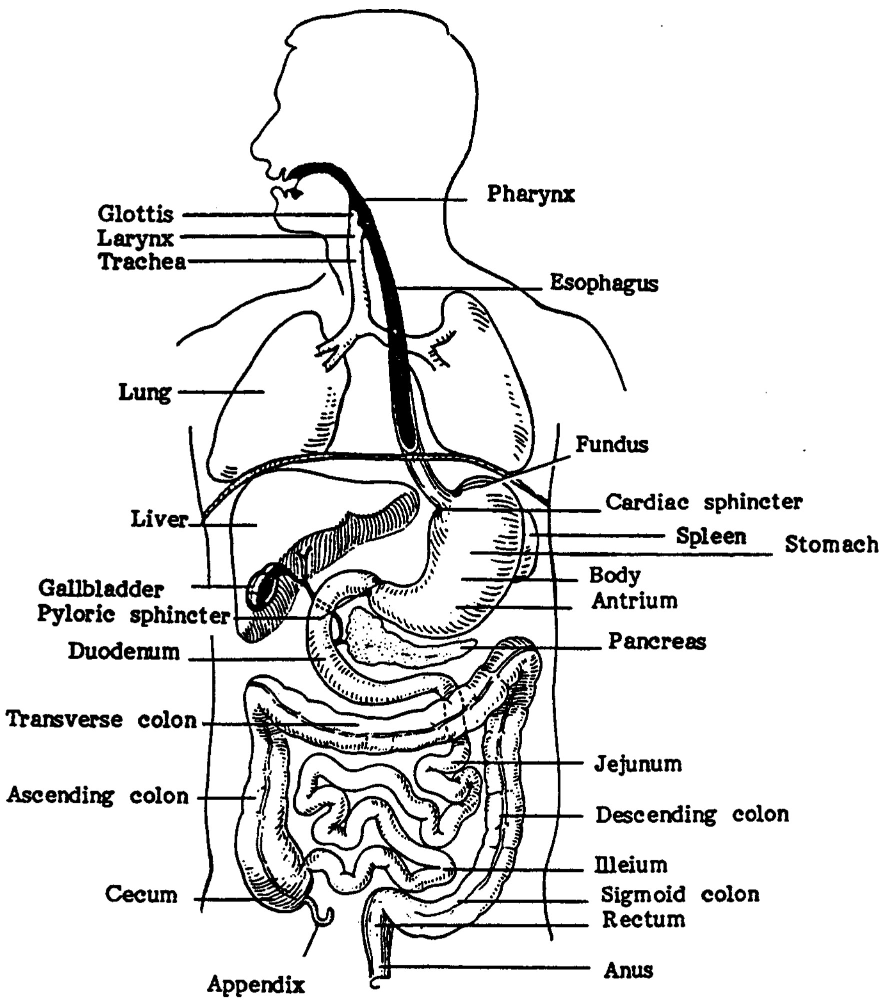
ORGANISM

In a many-celled living organism, cells are grouped together to form tissues; tissues work together to form organs; organs are organized into systems; and all of the systems working together make up an organism.

Section 2

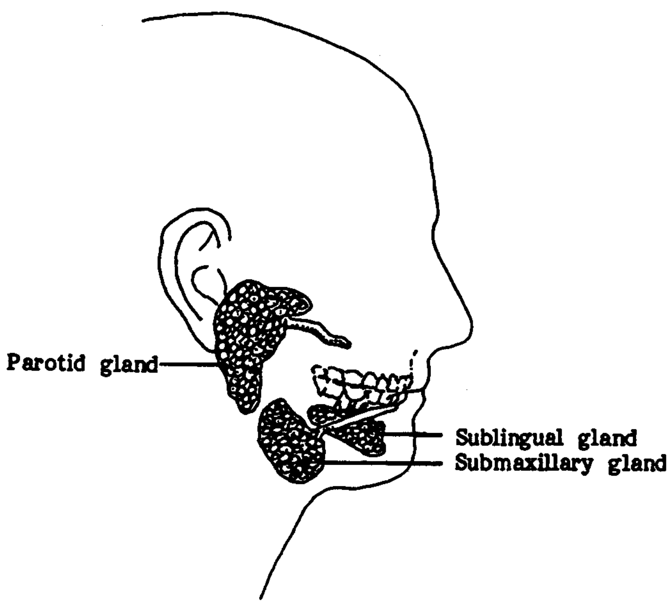
THE DIGESTIVE SYSTEM

Ingestion refers to the activity of the body by which food is taken into the system. Before food can be absorbed into the cells of the body, it must first be made soluble or digestible. During digestion the complex molecules of food are reduced into smaller ones capable of passing through the membranes of the body, after which the soluble molecules are absorbed into the cells.

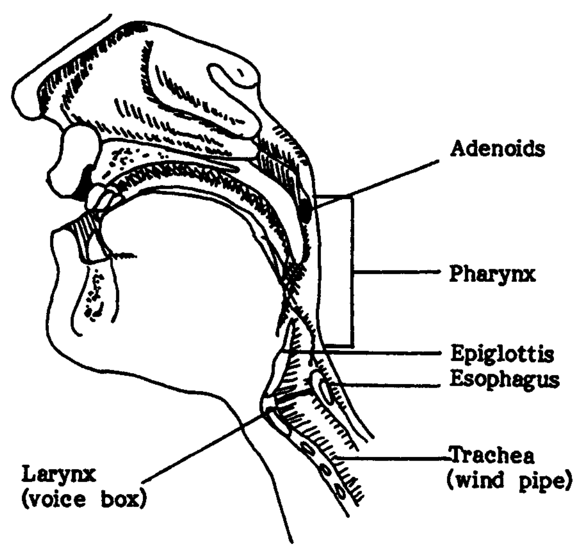


The Digestive System

Food is passed along through the body by way of the tube called the alimentary canal. This consists of the mouth, esophagus, stomach, small intestine, large intestine, and rectum. There are digestive glands leading into the alimentary canal from the mouth, stomach and small intestine. Two large glands, the liver and the pancreas, are outside the food tube and send their digestive fluids into it through ducts. The alimentary canal and the digestive glands make up the digestive system.



Salivary glands. (Produce a fluid called saliva containing important digestive enzymes.)



Oral cavity and throat.

Mouth

In the brief time that food is in the mouth two main things happen:

1. It is chewed and broken down into smaller pieces by the teeth. This is known as mechanical digestion.
2. It is attacked by enzymes in the digestive liquid, the saliva. This is known as chemical digestion.

Teeth: Human beings and most mammals develop two sets of teeth during a lifetime. The first, or milk teeth, number twenty. The second set in an adult number thirty-two teeth arranged in a semicircle, half on the upper jaw and half on the lower.

Salivary Digestion: While the food is being chewed into smaller particles, it is being moistened by saliva — a digestive liquid produced by three pairs of salivary glands. These glands are located under the tongue, in the cheek near the ear, and in the lower jaw. They empty into the mouth through ducts. Saliva contains the enzyme ptyalin which digests starch into a sugar (maltose).

Esophagus

After food has been chewed, lubricated by saliva, and partially digested by ptyalin, a small mass of it (bolus) is pushed into the throat (pharynx) where it is swallowed. A flap of tissue, the epiglottis, closes over the adjacent windpipe and prevents the food from going into the wrong tube. The esophagus is lubricated by mucus which is secreted by glands in its lining. Peristalsis, the alternate wavelike contractions and expansions of the involuntary muscles in the wall of the esophagus, moves the food along into the stomach.

Stomach

Food remains in the stomach from three to four and one-half hours. During this time it is constantly being churned and mixed by peristaltic action (mechanical digestion) with gastric juices which contain secretions of the stomach glands. These digestive glands produce the enzymes pepsin, rennin and a tiny amount of lipase, along with water, and hydrochloric acid.

Pepsin partially digests proteins. Rennin curdles the protein of milk (casein) and prepares it for digestion by pepsin. Complete digestion of the proteins will take place in the small intestine. Pepsin is active only in an acid medium, thus advertisements that imply that "acid stomach" is undesirable are misleading. Hydrochloric acid is necessary for digestion. Hydrochloric acid is further useful in dissolving minerals for absorption and in killing bacteria that have been swallowed. The very small amounts of the enzyme lipase digest only a tiny amount of fat into fatty acids and glycerol.

The contents of the stomach eventually take the form of a semi-liquid paste (chyme) and gradually pass out of the stomach's far, narrow end (the pylorus) into the small intestine through a muscular valve, the pyloric sphincter.

Small Intestine

Digestion of food is completed in the small intestine, a narrow tube over twenty feet long. Mechanical digestion continues as peristaltic action moves the food along and constantly mixes it with the digestive liquids. There are three such digestive liquids which are secreted by 1) intestinal glands in the small intestine, 2) the pancreas, and 3) the liver:

1. Intestinal juices secreted by intestinal glands in the small intestine contain the following enzymes:

   a. Erepsin, which digests proteins into amino acids;
   b. Maltase, which digests maltose into glucose;
   c. Lactase, which digests lactose (milk sugar) into glucose and galactose;
   d. Sucrase, which digests sucrose (cane sugar) into glucose and fructose;
   e. Small quantities of lipase, which digest fats into fatty acids and glycerol.

2. Pancreatic juice enters the upper end of the small intestine from the pancreas by means of the pancreatic duct. It contains the enzymes:

   a. Trypsin, which digests proteins into peptones, proteoses, and amino acids;
   b. Amylopsin, which changes starch into maltose;
   c. Lipase, which changes fats into fatty acids and glycerol.

3. The liver produces bile which is stored in the gallbladder. When food is being digested in the small intestine, the gallbladder contracts and secretes bile into it by means of the bile duct. Bile does not contain any enzymes. Instead it prepares fat for digestion by emulsifying it. The liver is one of the largest organs in the body. Besides forming bile, it also has a number of other functions. It changes excess glucose into glycogen and stores it; it destroys old, worn-out red blood cells; it converts amino acids into glucose and a nitrogenous waste called urea which is removed from the blood in the kidneys; it produces prothrombin, one of the substances needed in the clotting of blood; it prepares fat for use by the body; it serves as a reservoir for storing blood.

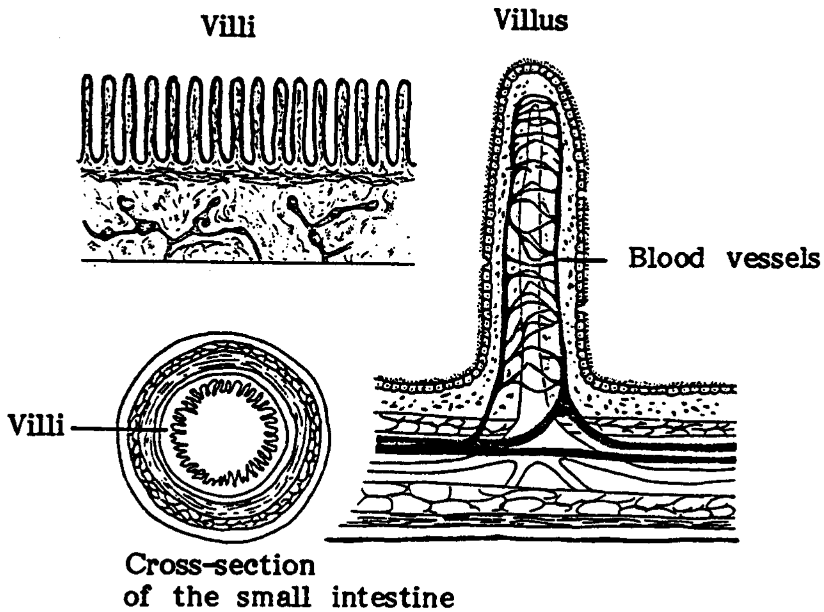


Diagram of villi in the lining of the small intestine.

Absorption of Digested Foods

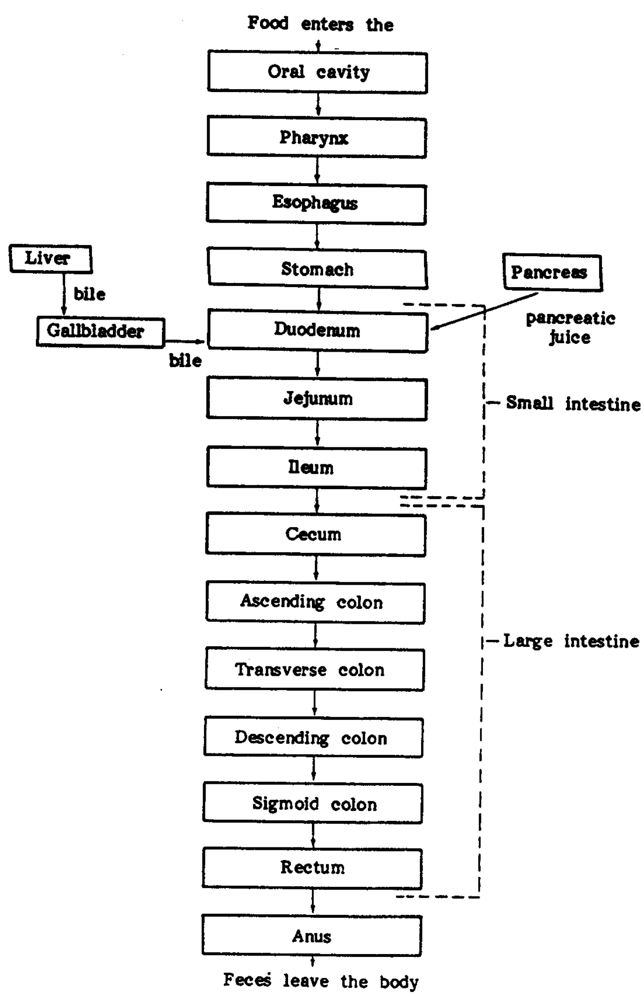
As the result of digestion in the mouth, stomach, and small intestine, the nutrients are converted into their end products: a) carbohydrates into glucose, b) lipids into fatty acids and glycerol, and c) proteins into amino acids. These soluble end products are absorbed through the walls of the small intestine. Here there are numerous microscopic, finger-like projections called villi which increase the absorptive surface of the small intestine.

The nutrients diffuse into the capillaries and become dissolved in the plasma of the blood. The blood goes into the liver. Here most of the rich supply of glucose is removed and changed into glycogen, or animal starch, for storage. Some glycogen is also stored in the striated muscles. Several hours after a meal, when the glucose level in the blood has fallen, glycogen is changed back into glucose and is transferred out of the liver into the blood. The fatty acids and glycerol do not enter the blood directly, but diffuse into the lacteals (lymph vessels which after a meal are filled with milky-white fat). These lead into larger lymph vessels and finally into the thoracic duct which empties into the bloodstream in the neck region.

Large Intestine, or Colon

After food has been digested and absorbed in the small intestine, the indigestible remains pass into the large intestine. A short distance from this point there is a small outpocketing of the large intestine, about the length of the little finger, called the appendix. It has no apparent use in humans, although in herbivorous animals it serves for digestion. Like the esophagus, the large intestine has no digestive functions. The mucous cells in its lining secrete mucus that provide lubrication for the solid matter being moved along by peristalsis. Water is absorbed by the large intestine during this time and is used over again by the body. The solid wastes consisting of indigestible food, especially the cellulose remains of plant food, intestinal secretions, and bacteria, are known as feces and are eliminated from the lower end of the large intestine (rectum) through the anus.

Pathway of food through the digestive tract.

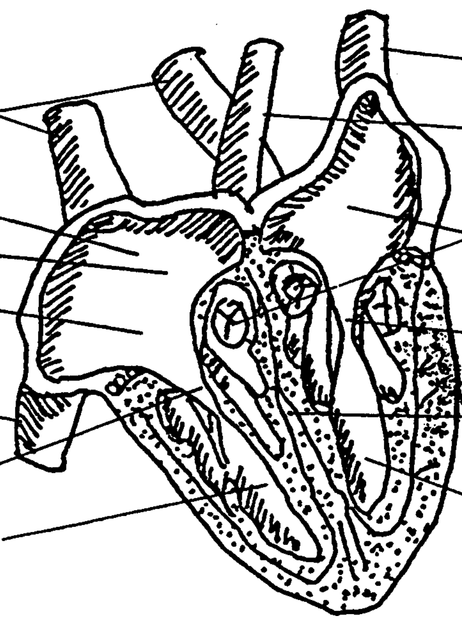


Section 3

THE CIRCULATORY SYSTEM

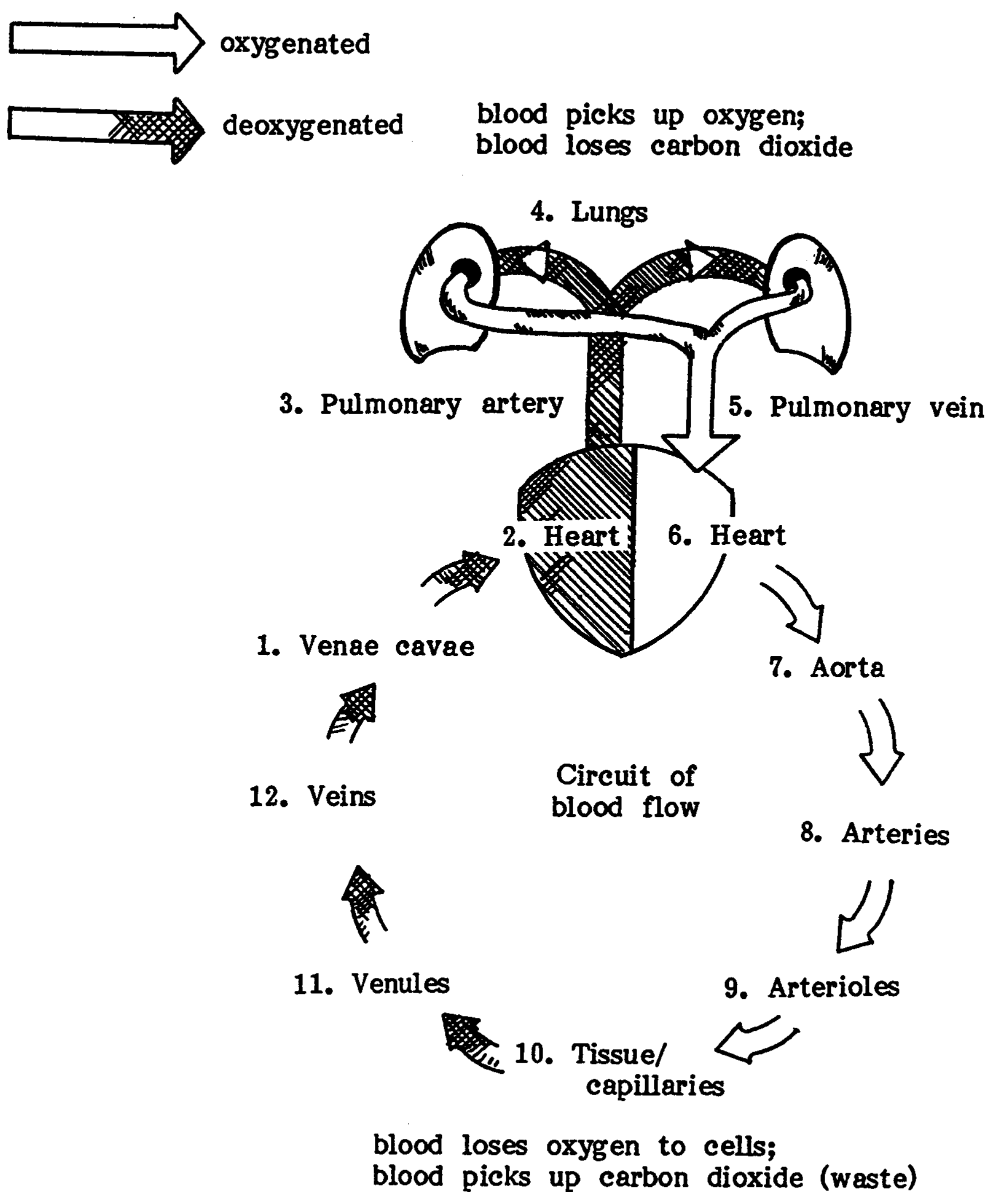
After it is digested, food is distributed throughout the body by means of the circulatory system. Each of the billions of cells in a human being depends for its existence on the continuous delivery of food, oxygen and other materials to it and the removal of wastes from it. The circulatory system of the body is arranged in a closed system of blood vessels in which the heart serves as a pump that keeps the blood moving. This was first demonstrated by William Harvey in the early part of the seventeenth century.

The Heart



The heart is a four-chambered muscular organ about the size of a man's fist. It is located approximately in the center of the chest, pointing to the left. It has two smaller upper chambers — the atria (auricle) which receive the blood, and two thick walled ventricles below them which pump the blood away from the heart. Between the atria and ventricles are valves which prevent the blood from flowing backward. A doctor may hear a "murmur" if there is a defect in a valve causing some of the blood to flow back into the atrium. Located in the right atrium is an area of specialized muscle tissue called the pacemaker, where the pulsations of the heart appear to originate and from which they spread like a wave to the rest of the heart.

The cells of the heart itself are nourished by the coronary arteries. If any of them become blocked by a clot, as in coronary thrombosis, the heart cells are deprived of food and oxygen, and death may result. The right and left sides of the heart really function as two pumps, i.e., the right side pumps blood to the lungs (pulmonary circulation) and the left side pumps blood to the rest of the body (systemic circulation).



Arteries

Arteries are large blood vessels that carry oxygenated blood away from the heart. They are thick-walled, containing a great deal of elastic fiber tissue. They also have layers of involuntary muscle that control the size of their opening. In older people the walls of the arteries sometimes lose their elasticity, resulting in a condition known as arteriosclerosis, or hardening of the arteries.

Veins

Veins are blood vessels that carry deoxygenated blood to the heart. They have thinner walls than the arteries, with less elastic fiber and muscular tissue. Blood passes through them in a steady flow, as compared with the spurting action of the arteries. All veins carry deoxygenated blood except for the pulmonary vein.

Capillaries

Capillaries connect the smallest arteries (arterioles) and the smallest veins (venules). They are microscopic with walls only one cell thick. They are located everywhere in the body, close to the cells. Food, oxygen and other materials diffuse out of the blood through the capillary walls into the intercellular fluid (ICF) surrounding the cells, and then into the cells. By the reverse process, wastes leave the cells, diffuse into the ICF, and then enter the blood through the capillary walls.

The Circulatory Route

When the right atrium contracts, blood is forced into the right ventricle. In turn, it contracts and sends blood to the pulmonary artery leading to the lungs. Here the blood enters capillaries surrounding the air sacs. Oxygen is absorbed through the capillary walls; carbon dioxide and water vapor are excreted. The oxygenated bright red blood then collects in the pulmonary veins which lead back to the heart, this time into the left atrium. It contracts and forces the blood into the left ventricle. The left ventricle pumps blood into the aorta, which carries blood to the entire body except the lungs (see diagram on the circuit of blood flow).

The aorta divides into arteries that go into the various parts of the body. The arteries branch into arterioles, which in turn lead to the capillaries. Oxygen and food from the bloodstream enter the cells via the lymph. Carbon dioxide and other wastes from the cells diffuse into the capillaries, which in turn unite to form venules (tiny veins), which lead to the veins. The blood is now largely deoxygenated and dark red in color and it is carried back to the heart. This circuit of blood takes less than 20 seconds and includes:

1. Pulmonary circulation. Blood from the right side of the heart is pumped through the pulmonary artery to the lungs where it absorbs oxygen and excretes carbon dioxide and water vapor, then back to the left side of the heart through the pulmonary veins. Deoxygenated blood is refreshed or oxygenated in this part of the circulatory route.

2. Systemic circulation. This is the flow of "body" circulation, in which blood from the left ventricle goes through the aorta to the upper and lower parts of the body and back to the right atrium. Arteries deliver blood containing food and oxygen to the internal organs. Veins leaving these organs collect the blood now containing carbon dioxide and nitrogenous wastes. The arteries entering the kidneys carry excretions of the cells, which are filtered out by the kidney tubules. The large kidney veins, which return the blood to the circulatory route, are relatively free of wastes.

3. Portal circulation. Digested food is absorbed in capillaries of the villi in the small intestine. These capillaries lead out of the small intestine by means of the portal vein which then enters the liver. Here the blood goes into capillaries which carries it to the liver cells. Excess glucose is removed and stored as glycogen, or animal starch. Portal circulation is essentially a part of systemic circulation.

LYMPH AND LYMPH CIRCULATION

The lymphatic system is not really a separate system of the body. It is part of the circulatory system, since it consists of lymph, a moving fluid that comes from the blood and returns to the blood by way of the lymphatic vessels. In addition to lymph and the lymphatic vessels, the system includes lymph nodes and specialized lymphatic organs such as the thymus and spleen.

Lymph forms as blood plasma and filters out of the capillaries into the microscopic spaces between tissue cells. Here it is called interstitial fluid or tissue fluid. Most of this interstitial fluid goes back into the blood by the same route it came, i.e., back through the capillary membrane. The remainder enters tiny lymphatic capillaries to become lymph. It returns to the blood in veins in the neck region. Lymph serves a unique transport function by returning tissue fluid, proteins, fats, and other substances to the general circulation. Unlike vessels in the blood vascular system, however, the lymphatic vessels do not form a closed ring or circuit. Lymph transports needed proteins, which have leaked out of the blood capillaries back to the bloodstream via the veins. Both blood and lymph protect the body by carrying disease-fighting cells and protein substances called antibodies, which combat infection. Lymph serves as an intermediate liquid.

THE BLOOD

There are almost six quarts of blood in an average-sized person. Blood consists of a liquid (plasma) in which three types of cells are carried: red blood corpuscles, white blood corpuscles, and platelets.

Plasma

Plasma, the liquid part of the blood is straw-colored, consisting of 90 percent water, and containing: dissolved nutrients (glucose, amino acids, fatty acids, salts, vitamins), wastes, antibodies, hormone, respiratory enzymes, and fibrogen.

Red Blood Corpuscles

Almost all the cells in the blood are red blood cells. Their function is to transport oxygen. Red blood cells, or erythrocytes, are so small that a cubic millimeter of blood contains about 5,000,000 of them. They are so numerous that blood appears red. Without them, blood is pale yellowish in color. They are disc-like cells which are concave on both sides. They contain the protein hemoglobin which gives them their color. When blood passes through the lungs, the oxygen in the air combines with the hemoglobin of the red blood corpuscles to form oxyhemoglobin. As these cells circulate through the body, oxygen diffuses from them into the cells.

Red blood corpuscles are manufactured in the marrow of the bones. They lose their nucleus when they enter the blood stream and recently it has been shown that they remain active for about four months! Worn-out red cells are removed from the blood by the liver and the spleen. The spleen is also a storage place for active red blood cells and contracts when extra amounts of red blood cells are needed in the blood stream.

The element iron is needed for the formation of hemoglobin. If it is lacking in the diet, anemia results wherein a person has lowered vitality since there are not enough red blood cells to bring oxygen to the tissues. Vitamin B-12 has been found useful in treating serious cases of pernicious anemia.

White Blood Corpuscles

Approximately 1 out of every 500 blood cells is a white blood cell. The white blood cells, or leukocytes, move like amoebae and engulf bacteria and other foreign matter that enter the body. For this reason they were named phagocytes (eating cells) by their discoverer, Eli Metchnikoff (1845-1916). They form pseudopodia and can crawl through the capillary walls into the tissues. The white blood cells are formed in bone marrow and in the lymph glands.

Platelets

Platelets are even smaller in size than the red corpuscles. They are important in initiating the set of reactions that takes place when blood clots. Some persons inherit a disease known as hemophilia in which the blood does not clot. In other cases there may be poor clotting of a cut or a wound if a person is lacking in Vitamin K or the element calcium.

Blood Types

Although all blood contains plasma and the three types of blood cells mentioned above, it is chemically different in various people. At the beginning of the century, Dr. Karl Landsteiner discovered that some red blood cells contain substances called agglutinogens, which react with antibodies known as agglutinins in the plasma of other people.

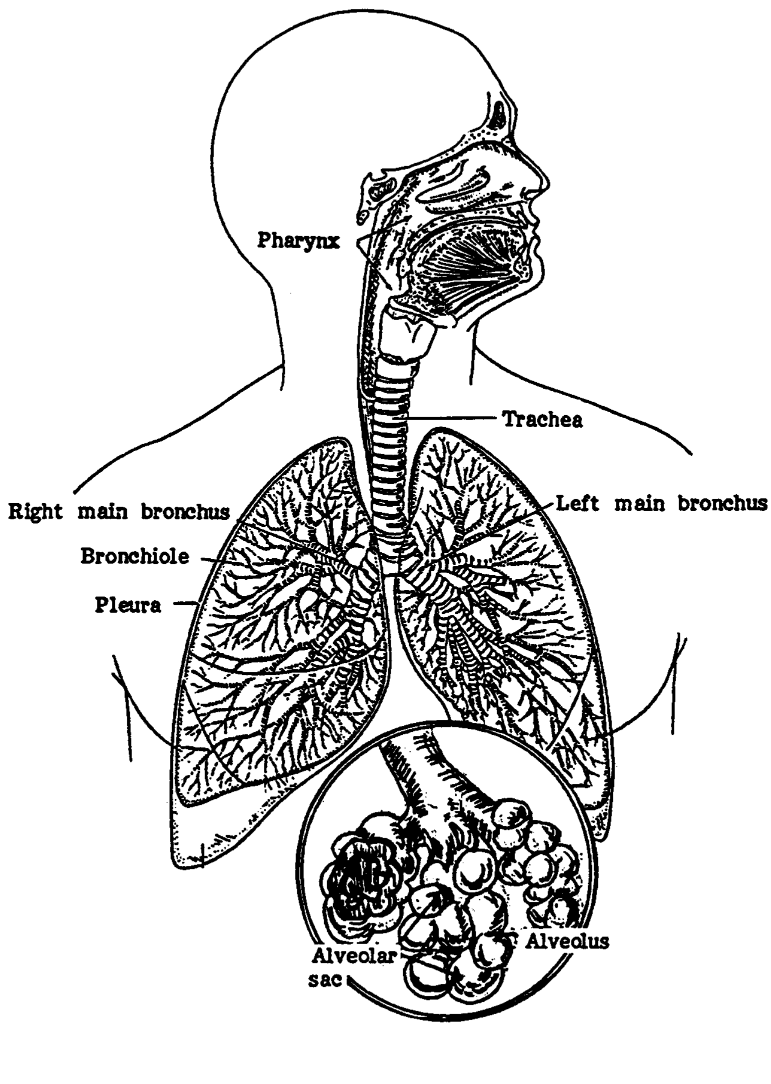
On the basis of these differences, he classified blood into four types, now referred to as A, B, AB, and O. Agglutinogens of Type A are different from those of Type B blood. Consequently, if blood from one is mixed with another, they will agglutinate, or clump, because of the action of the agglutinins. Type AB has both agglutinogens A and B, and Type O has neither. Here it can be seen that a person with Type AB blood can receive blood from A, B, AB, or O. Since Type O blood has no agglutinogens, it can be transfused to any of the other three types and is known as the "universal donor."

Other types of blood include the M, N, Hr, and P-factors, as well as Rh-factor, the most recent antigen found in the human red blood cell. About 85 percent of white Americans are Rh-positive, indicating that their blood contains this Rh-positive factor. Rh-negative blood normally contains no agglutinin comparable to A or B. If both parents are Rh-positive, there is normally no difficulty in the development of their children. However, if the father is Rh-positive and the mother is Rh-negative, the red blood cells of the developing fetus may be destroyed (erythroblastosis) because of the production of antibodies counteracting them in the mother's body.

Section 4

THE RESPIRATORY SYSTEM

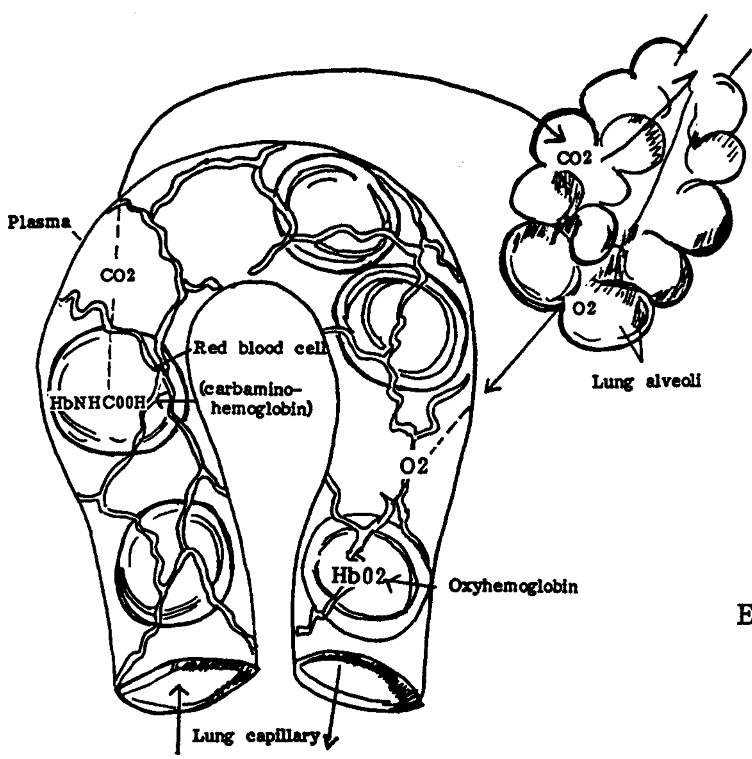
After food has been delivered to the cells, it must be combined with oxygen in order to release energy. When this occurs, carbon dioxide and water are given off as wastes. During this process of respiration, numerous respiratory enzymes participate in the series of reactions by which energy is produced in every cell of the body. The respiratory system includes the structures through which oxygen comes into the body to reach the bloodstream and through which carbon dioxide and water vapor leave.



The Respiratory System

Air first enters through the two nostrils in the nose, where large hairs hold back some of the dust. Farther along, the nasal passages are lined with cilia which beat bacteria and dust outward. The sticky mucus secreted by the epithelial cells also traps bacteria and dust. Thus, the air is filtered as it enters the body. It is also moistened and warmed as it passes over the thin lining of cells in the nasal passages and through the sinuses. The sinuses are cavities in the head connected with the nasal passages by narrow openings. During a cold, their membranes may become infected and swollen, blocking the openings and causing the troublesome condition known as sinusitis, or "sinus trouble."

Air continues into the pharynx, or throat, at the back of the mouth. It is obvious that breathing by mouth does not permit the air to be cleansed, moistened of warmed, as in nasal breathing. The pharynx also has two small openings leading to each ear through the narrow Eustachian tubes. The trachea, or windpipe, next receives the air. The upper end is covered with a flap of tissue, the epiglottis, which is open during breathing. However, when food is being swallowed into the nearby opening of the esophagus, the epiglottis closes and keeps food from entering the trachea. The wall of the trachea contains rings of cartilage which keep the passageway open. The inner surface is lined with ciliated epithelial cells which beat dust and bacteria upward.



Exchange of gases in lung capillaries.

The trachea divides into two bronchi which are tubes that carry air into the lungs. Each bronchus branches into smaller and smaller bronchial tubes, or bronchioles, which spread through the lungs. At the end of each of the millions of microscopic bronchial tubes there is an alveolus or air sac. The wall of the air sac is made up of one layer of cells surrounded by a network of capillaries. As the blood flows through these capillaries, oxygen diffuses from the air through the walls of the air sacs and combines with hemoglobin. Carbon dioxide and water vapor diffuse out of the blood into the air sacs and are eliminated when the air is carried out.

When air is inhaled, it contains about 79 percent nitrogen, 20.9 percent oxygen, and 0.04 percent carbon dioxide, the remaining being inert gases. After it has reached the air sacs and diffusion has occurred, it is exhaled with 79 percent nitrogen, 16.3 percent oxygen and 4.5 percent carbon dioxide.

Breathing Mechanism

The lungs are elastic, spongy organs located in the thorax, or chest cavity, which is a closed chamber. The outside of the lungs is covered with a moist, smooth membrane, the pleura, which also lines the thorax. A condition known as pleurisy results when the pleura becomes infected. The diaphragm, the muscular floor of the thorax, consists of voluntary striated muscle, separating it from the abdominal cavity.

The act of breathing involves the movement of both the diaphragm and the ribs to enlarge or decrease the size of the chest cavity. During this process, the lungs either are filled with air or are made to give up their air through the following processes:

1. Inspiration, or inhaling. The diaphragm, which is curved upward when it is relaxed, contracts and flattens out. The rib muscles also contract, causing the ribs to be raised and spread apart. Both of these actions enlarge the chest cavity and reduce the internal pressure on the lungs. Air from the outside, where the atmospheric pressure is higher, then is forced into the lungs. This brings air into the air sacs where the exchange of gases takes place.

2. Expiration, or exhaling. The diaphragm relaxes, curving upward. The rib muscles relax, lowering the position of the ribs. The chest cavity becomes decreased in size, compressing the air in the lungs and forcing it out.

Normal breathing takes place about 15 to 18 times a minute. Exercise or emotional conditions can cause it to increase.

Control of Breathing

Although breathing is a voluntary activity involving voluntary muscles, it is automatically controlled by a part of the brain, the medulla. It therefore goes on without our having to think about it. The rate of breathing is controlled by the amount of carbon dioxide in the blood. As the blood circulates, an increased amount of carbon dioxide in the blood stimulates the cells of the medulla to send impulses to the chest muscles and diaphragm, causing them to contract and expand more rapidly. The breathing rate then increases. This is what happens when we are exercising and the cells give off large amounts of carbon dioxide. The amount of air reaching the air sacs of the lungs is also controlled to some extent by the size of the opening of the bronchial tubes. During periods of excitement or strenuous exertion under the influence of extra adrenalin produced by the body, these openings may enlarge, permitting an added supply of air to reach the air sacs.

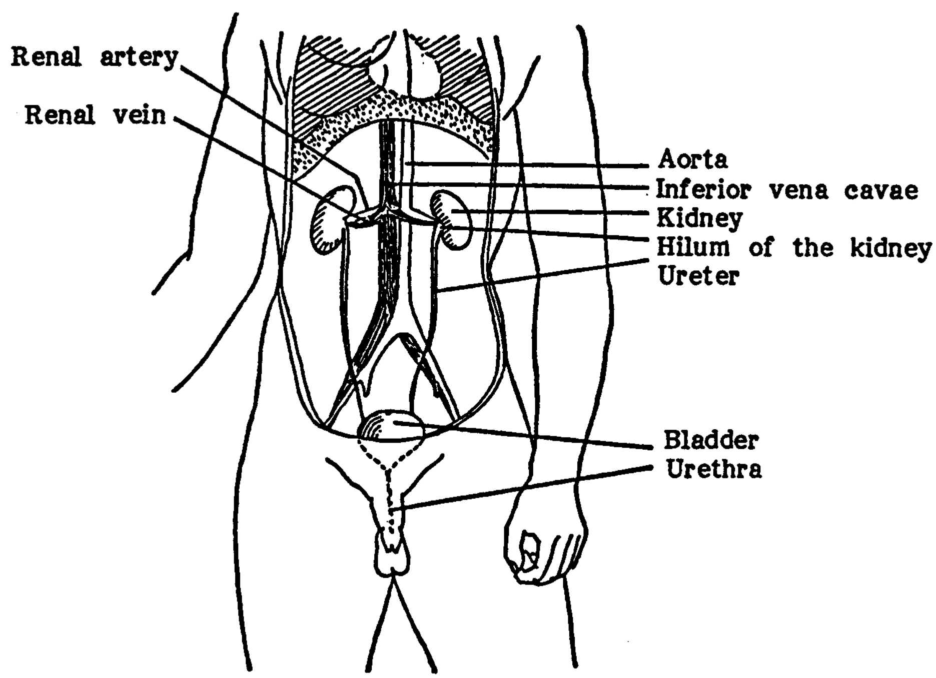
Section 5

THE EXCRETORY SYSTEM

Each organ and system does its specific job for the good of all. The digestive system prepares food for use by the cells. The circulatory system distributes food, oxygen, and other materials to the cells and removes carbon dioxide and other wastes. The respiratory system provides for the intake of oxygen and the excretion of carbon dioxide and water vapor. The excretory system completes the job of removing wastes from the body.

The Lungs

When food is oxidized by the cells, carbon dioxide and waste are given off as waste products. They diffuse out of the blood into the alveoli of the lungs and are carried out of the body in the exhaled air.



The Excretory System

The Kidneys

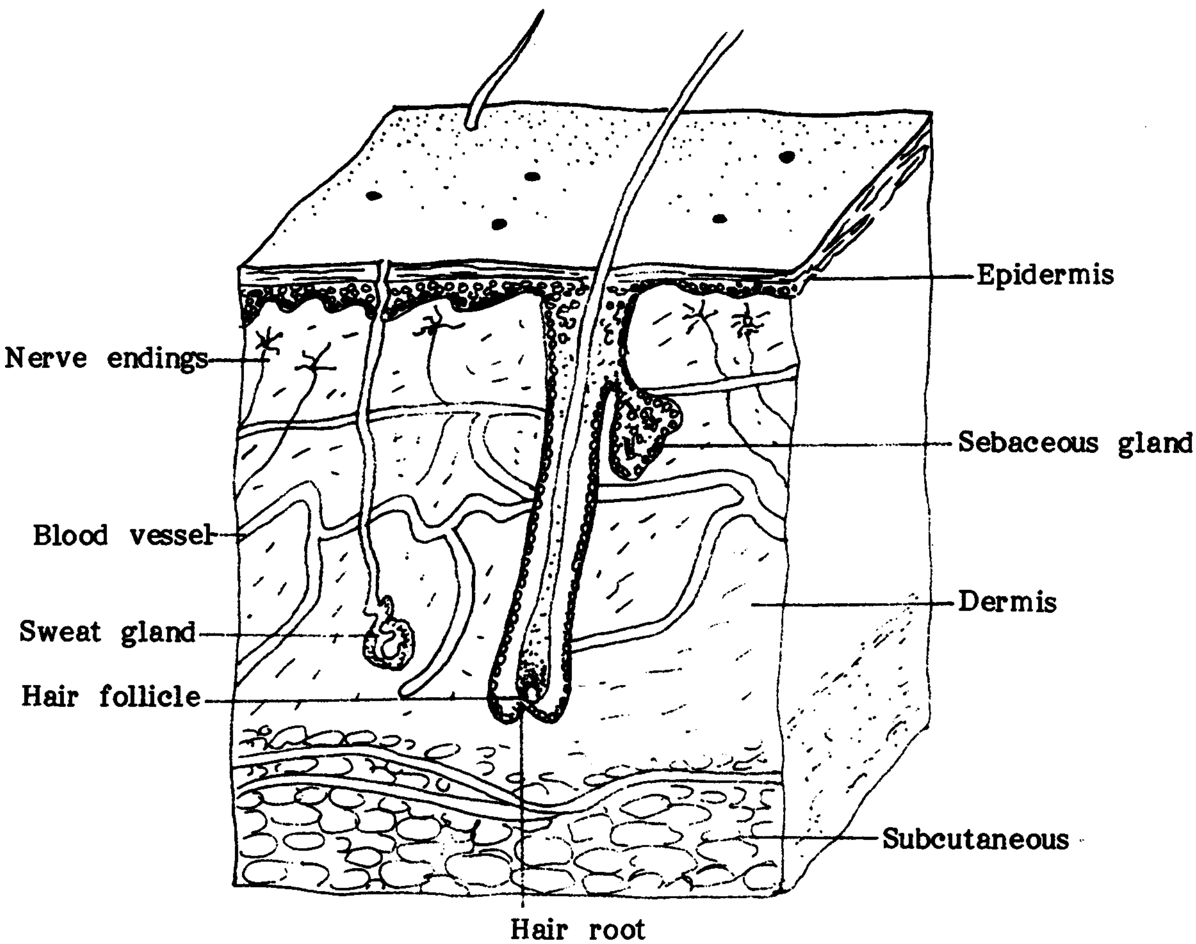
The two kidneys are dark red, kidney bean-shaped organs located above the small of the back. A large artery, the renal artery, carries blood containing a high percentage of wastes into each kidney. It branches into smaller blood vessels that become capillaries arranged in a dense network called a glomerulus. As the blood flows through each glomerulus, a plasma like liquid containing water, urea, salts, fatty acids, amino acids and glucose diffuses out. As this liquid moves along, water, minerals and the digestive end products are reabsorbed into the capillaries by active transport. The remaining liquid collects as urine. From here the urine passes out of each kidney into the urinary bladder. The urine leaves the bladder at intervals through a tube called the urethra.

Urine is about 95 percent water. The remainder is nitrogenous waste: urea, mineral salts, uric acid and other materials. Urea is produced as a waste when the liver breaks down amino acids in a process called deamination. The amino group is removed from the amino acid molecule through enzyme action and rearranged into ammonia. This is then combined with carbon dioxide and, through several reactions, becomes urea. The kidney is a vital organ for removing the waste materials that would otherwise poison the body. It also helps to maintain the correct balance of water and mineral salts in the body.

The Skin

Besides excreting water to maintain the balance of salts in the body and helping to regulate the temperature of the body, the skin has the following other functions:

1. Protection against the entrance of bacteria into the body.
2. Protection of its underlying tissues against mechanical injury and drying up.
3. Carrying sensations of outside stimuli such as touch, heat, cold and pain, by means of the nerve endings located within it.
4. Formation of Vitamin D upon exposure to ultraviolet rays.



Epidermis
Nerve endings
Sebaceous gland
Blood vessel
Dermis
Sweat gland
Hair follicle
Subcutaneous
Hair root

The Skin

Section 6

THE ENDOCRINE SYSTEM

The body carries on many activities with the help of its various organs and systems. These activities are all coordinated so that they go on at the proper rate, at the proper time, and in the proper amounts. For example, when food leaves the stomach and enters the small intestine, the pancreas and the liver send their secretions to join intestinal juices in digesting it. These digestive organs do not send their secretions until that time. How are they controlled?

1. By the secretion of secretin. Certain cells in the lining of the small intestine secrete a chemical substance called secretin when food enters from the stomach. Secretin diffuses directly into the bloodstream and is carried through the body. When it reaches the pancreas, it stimulates the digestive glands to produce pancreatic juice which pours into the small intestine through the pancreatic duct. Secretin thus serves as a chemical messenger, or hormone (endocrine). A hormone is a chemical produced in one part of the body that is transported to other parts where it exerts specific effects.

2. By other hormones in the alimentary canal. When food enters from the stomach, the lining of the small intestine secretes two other hormones that serve similar functions as does secretin:

   a. Cholecystokinin, which stimulates the gallbladder to contract and send bile into the small intestine.
   b. Enterocrinin, which stimulates the digestive glands of the small intestine to secrete intestinal juices.

Like secretin, these hormones are circulated in the blood stream. The beginning of digestion in the small intestine is coordinated by these three different hormones which are produced at the time food arrives from the stomach. The lining of the stomach itself also secretes a hormone (gastrin) when food enters it. Gastrin is carried in the blood stream to the digestive glands in other parts of the stomach which are stimulated to produce gastric juices.

Endocrine Glands

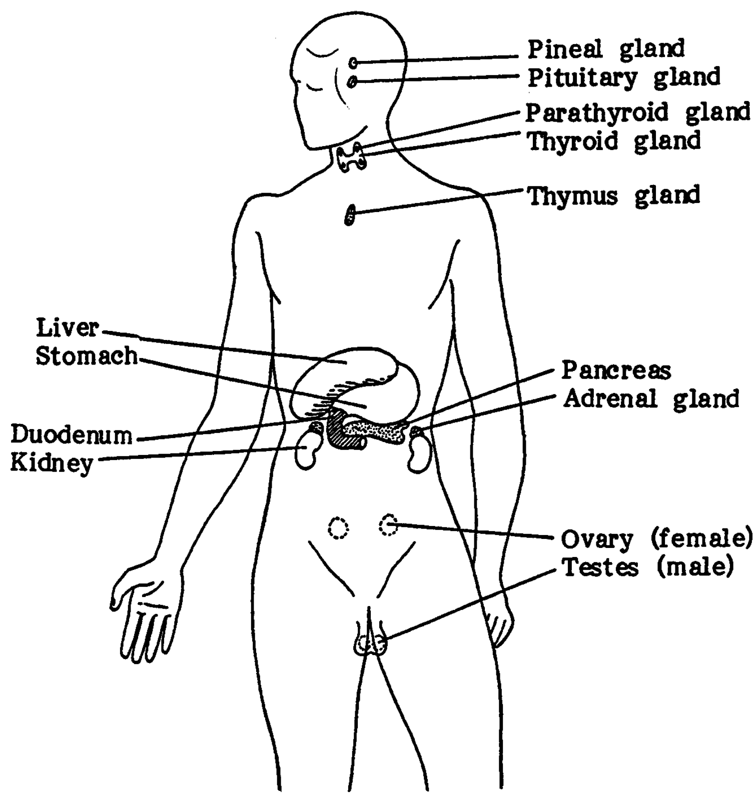
Endocrine glands are different from digestive glands (which have a duct leading to the digestive system) in that they are "ductless." Their secretions (the hormones) diffuse directly into the blood and are transported to other parts of the body where they are used for specific purposes. These endocrine glands include the thyroid and parathyroid, the pancreas, and adrenal and pituitary glands.

Thyroid Gland

The thyroid gland is located at the base of the neck below the larynx. It absorbs large amounts of iodine from the blood for making the hormone thyroxin. Thyroxin is brought by the bloodstream to all the cells of the body where it controls the rate at which oxidation takes place and energy is released.

The Parathyroid Glands

There are four small parathyroid glands located next to the thyroid gland. They secrete the hormone parathormone which regulates the absorption and use of the element calcium by the body. It is also important in bone formation. If it is lacking, the muscles do not function properly and the individual may develop a case of involuntary muscle contractions or convulsions known as tetany. This can be relieved by calcium salts.



The Endocrine System

The Pancreas

In addition to producing pancreatic juice, the pancreas secretes the hormones insulin and glycogen. The value of insulin to the body is:

1. It helps the cells to utilize glucose for energy.
2. It causes the liver to convert excess glucose in the blood into glycogen for storage.

In these ways the amount of glucose in the blood is always reduced to a constant level. Glycogen, a recent discovery, seems to counteract insulin. It increases the blood level of glucose by causing the liver and small intestine to release it.

The Adrenal Glands

The adrenal glands are located on top of the kidneys. They consist of two parts: 1) the medulla, or inner section, and 2) the cortex, or outer layer.

1. Medulla. The medulla produces the hormone adrenalin. During periods of great emotional stress, such as anger or fear, a large amount of adrenalin is secreted into the bloodstream which causes the following:
   a. The liver is stimulated to convert glycogen to glucose.
   b. The heart beats faster.
   c. The smooth muscles of the blood vessels contract, causing an increase in blood pressure.
   d. The breathing rate is increased.
   e. The blood vessels in the skin and the digestive system contract, and digestion is reduced.
   f. The clotting rate of blood is sped up.
   g. There is an increase in energy, strength and alertness.
2. Cortex. At least thirty hormones are secreted by the cortex of the adrenal glands! In general, they seem to be important in maintaining the proper balance of liquids and mineral salts in the body; they also play a role in carbohydrate metabolism. One of them, cortisone, plays a role in the healthy condition of the cartilage in the joints between the bones. Cortin is another hormone of the cortex. It appears to control the use of water and salts by the cells. It also affects blood pressure. Other hormones of the cortex appear to have an influence on the development of secondary sexual characteristics.

Pituitary Gland

This gland is about the size of a pea and is situated at the base of the brain. It has three main parts. Despite its small size, it secretes many hormones that interact with and control the other ductless glands. For this reason it is referred to as the "master gland." Some of its hormones have the following effects:

1. ACTH (adrenocorticotropic hormone) stimulates the cortex of the adrenal gland to produce a number of hormones, including cortisone.
2. Growth hormone promotes the growth of the body. In rare cases too much or too little of it may be produced in children. If there is an excess of it, a child continues to grow to extraordinary height (gigantism); if there is too little, the child remains a midget (dwarfism).
3. Prolactin is a hormone from the anterior (front) part of the pituitary that stimulates the mammary glands to produce milk.
4. Another hormone stimulates the thyroid gland to produce thyroxin.
5. One of the hormones from the posterior pituitary (pitocin) stimulates contraction of the smooth muscles of the uterus during childbirth.
6. Other hormones interact with the reproductive organs — the testes and the ovaries (gonads) — and stimulate them to develop and to produce, additional hormones.

Thymus Gland

This is a large gland in children and is located in the chest. It decreases in size with age. It is thought to play a part in growth and development, but this has not been confirmed. Recent evidence indicates that the thymus plays a role in antibody production and immunity.

Pineal Gland

Another gland of which we have little understanding is the pineal, located in the brain. Its function is not known.

COORDINATION OF THE BODY'S ACTIVITIES

Very small amounts of the hormones are needed, yet they play an important part in regulating various activities of the body. The ductless glands not only stimulate some of these activities, but they also interact with each other. Thus, in the oxidation of glucose, thyroxin regulates the rate of oxidation; insulin permits the cells to oxidize glucose and stimulates the liver to store it as glycogen; adrenalin stimulates the liver to convert glycogen back into glucose and stimulates the rapid oxidation of glucose; the pituitary hormones control the thyroid and adrenal glands.

Section 7

THE NERVOUS SYSTEM

The nervous system of man is a complex communication system that branches throughout his billions of cells, receiving and sending messages, and directing his numerous voluntary and involuntary activities. The nervous system is organized into several parts: the central nervous system — consisting of the brain, spinal cord and nerves— the autonomic nervous system, and the sense organs.

NEURONS

The nervous system is composed of neurons, or nerve cells, which are specialized to possess the property of irritability. There are three chief types of neurons:

1. Sensory (afferent) neurons transmit impulses from various sense organs (eye, ear, skin, etc.) to the brain or spinal cord.
2. Motor (efferent) neurons transmit impulses from the brain or spinal cord to muscles, causing them to contract, or to glands, stimulating them to secrete.
3. Associative (connective) neurons make connections between sensory, motor and other associative neurons; they are found in the brain and spinal cord.

Structure of a Neuron

Neurons are quite different in appearance from the other cells of the body. A motor neuron has a cell body (or cyton) containing a nucleus and most of the cytoplasm but also spreading out from it are many branched, threadlike dendrites. The motor neuron has a very long extension (the axon) which may be several feet long even though it is microscopic, along with a white, fatty covering (the axon sheath, or myelin sheath) which insulates it. The end of the axon branches into an end brush which lies in a muscle or gland. Although the other two types of neurons are somewhat different in their appearance from a motor neuron, they are basically alike in their structure. Axons of thousands of neurons are arranged in bundles called nerves, as they leave the brain or spinal cord.

Nerve Impulse

Neurons have a high degree of irritability. They transmit messages, or impulses, along their length and from one neuron to another at the rate of over 300 feet a second.

Their transmission is accompanied by the use of oxygen and the excretion of carbon dioxide. There is a change in the balance of sodium and potassium ions along the length of the neuron. Heat energy is released. In addition to this chemical reaction there also is an electrical charge which can be measured. A record taken of electrical impulses occurring in the brain is called an electroencephalograph (EEG).

Synapse

Neurons are not connected with each other like the wires in an electrical circuit. Instead, the end of an axon lies very close to the dendrites of another neuron, forming a branched network in which the fibers do not touch but are almost connected. This area is called a synapse. The direction of flow of an impulse is always from the axon of one neuron across a synapse into the dendrites of another neuron.

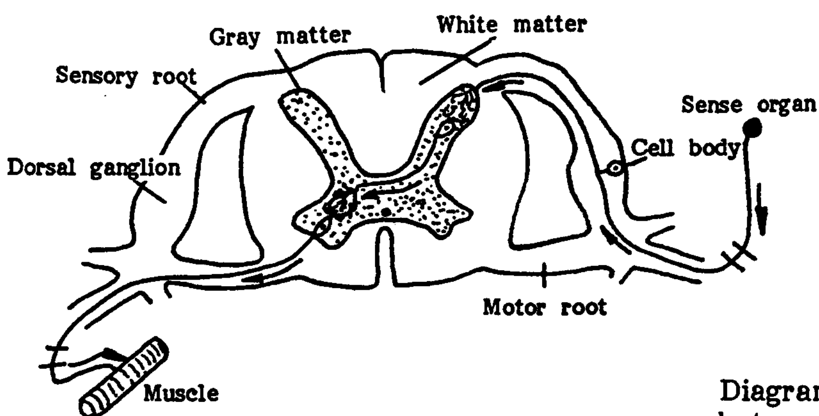
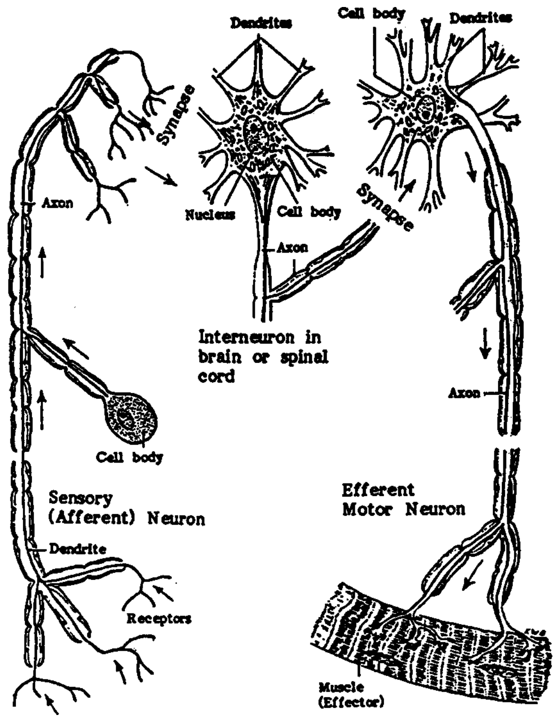


Diagram showing the relation between the spinal cord and spinal nerves.

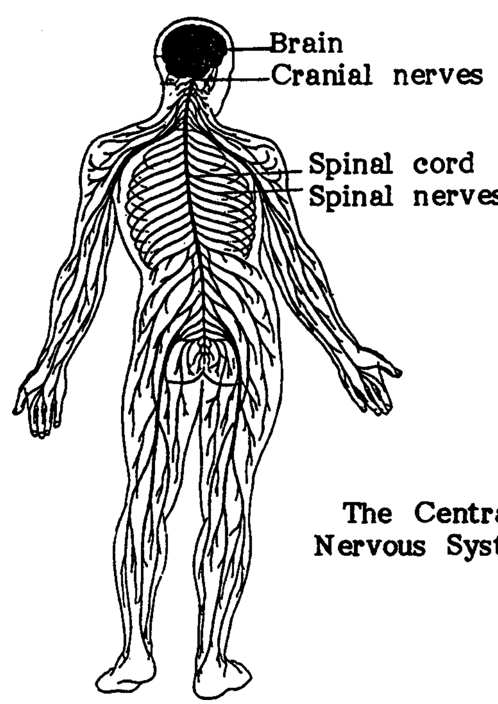
Reflex Arc

During an actual reflex, many more neurons of all three types (sensory, motor, and associative), as well as many muscle fibers, are involved. It takes only a moment for the arm to be withdrawn quickly and the finger saved from the flame. There is no thought involved in this reflex act. It is centered in the spinal cord. The individual becomes aware of the incident when the associative neurons of the spinal cord send impulses along each other up to the brain. Many neurons now become involved, as there is thought about it; thus a sensation of pain. It is interesting to note that although countless neurons are located closely next to each other, the impulses take just the right path.

Diagram representing three types of neurons. Each neuron has three parts: a cell body and two types of extensions, dendrite(s) and axon.



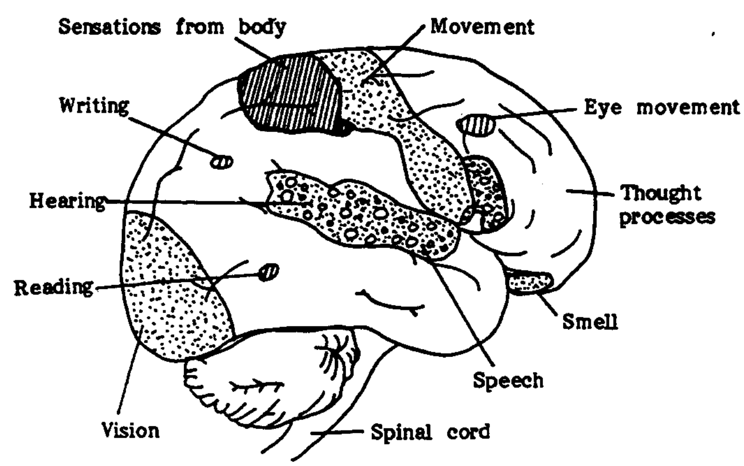
THE SPINAL CORD



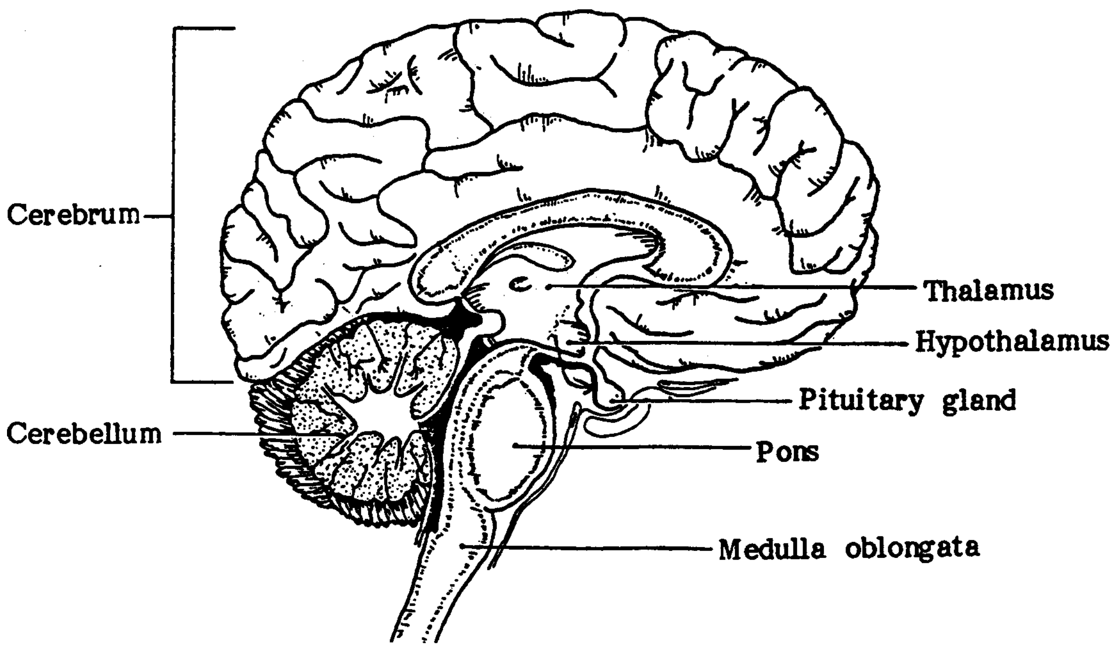
The Central Nervous System

The spinal cord runs down the length of the back from the brain and is enclosed in the vertebrae — the bones of the backbone. There are 31 pairs of nerves that leave the spinal cord and branch out to the body. One of them, the sciatic nerve which runs into the leg, is the largest in the body and is as thick as a pencil. The center of the spinal cord has a butterfly-shaped mass of gray matter which contains the cytons of the neurons. Surrounding it is the white matter in which the axons are located. One of the functions of the spinal cord is to serve as the pathway for impulses from the brain to the various parts of the body and back. Another function (as mentioned in the description of the reflex arc) is to serve as a center of reflex actions.

THE BRAIN



Some of the centers in the cerebral cortex.



Parts of the brain.

The brain of man is the largest and most highly developed of all the animals. It is protected by the skull, or cranium, and lies enclosed by a layer of fluid. It is covered by three sets of membranes, the meninges. These also cover the spinal cord. When they become infected, the disease meningitis results. There are twelve pairs of nerves (the cranial nerves) that branch out from the brain. They include the optic nerve, which brings sight impulses to the brain from the retina of the eye; the auditory nerve, which transmits sound sensations from the ears; and the olfactory nerve, which carries the sensation of smell from the nose.

The number of neurons in the brain is fixed at birth and does not change. However, there is an increase in the number of dendrites and neuron connections as an individual grows. The brain consists of three main areas: 1) the cerebrum, 2) the cerebellum, and 3) the medulla.

1. Cerebrum. This is the largest part of the human brain. It has two halves known as cerebral hemispheres. The surface has many folds, or convolutions, which increase the volume of the cerebrum. The outer part, the cortex, contains gray matter which is made up largely of cytons. The white matter is within this layer, and it contains nerve fibers, or axons. This arrangement is the reverse of the spinal cord where the white matter is on the outside of the gray matter.

The cerebrum is the seat of intelligence and thought. It gives us the ability to learn, reason and remember. It helps us create great music, literature, art and scientific theories. Various areas of the cerebrum have been mapped. Electrical impulses called brain waves can be recorded from the cerebral cortex. In a person who is awake but not thinking hard, continuous waves can be recorded at a frequency of about 10 per second. These are called alpha waves. When a particular part of the brain becomes very active, for example the motor area, additional beta waves of higher intensity and frequency are formed. During sleep only a few straggly delta waves can be recorded.

2. Cerebellum. Below the cerebrum, in the rear of the cranium, is the smaller cerebellum. It coordinates movement of the voluntary muscles so that they work together. The control of the body's balance is also centered in the cerebellum.

3. Medulla. The part of the brain located at the top of the spinal cord is the medulla. It is the center for breathing and heartbeat. When it is stimulated by the presence of increased amounts of carbon dioxide in the blood, it sends impulses to the diaphragm and chest muscles which speed up the rate of breathing. The medulla also serves as the area through which impulses travel from the spinal cord into the brain and back. Certain reflexes, such as blinking, sneezing, swallowing, and the secretion of salivary juice, are centered in the medulla.

AUTONOMIC NERVOUS SYSTEM

We usually are not aware of the autonomic nervous system because it controls the internal, involuntary functions. It consists of masses of cytons called ganglia which are located on either side of the backbone. This chain of ganglia is connected by nerves with the spinal cord on one side and the internal organs on the other. There are also nerves connecting them with clusters of ganglia called plexuses, located in several parts of the body, which serve as local centers of control. The solar plexus is located near the stomach; others are located at the heart, in the lower part of the abdomen, and the side of the head.

The involuntary actions controlled by this system of ganglia and plexuses include heartbeat, secretion of digestive juices, size of the opening of the blood vessels, sweating rate, peristalsis, and the size of the pupil of the eye. Emotions such as anger, fear and joy, which stimulate the production of adrenalin, act on the autonomic nervous system first, which in turn sends impulses to the adrenal glands causing them to secrete.

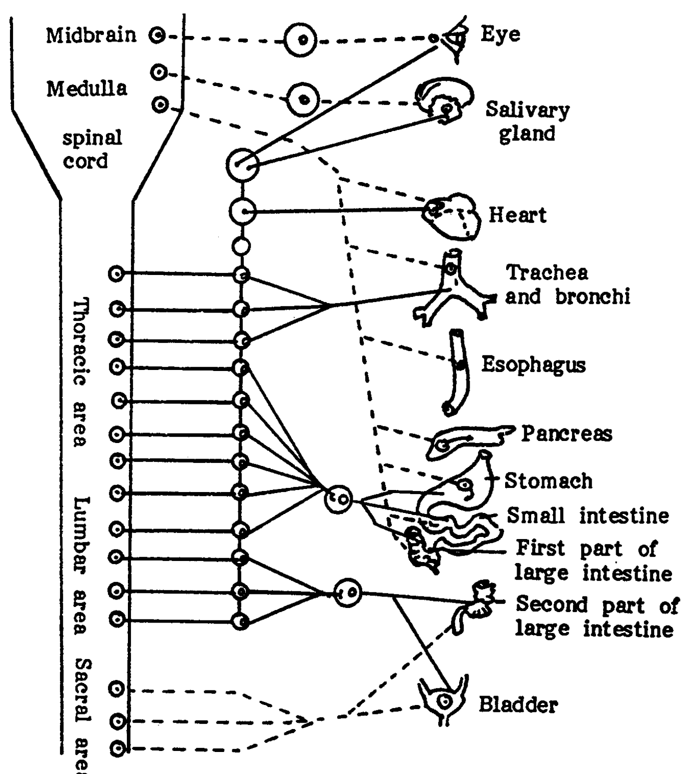
There are two sets of nerves to the inner organs: one stimulating them to action, the other causing them to relax. Thus, peristalsis of the digestive tract is stimulated by certain nerves of the autonomic system. The end brushes of the motor neurons secrete acetylcholine which has a stimulating effect on the smooth muscles. There are also, however, nerves whose end brushes secrete a substance like adrenin, which inhibits and slows down peristalsis. The secretions of the glands, contractions and relaxations of the heart, the size of the bronchioles in the lungs, the extraction of urine by the kidneys, and the other internal activities are similarly regulated by this balance between the nerves of the autonomic nervous system.

SENSE ORGANS

The sense organs are specialized to receive impulses from the outside. For this reason they are known as receptors. They are sensitive to a specific type of stimulus. The sense organs include:

1. Eyes, which are sensitive to light;
2. Ears, which are sensitive to sound;
3. Olfactory nerves in the nose for smelling;
4. Taste buds in the tongue for tasting;
5. Receptors for pressure, pain, heat and cold on the skin.

There are also internal receptors such as those that give us the sensation of hunger when the stomach is empty and a sense of balance in the muscles.



Organs of the body stimulated by the autonomic nervous system.

COMPARISON OF THE NERVOUS AND ENDOCRINE SYSTEMS

The nervous and endocrine systems are similar in that they both:

1. Secrete chemical messengers.
2. Play a major role in maintaining homeostasis.

On the other hand, the nervous and endocrine systems are different in the following ways:

1. The responses of nerves are much more rapid than those caused by endocrines.
2. The responses of nerves do not last as long as those caused by endocrines.
3. Nerve impulses are transmitted along neurons; hormones are carried in the plasma of the transport system.

SUMMARY OF THE NERVOUS SYSTEM

STRUCTURE FUNCTION

Brain:

Cerebrum:

Controls thought, reasoning, memory, voluntary activities, sensory areas for sensation, motor areas for voluntary movement.

Cerebellum:

Coordination of muscles; balance.

Medulla:

Controls breathing, heartbeat and certain reflexes (blinking, sneezing, swallowing, salivary secretion)

Spinal Cord:

Pathway for impulses to and from the brain; center of reflex actions.

Autonomic Nervous System:

Regulates internal activities: heartbeat, peristalsis, kidney action, glandular secretion, size of bronchioles and blood vessels.

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ANATOMY AND PHYSIOLOGY FOR YOGA TEACHERS

A comprehensive understanding of human anatomy and physiology is essential in becoming a knowledgeable yoga teacher and addressing the needs of your students. As a preparation for an in-depth study of human anatomy as it relates to yoga asana, you will need to become thoroughly familiar with the different parts of the muscular and skeletal systems, and the basic physiology of the body.

This month you will begin your study by familiarizing yourself with the parts of the human anatomy which are listed below. You will need to be able to identify each one on an anatomical diagram, and in some cases, to describe its function. To gain this knowledge, you will be referencing Green's *Human Anatomy* and reviewing pages 1-42 of this section. You may also want to reference *The Breathing Book* and *Yoga, the Iyengar Way*. These texts will familiarize you with the terminology which we will be using to discuss the body and its structures.

1. Parts of the Foot
2. Parts of the Pelvis
3. Femur
4. Humerus
5. Sacrum
6. Sternum
7. Scapula
8. Perineum
9. Soft Palate
10. Quadriceps
11. Hamstrings
12. Biceps
13. Triceps
14. Trapezius
15. Groin
16. Coccyx
17. Gastrocnemius
18. Achilles Tendon
19. Sections of the Spine
20. Patella
21. Internal Organs*
22. Floating Ribs
23. Latissimus Dorsi
24. Rhomboids
25. Endocrine System
26. Radius
27. Ulna
28. Septum
29. Deltoids
30. Psoas
31. Diaphragm
32. Fibula

* large intestine, small intestine, liver, spleen, pancreas, kidneys, adrenals, heart, lungs, thymus, pineal, pituitary, diaphragm, thyroid, parathyroid

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TERMS AND ACTIONS

Groin depth
The groin is the crescent-shaped crease between the thigh and hip. If the femur is towards the quadriceps, the groin will feel tight and full. The natural placement for the femur is toward the hamstring. This placement creates depth to the crease of the groin.

Groin length
Once the groin depth has been established, length can be created between the pelvic rim and the thigh without disturbing the depth of the groin.

Femur grounding
Bringing the head of the femur into the center of the back of the hip socket.

Extension
In asana terms, extension can be used generically; it can be used to describe the lengthening of any body part. When referring to the spine, extension means that the front of the spine is longer than the back of the spine.

Flexion
More generically, flexion can be used to refer to any muscular contraction. When referring to the spine, flexion means that the back of the spine is longer than the front of the spine.

Internal rotation
Referencing from the front body, internal rotation of the legs is when the outer leg rotates towards the inner leg. Often, in asana terms, this term is also used to refer to the neutral position of the legs.

External rotation
1. Using the front of the body as a reference, external rotation of the legs is when the inner leg rotates towards the outer leg.

2. Using the front of the body as a reference, external rotation of the shoulder is when the inner arm rotates towards the outer arm. If the arms are extended over the head,

the action of the arms is reversed, though the action in the shoulder joint is the same. This seeming reversal of the action is only perceptual, caused by the change in arm position.

Lordosis
This is the natural concavity of the lumbar and cervical spine. If the concavity is greater than normal, the term "hyper" is used as a prefix. If the concavity is less than normal, the term "hypo" is used as a prefix.

Kyphosis
This is the natural convex state of the thoracic and sacral areas of the spine. If the convexity is greater than normal, the prefix "hyper" is used. If the convexity is less than normal, the prefix "hypo" is used.

Scolliosis
This is a lateral curvature of the spine. It is an anomaly of the spine of which there are many variations.

Muscle tone
Good muscle tone is a muscle's ability to hold a partly contracted state for a given period of time and then relax again. If a muscle cannot fully relax, it is said to be hypertonic. If a muscle cannot flex effectively, it is said to be hypotonic. It is possible for a muscle to have some element of both hyper and hypo tone.

Action and resistance
In order to control any action, some form of resistance is needed. Begin to observe throughout your asana practice where the resistance comes from to stabilize each action.

Action
This term implies an isometric movement. This means that there is no overt movement of any part of the body, but there is still activity in the musculature.

Movement
This term implies that some part of the body is actually changing its position.