

2. Describe the *capillaries*, their structure, and action in regard to nutrition and respiration.
3. Describe the *veins*, their structure and action.
4. Describe the pulmonary circulation and the portal circulation.
5. Give the time required for a drop of blood to make the complete round of the circulation.
6. Describe the lymph, the lymphatics, the flow of lymph, and the use of lymph.
7. Describe *lymph nodes* and give their use.
8. Describe the circulation in reptiles and toads, in fishes, in insects, in shellfish, in the ameba.
9. Give an outline of ancient ideas concerning the circulation of the blood, and tell when and by whom the true circulation was discovered.

CHAPTER XXI

REGULATION OF THE FLOW OF BLOOD

316. Vaso-motor nerves. — The muscles in the walls of the smaller arteries regulate the amount of blood passing through them. A special set of nerves, called *vaso-motor nerves*, causes the arteries to contract. When these nerves are paralyzed, the muscles relax, and the artery becomes fully distended by the pressure of the blood. When any part of the body is working, its arteries dilate in order to supply a greater amount of blood to the part.

The vaso-motor nerves are affected by influences from the brain. Embarrassment and bashfulness paralyze those of the head, so that more blood goes to the face and it becomes redder, or blushes. On the other hand, fear and grief stimulate the nerves and cause a contraction of the arteries, which drives the blood from the face so that paleness results. *Heat* applied to the skin causes the arteries to *dilate*, and thus to contain more blood.

317. Congestion. — More than the natural quantity of blood remaining in a part for some time is called *congestion*. It is liable to injure the cells. Cold causes the arteries of the skin to *contract* so that less blood can pass through them. The blood intended for the skin is thus directed through the deeper arteries which already contain their full amount of blood. So congestion of the deeper parts often results. In this way we get cold in our throats.

318. Secondary effects of heat and cold. — When heat has acted upon the skin for some time it causes a contraction of the blood tubes. When first put into a tub a washerwoman's hands become

red, but in a few moments they become white and shriveled from the contraction of the arteries.

When cold has acted upon the arteries for some time it paralyzes them so that they dilate. When a boy begins to snowball, his hands are cold, but after a while his hands glow with redness and warmth because the paralyzed tubes admit more warm blood.

319. Effects of injury upon the arteries. — When injured in any way, the injured part becomes red and warmer. This is because the same cause which produces the injuries also partly paralyzes the smaller arteries, so that they dilate and bring an extra quantity of blood for the repair of the wounded part. Here, as elsewhere, nature wonderfully adapts the body to its surroundings.

320. Nature's arrest of hemorrhage. — Cut capillaries cause only an oozing of blood which collects like drops of dew over the whole cut surface. Blood does not spurt from a cut vein, but wells out in a slow stream. When an artery is cut, the blood flows in a strong jet. Bleeding from either of the vessels usually stops in a few moments. The muscles of the blood tube contract and lessen the size of the tube, or even entirely shut it up; the blood also clots in the cut, and a small plug of clot extends into the end of the blood tube. In these two ways bleeding from small cuts is soon stopped naturally. But in a large artery the blood pressure is so great that it forces away the clot as fast as it is formed, so that bleeding may continue until death occurs.

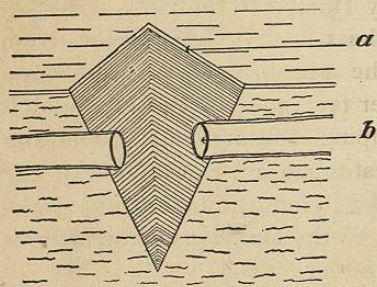
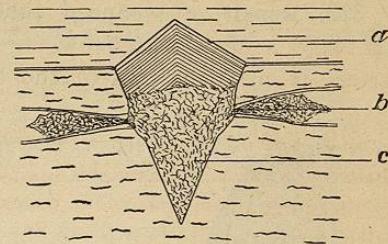


Diagram of a bleeding cut.

a upper edge of a cut.
b a cut blood tube.

321. How to stop a bleeding. — It should be remembered that sufficient pressure will instantly stop any bleeding.

If a hand is placed on each side of the cut, so as to hold its edges firmly together, no bleeding can occur. A second way of stopping bleeding is by pressing a handkerchief, or a finger, or even the whole hand, into the wound. A third way in which bleeding may be stopped is by cutting off



Natural stoppage of bleeding.

a upper edge of a cut.
b blood tube, showing its contracted cut end filled with a clot.
c blood clot.

the supply of blood to the part. This may be done by tying a handkerchief very tightly around the limb between the wound and the heart. The knot in the handkerchief should lie over the artery, and, if necessary, a stick may be inserted under the band and twisted tightly. Of these three ways of stopping bleeding, that of compression by the hands is the best to use at first.

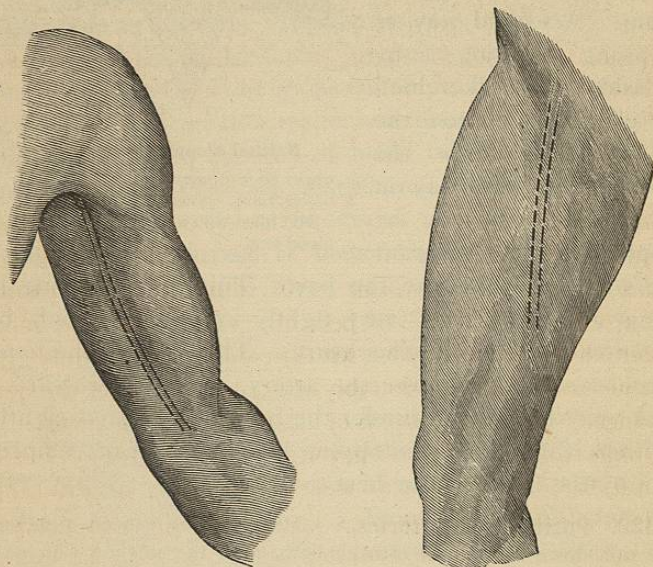
322. Position of arteries. — Main arteries run in a general direction down the middle of each limb, upon the side on which the limb can be bent. Thus in the upper part of the arm, the artery runs across the center of the armpit, and then down the inner side of the upper arm. At the elbow it lies in the center of the front side of the arm. An artery lies upon the thumb side, and another upon the little finger side of the front of the wrist.

In the leg the main artery lies in the middle of its upper part, and reappears at the surface in the middle of the bend of the knee. At the ankle it is divided into two, one of which is just behind the inner ankle bone, and the other runs down the middle of the front of the foot.

There is a large artery and a large vein in the middle of each side of the neck. These positions should be remembered, for they are the principal places in which a large blood tube is likely to be wounded,

and they mark the course of the tubes in case they should need to be compressed to stop bleeding.

323. Repair of wounded tubes.—When a vein is cut in two, its ends may grow together again, but when an artery is cut, each end of the tube remains permanently



The left upper arm.

The dotted line indicates the course of the main artery (the brachial).

The right thigh.

The dotted line indicates the course of the main artery (the femoral).

closed, and thus the supply of blood to the part is at least partly cut off. Branches from an artery communicate with other branches which begin a few inches further down the same artery. When the artery is cut, these communicating branches enlarge, and thus permit the natural amount of blood to flow around the wound and

so reach the artery below the cut. When capillaries are cut, a new set is produced to take their place.

324. Effect of tight bands.—A tight band will obstruct the flow of blood in the veins, while, unless it is very tight, it scarcely affects the arteries. So the blood freely enters a part through the arteries, but is held back in the veins below the band, until the part is distended with blood, and the proper amount of new arterial blood is prevented from entering. As a result the nutrition of the part suffers and slight injuries do not heal readily. The veins swell from the extra amount of blood they contain, and finally enlarge in places, forming what are called *varicose veins*. Tight garters are common offenders in this respect.

325. Alcohol and arteries.—When a cup of hot coffee is swallowed, the temperature of the stomach and of the blood in its walls is raised. Then nature at once causes the arteries of the skin to become enlarged so that more blood may come in contact with the cool air, and thus give off the surplus heat. Probably in the same manner the heat produced by the destruction of alcohol causes the arteries of the skin to dilate so that they contain an excess of blood. A red face and nose are well-known signs of drinking. This dilation of the arteries is one of the most marked and constant effects of drinking.

326. Alcohol and the nutrition of cells.—Naturally, when a part of the body is at work, its blood tubes become larger, while those of the resting parts become smaller. If the blood tubes of distant parts remain large, there will not be sufficient blood to fill those of the working part, and thus the part will not be able to put forth its full strength. If a part is injured, it cannot get enough extra blood to repair itself quickly. Thus wounds will be apt to heal slowly, while inflammation will be more likely to set in.

If a part is continuously supplied with an excess of blood by dilated arteries, there is apt to be an overgrowth of some of its tissues, especially of connective tissue. An excess of this tissue interferes with the action of the working cells of the part. This change is apt to occur especially in the arteries themselves, making them thick and hard. It naturally comes on during old age, but is often hastened by the use of strong drink. The affected arteries cannot change their size, and so the parts which they supply suffer in nutrition. Although an excess of blood may go to a part, yet it is not renewed so often as it should be.

SUMMARY

1. The muscles in the arteries give them the power of becoming smaller or larger in order to regulate the amount of blood going to any part of the body.
2. The contraction and relaxation of the arteries is controlled by a set of nerves called vaso-motor nerves.
3. Heat, cold, work, and mental influences are a few causes which excite the action of the arterial muscles.
4. Contraction of arteries near the surface and dilatation of the deeper ones is the common cause of taking cold.
5. Alcohol causes a paralysis of the muscles of the arteries so that they may remain permanently enlarged. The arteries of the face and stomach are most affected.
6. Small blood tubes, when cut, bleed for a moment until the ends of the tubes contract and a clot plugs them up completely.
7. Large blood tubes may bleed until death occurs. Bleeding can always be stopped by grasping the part boldly and firmly.

8. Large blood tubes run down the middle of the limb upon the side toward which the limbs are bent.
9. Tight bands obstruct the flow of blood going from a limb, but permit blood to enter. Thus the limb swells and the veins enlarge.

DEMONSTRATIONS

78. The effect of injury upon the arteries can be illustrated by scratching the arm with the point of a pin. In a few seconds a bright red mark appears in its track.

79. Hold the hand in a basin of hot water. Notice that at first the skin is red from the dilatation of the arteries. In course of ten minutes the skin becomes white and puckered, because heat has a second effect of contracting arteries.

80. Show how bleeding can be stopped, by boldly grasping an imaginary cut and holding its edges tightly together. Show how a band can be tied loosely around a limb above a cut, and then by means of a stick inserted under the band, can be twisted as tightly as one pleases so as to control bleeding.

REVIEW TOPICS

1. Describe *vaso-motor nerves*.
2. Show how vaso-motor nerves are affected by influences from the brain; by heat and cold; by injuries.
3. Describe congestion and how it is caused by cold.
4. Give the effects of alcohol upon the contraction and dilatation of the arteries.
5. Give the difference between arterial, capillary, and venous bleeding.
6. Describe how bleeding naturally stops.
7. Describe three ways of stopping bleeding.
8. Describe how nature restores the circulation after an artery is cut in two; after a vein is cut; and after capillaries are cut.
9. Give the effect of tight bands upon the circulation of a limb.