

PHYSIOLOGY AND MEDICINE.

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PHYSIOLOGY OF THE CIRCULATORY SYSTEM.

THE blood consists of two elements, fluid and solid: the fluid part is called *plasma*; the solid part takes the form of little bodies called *corpuscles* which are suspended in the plasma. These corpuscles are of two kinds, red and white, the red being about five hundred times as numerous as the white. The amount of blood occupied in a cubic space, the sides of which measure $\frac{1}{8}$ inch in length, contains about 5,000,000 red and about 10,000 white blood corpuscles. The latter are more subject to variations in number in health; only 5,000 may be found in the above cubic area and yet the blood be quite healthy. The red blood corpuscles are about $\frac{1}{2500}$ inch in diameter; they give the colour to blood. The white blood corpuscles are somewhat larger than the red, and are of different kinds. The amount of blood in the body has been taken as approximately $\frac{1}{12}$ of the weight of the individual, but according to recent investigations the amount is said to be about $\frac{1}{9}$ of the body weight.

When blood is shed, it coagulates, the resulting constituents being *blood clot* and *blood serum*. If the clot is examined under a microscope it is seen to consist of a dense network of a stringy substance, called *fibrin*, entangling the blood corpuscles.

$$\text{Blood} = \left\{ \begin{array}{l} \text{plasma} = \left\{ \begin{array}{l} \text{blood-serum} \\ \text{fibrin} \dots \dots \dots \end{array} \right\} \\ \text{corpuscles} \dots \dots \dots \end{array} \right\} = \text{blood clot.}$$

The blood has three very important functions to perform—(1) to bring nourishment to the tissues in all parts of the body, (2) to remove waste products from the tissues, and (3) to defend the body from injurious foreign substances and microbes. Water and food materials enter the blood from the gastro-intestinal tract; and oxygen, which is also necessary for the life of the tissues, enters from the lungs. Carbonic acid is removed from the blood by the lungs and other waste products chiefly by the kidneys and sweat glands. The colouring matter (*hæmoglobin*) of the red blood corpuscles carries the oxygen and readily gives it up to the tissues; the plasma contains the carbonic acid in solution. One of the chief functions of the white blood

es is to defend the body, one variety of these corpuscles having the special name of *phagocytes* from their propensity to swallow and other foreign bodies. In order that nourishment may be carried to all parts of the body and protective forces carried expeditiously wherever part of the body is attacked and in order that waste products be promptly removed from the tissues to the excretory organs, the blood circulate.

CIRCULATION of the blood is meant the flow of blood through blood to all parts of the body and its return therefrom. The heart maintains the flow, acting like a pump and discharging blood intermittently—about 75 times per minute. The circulatory apparatus includes besides the heart, arteries, capillaries and veins (comprising the blood vascular system) and lymphatic vessels, lymphatic glands, and lymph spaces (comprising the lymph vascular system). An artery is a vessel which carries blood from the heart; a vein, one which carries blood to the heart: an artery does not necessarily carry bright red arterial blood;—the pulmonary artery, for instance, contains dark venous blood.

Course of the Circulation.—After birth there is no direct communication between the left and right sides of the heart: the right side contains impure dark venous blood; the left, pure bright red arterial blood. The venous blood is brought to the right auricle by two large veins, one vein bringing blood from the veins of the head and upper limbs, the other bringing blood from the veins of the abdomen and lower limbs. From the right auricle the blood enters the right ventricle and from there is driven through the pulmonary artery to the lungs to be purified (give up carbonic acid and take up oxygen). The purified blood is brought from the lungs through the pulmonary veins to the left auricle of the heart. From the left auricle it enters the left ventricle and thence the aorta and other large arteries of the body. From the large arteries the blood is carried through smaller and smaller arteries, the smallest arteries being called arterioles, till it reaches the smallest of all the blood vessels, the capillaries. It is here, in the capillaries, that the interchange of material between the blood and tissues takes place. In the arteries the flow of blood was intermittent; between the minute arteries and the capillaries, owing to the very high resistance of the ultimate arterioles, the flow gradually becomes constant: and this constancy in flow favours the interchange of material between blood and tissues. From the capillaries the blood enters the veins and is conveyed back to the heart.

The lymph in the lymph spaces of the tissues is derived from the blood plasma, some of the more watery (*i. e.*, with small molecules) constituents of the plasma exuding from the walls of the capillaries and entering the lymph spaces. From the lymph spaces, the lymph may to some extent re-enter the capillaries and smallest veins and so reach the heart; but most of the lymph on leaving the lymph spaces enters the lymphatic vessels and after passing

through one or more lymphatic glands, which act like sieves, is carried in one of two large lymphatic vessels, which enter the jugular veins one on each side of the neck, and is thus brought back to the heart. Any poison introduced into the body is absorbed with the lymph from these lymph spaces and conveyed towards the heart by the lymphatic vessels; but before it can enter the veins at the root of the neck it has to pass through one or more lymphatic glands situated in the course of the lymphatic vessels. These lymphatic glands, which contain many cells identical with one variety of the white blood corpuscles, are sometimes able to arrest and destroy the poison which may thus be prevented from entering the blood circulation. The lymphatic glands, however, during this defensive action may become enlarged and inflamed, as is often seen in the case of the axillary glands after a dirty wound of the hand.

Fœtal Circulation.—The circulation of the blood before birth differs from that after birth. Before birth there is a direct communication between the right and left auricles, by the *foramen ovale* which closes after birth. There is also a direct communication between the pulmonary artery and the aorta. The fœtus is nourished by the mother's blood. Nourishment, including oxygen, passes from the mother's blood through the placenta into the blood of the fœtus; similarly waste materials from the tissues of the fœtus pass through the placenta into the mother's blood to be excreted by the mother's kidneys and other excretory organs. The actions of the lungs, gastro-intestinal tract, kidneys and sweat glands of the fœtus are in abeyance and their several functions are performed by the placenta.

From the placenta, arterial blood, carrying nourishment for the fœtus, is conveyed by the umbilical vein (which with the two arteries of the same name are contained in the umbilical cord) to the inferior vena cava of the fœtus. In the inferior vena cava it mixes with venous blood coming from the abdomen and lower limbs of the fœtus and is carried to the right auricle. From the right auricle the stream of blood is guided in a special groove to the foramen ovale by which opening the blood enters the left auricle. From the left auricle the blood passes into the left ventricle and thence into the aorta. The first two branches of the aorta carry blood to the head and upper limbs and these two branches arise from the aorta before it is joined by the communicating duct from the pulmonary artery. It follows therefore that the head and upper limbs of the fœtus receive comparatively pure blood, the placental blood being mixed with only that amount of venous blood which came from the abdomen and lower limbs of the fœtus. The venous blood from the head and upper limbs of the fœtus reaches the right auricle by the superior vena cava. Thence it passes through the right ventricle into the pulmonary artery. As the function of the lungs is in abeyance, these organs receive only sufficient blood to nourish them; so most of the blood which enters the pulmonary artery of the fœtus passes on into the aorta through the

ductus arteriosus, and reaches the aorta after the branches for the head and upper limbs have been given off. After this junction, the blood in the aorta is relatively impure: it is conveyed to the abdomen and lower limbs and nourishes these, but the chief part passes into the umbilical arteries and is thus returned to the placenta to be again purified and to receive another supply of nourishment and oxygen.

The Portal Circulation.—The blood which is conveyed by arteries from the aorta to the stomach, intestines and spleen passes through two sets of capillaries. The arteries on reaching these organs break up as usual into capillaries; but the veins arising from these capillaries in spleen and gastro-intestinal wall unite to form the portal vein, which enters the liver and breaks up into a second set of capillaries in that organ. The blood after passing through the first set of capillaries in the spleen and gastro-intestinal wall and through the second set of capillaries in the liver passes into the hepatic vein and thence into the inferior vena cava just before it enters the right auricle. The blood that passes through the capillaries of the gastro-intestinal wall contains nutritive material absorbed from the gastro-intestinal tract: this blood undergoes certain changes in its passage through the second set of capillaries in the liver before being returned to the heart and the general circulation.

(To be continued.)

BETTER one's duty though destitute of merit, than the duty of another well discharged. Better death in the discharge of one's own duty; the duty of another is full of danger.

BHAGAVAD-GITA.

EXPENSIVE.

"I want some cloth to make my dolly a dress," announced a little girl of seven as she entered a store the other day.

"How much is it?" she asked when the merchant handed her the package.

"Just one kiss," was the reply.

"All right," she said; "Grandma said she would pay you when she came in to-morrow."—*Ladies' Home Journal*.