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PHYSIOLOGY FOR PUPIL-MIDWIVES

COMYNS BERKELEY

M.C., M.D. Cantab.



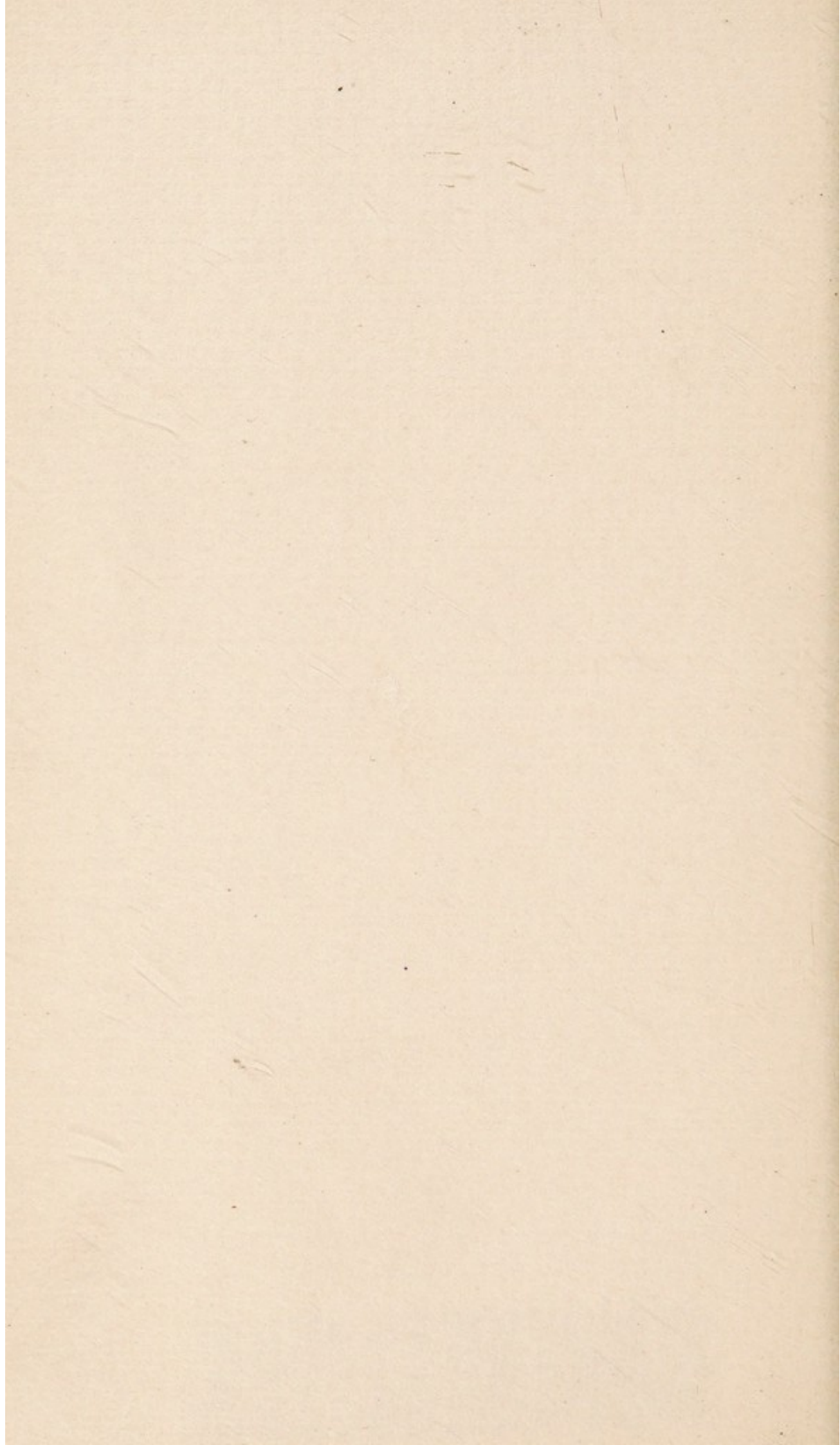
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Including Questions and Answers
founded on the Rules of the C.M.B.

BY

COMYNS BERKELEY

M.A., M.C., M.D. Cantab., F.R.C.P. Lond., M.R.C.S. Eng.

Obstetric and Gynæcological Surgeon to the Middlesex Hospital;
Lecturer on Midwifery at the Middlesex Hospital Medical School;
Consulting Surgeon to the Chelsea Hospital for Women; Consulting
Obstetric Surgeon to the City of London Maternity Hospital; Con-
sulting Gynæcological Surgeon to the Clacton-on-Sea, Eltham, and
Hornsey Hospitals; Director of the Metropolitan Asylums Board
Radium Centre, North Western Hospital; Examiner in Midwifery
and Diseases of Women to the Universities of Bristol and Glasgow,
and Examiner to the Central Midwives Board. Sometime Examiner
in Midwifery and Diseases of Women to the Universities of Oxford,
Leeds, Liverpool, London, Manchester, Sheffield and South Wales,
the Conjoint Board of England, and the Society of Apothecaries,
London

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M.A. M.C. M.D. Candis F.R.C.P. Lond. M.R.C.S. Eng.

Obstetric and Gynaecological Lecturer to the Midwives Hospital,
Lecturer on Midwifery at the Midwives Hospital Medical School;
Consulting Surgeon to the Chelsea Hospital for Women; Consulting
Obstetric Surgeon to the City of London Maternity Hospital; Con-
sulting Gynaecological Surgeon to the Grafton Hospital, Finsbury, and
to the Gynaecological Hospital, St. George's Hospital, London.
and Lecturer of Women to the University of Bristol and Glasgow,
and Lecturer to the Central Midwives Board, London.

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PREFACE

THIS little book appears under its present title and as a separate volume for the first time. Formerly, with the exception of Part III dealing with the Powers and Responsibilities of Midwives, the subject-matter was embodied in the author's "Handbook of Midwifery." The first six chapters of that book were devoted to Elementary Physiology with the aim of enabling the pupil-midwife to understand, among other things, the principles of the circulation when studying hæmorrhage, of respiration when studying asphyxia neonatorum, and of digestion and excretion when studying infant feeding and the toxæmias of pregnancy.

The present volume also contains the series of Questions and Answers founded on the Rules of the Central Midwives Board which formerly appeared in the Handbook and proved very useful for examination purposes. A new section has been added setting forth the relations which subsist between the midwife and the various Public Bodies, and the opportunities which exist for securing grants in aid of training.

My aim in dividing the original volume into two has been to enhance its utility. Those who, as pupil-midwives, require the Physiology Section and the Questions and Answers, are now provided with this matter in small compass and convenient form, while practising midwives who may need the "Handbook" for permanent use will find the parent volume still not too cumbersome for taking with them when visiting their patients.

January, 1929.

C. B.

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PHYSIOLOGY FOR PUPIL- MIDWIVES

PART I.—PHYSIOLOGY

CHAPTER I

The Circulation

BEFORE entering upon the subject proper of this chapter, the reader may be reminded that physiology is the science which deals with the normal functions of the tissues and organs of the body.

In order that the body may be kept healthy and vigorous, it is necessary that its tissues should be supplied with oxygen and other forms of nourishment, and deprived of carbonic acid and other forms of waste product. The oxygen is obtained from the air we breathe, through the medium of the lungs, and the other forms of nourishment from the liquid and solid food we take, through the medium of the alimentary canal. The waste products, or poisons as they really are, result from changes in the tissues associated with the growth of the body and its maintenance a in state of health, the action of the muscles and nerves, and the decay associated with advancing years and disease. These waste products are got rid of as follows: The carbonic acid and a certain amount of water escape through the medium of the lungs, and the rest of the

water and the other forms of waste product escape in the urine, fæces, and perspiration, through the medium of the kidneys, alimentary canal, and skin.

THE BLOOD

The amount of blood in the body is about one-twentieth of the body-weight.

Although blood, as it escapes from the blood-vessels, appears to be only fluid, it is, as a matter of fact, partly fluid and partly semi-solid. The fluid portion is known as the plasma, and the semi-solid particles, which float in the plasma, are known as corpuscles.

The blood is the medium by which nourishment is conveyed to the tissues and organs of the body, and by which poisons are removed from them, and it is able to effect these objects by circulating through every part of the body.

The blood also acts as a medium of defence, in that some of its white corpuscles are able to devour microbes which have gained entrance to the blood-stream, and its plasma may contain certain substances capable of neutralizing the poisons elaborated by the microbes. An additional property of the blood is the power it has of clotting.

Plasma.—The plasma contains the nourishment (apart from the oxygen) which the tissues require; the waste products which it is necessary they should get rid of; water, and a small amount of mineral salts. Of these constituents, 90 per cent. consists of water. It is interesting to note that in every pint of blood in the body there is a teaspoonful of salt, most of which is sodium chloride, or the salt that is used in cooking and eating. The addition of a teaspoonful of common salt to a pint of water constitutes what is known as "normal saline."

The reason why normal saline is injected into the circulation of a person who has lost a large amount of blood will now be apparent.

Corpuscles.—The corpuscles, which can be seen only by putting a drop of blood under the microscope, are minute disk-shaped bodies, of two kinds: red corpuscles, which give to the blood its distinctive colour, and white corpuscles. These corpuscles consist, for the most part, of living tissue, or *protoplasm* as it is called, and the red variety contains, in addition, a little iron. All the red and most of the white corpuscles are derived from the red bone-marrow, while a few of the white corpuscles are derived from the lymphatic glands. The red corpuscles are destroyed in the liver, and the white corpuscles in the spleen and tissues.

Red Corpuscles.—The red corpuscles are by far the more numerous, and there are 5,000,000 in a drop of blood about the size of a pin's head. They measure less than $\frac{1}{3000}$ of an inch across, and $\frac{1}{12000}$ of an inch in thickness. The red corpuscles are the means by which oxygen is conveyed to the tissues. This function they are able to fulfil owing to the presence in them of a substance called *hæmoglobin*, which very readily combines with any oxygen in its neighbourhood and colours the blood red. Hæmoglobin contains a small quantity of iron.

White Corpuscles.—The white corpuscles, or leucocytes, are much less numerous than the red: there is about one white to 500 red corpuscles, so that, roughly, in the drop of blood there would be 10,000 white corpuscles. They are larger than red corpuscles, measuring $\frac{1}{2500}$ of an inch across. Like the red corpuscles, they have very important functions to perform. Thus they contain a substance which, if liberated from them, is able to clot blood, and

they also eat microbes which may get into the blood, so that they are known as *phagocytes*. If any part of the body is inflamed, white corpuscles collect in large numbers in its neighbourhood, in an endeavour, successful or otherwise, to arrest the inflammation. Many of them die in the attempt; and an abscess is, in part, a local collection of dead leucocytes.

Clotting of Blood.—Blood, when its composition is normal, and it is flowing through blood-vessels with a smooth, healthy lining, keeps its fluid state. When, however, its composition is not normal, or when the lining of the blood-vessel through which it is flowing is diseased or injured, or when its flow is arrested, blood becomes semi-solid, or clots, as it is termed. This property which blood has of clotting is a most important attribute, for when, as the result of a wound, small blood-vessels are opened, the person would bleed to death if the blood did not plug the cut ends of the vessels by clotting. In a similar way, as we shall see later, hæmorrhage from the placental site, which contains the open ends of many blood-vessels (sinuses), may be prevented. If a large blood-vessel is wounded, the blood escapes too quickly for a clot to form. If, however, a ligature is applied to the vessel, then the clot forms, so that when the ligature dissolves the escape of blood is still prevented.

When blood first clots it has the appearance and consistence of red jelly. After a while this jelly will be seen to divide into two parts, a small red clot floating in yellowish liquid. This clotting is caused by the white corpuscles parting with one of their constituents, which has been named *fibrin ferment* or *thrombin*. When this thrombin escapes into the plasma, it combines with one of the liquid proteins

in that fluid, called *fibrinogen*, and makes it solid, just as clotting is induced in milk by adding rennin to it, when the caseinogen is converted into casein. Under the microscope, *fibrin*, as the solid protein is called, can be seen to consist of thin threads, and these have the power of contracting. As the fibrin contracts, it imprisons the corpuscles, thus forming a red clot, and the yellowish fluid that is squeezed out is called *serum*. Serum, however, has lost its vital properties, so that whereas plasma may be called a living substance, serum is dead.

THE HEART AND BLOOD-VESSELS

The blood circulates in the body and throughout its tissues by means of a pump, pipes, and vacuum pump. The pump is known as the heart, the pipes are called arteries, capillaries, and veins, and the vacuum pump is the chest. The arteries convey to the tissues the oxygen derived from the lungs, and the other forms of nourishment obtained from the alimentary canal and liver; the veins convey the carbonic acid from the tissues to the lungs, and other forms of waste product to the organs which are able to get rid of them—namely, the skin, liver, kidneys, and large intestine. The capillaries allow of this interchange of nourishment and waste by the tissues.

Heart.—The heart is composed mostly of muscle, by means of which it is able to act as a pump. It is covered on its inner side by a smooth membrane which, as long as it is healthy, prevents the blood clotting in the heart. This membrane is known as the endocardium, and inflammation of it, or endocarditis, is one of the commonest forms of disease to which the heart is liable. The heart is covered on its outside by two layers of a smooth membrane known

as the pericardium. Between these two layers is a small quantity of lymph, which acts as a lubricant and enables the heart to beat easily.

On cutting open the heart it will be seen to be divided into four compartments by two partitions, one partition running vertically and the other horizontally. (Figs. 1, 2, 3.) The two compartments in the upper portion of the heart are known as the auricles, that on the right side being called the right auricle, and that on the left side the left auricle. The two compartments in the lower portion of the heart are known as the ventricles, and these are named the right and the left ventricle, according to their position. There are thus an auricle and a ventricle on each side of the heart. The partition between each corresponding auricle and ventricle is pierced, so that the blood can pass from one to the other. If the heart is healthy the blood can pass only from the auricle to the ventricle, because the aperture is covered by a valve, which allows the blood to flow from the auricle into the ventricle, but not from the ventricle back into the auricle. If, however, the valve becomes damaged so that it cannot close properly, some of the blood may leak back, thus giving rise to the commonest variety of heart disease. There is no communication between the two auricles or the two ventricles, except in congenital malformations of the heart. When babies are born with such a malformation, their colour remains blue.

Blood-vessels.—The blood-vessels are the pipes which carry the blood round the body and into the tissues.

Inserted into the heart are the eight largest blood-vessels of the body. Six of these vessels communicate with the auricles, and two with the ven-

trices. Those blood-vessels which are inserted into the auricles are known as veins; the four *pulmonary veins* communicating with the left auricle, the *superior vena cava* and *inferior vena cava* with the right auricle. The blood-vessels which are in-

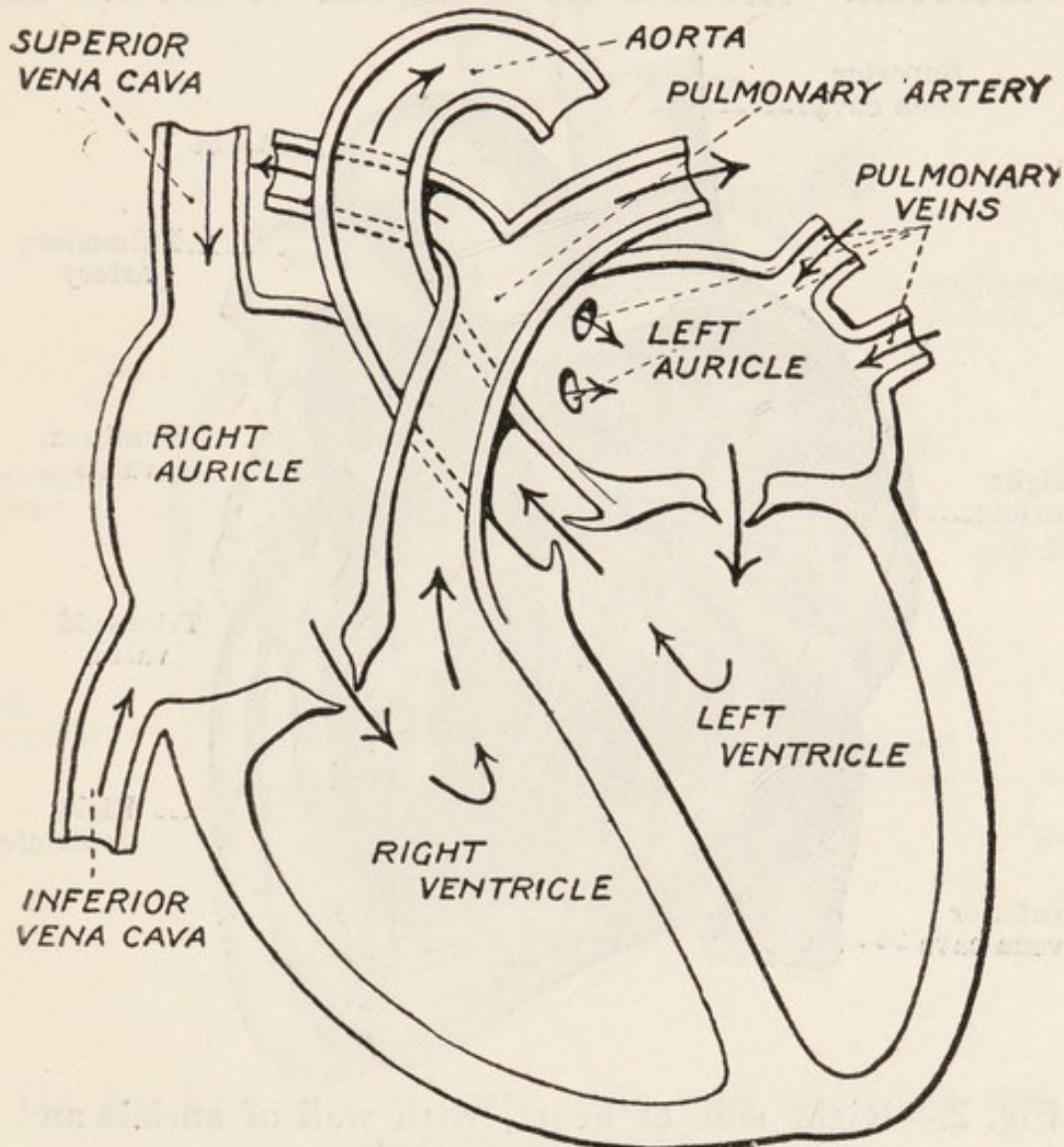


Fig. 1.—Diagram of the heart.

serted into the ventricles are known as arteries; the *aorta* on the left side and the *pulmonary artery* on the right. Just as the opening between each corresponding auricle and ventricle is guarded by a valve, which only allows the blood to flow from the auricle into the ventricle, so the orifices of the

arteries, at their junction with the right and left ventricles respectively, are provided with valves which will only allow the blood to flow from the right and left ventricles into the pulmonary artery and aorta respectively.

Arteries.—Arteries are composed of muscle and

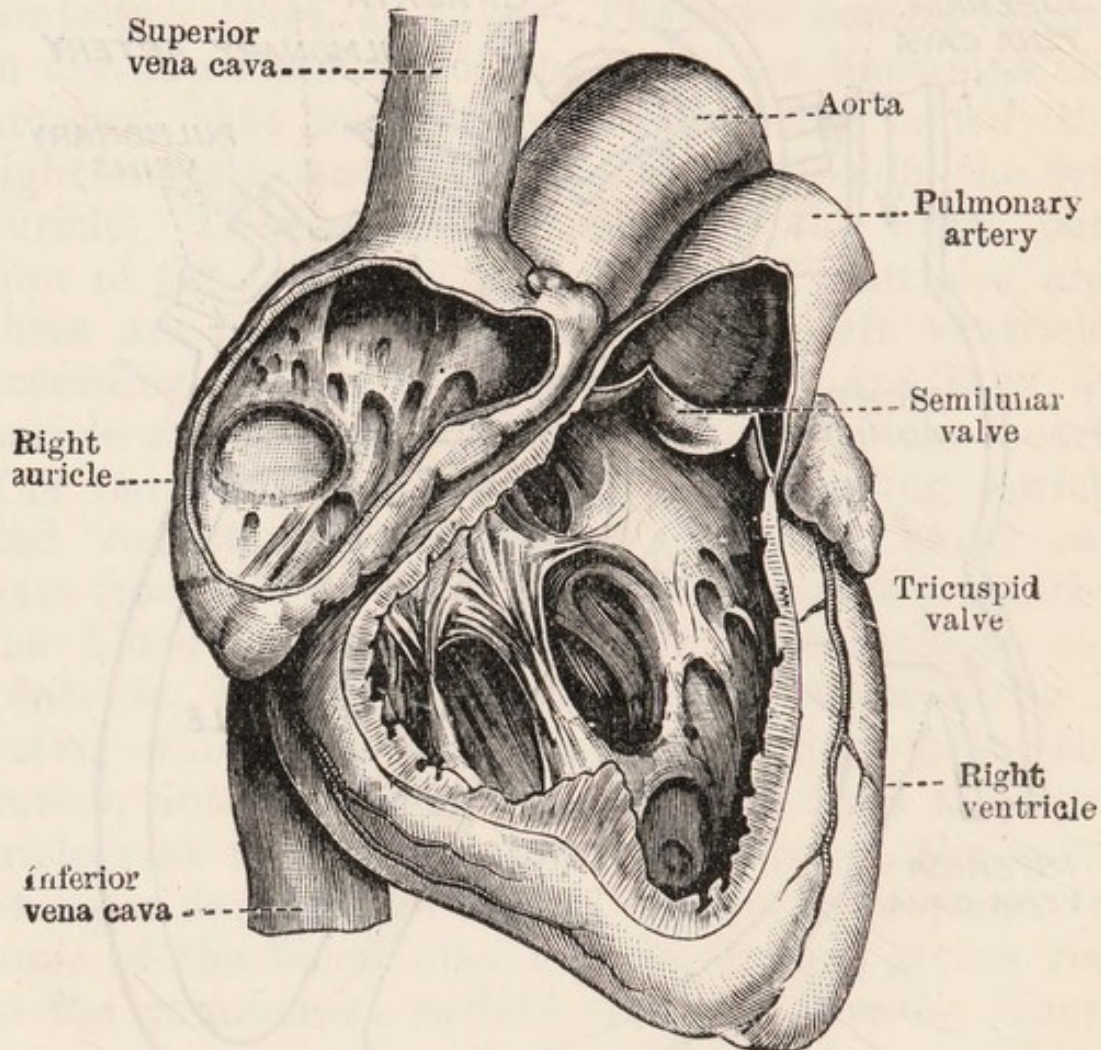


Fig. 2.—Right side of heart, with wall of auricle and ventricle removed.

elastic tissue, and are lined with a smooth membrane. They do not require valves, as the blood is kept flowing in one direction by the force given to it when the ventricles of the heart contract, by the closure of the pulmonary and aortic valves, and by the elastic rebound of the walls of the artery after their distension by the inflow of blood. The pul-

monary artery divides and the aorta gives off branches a short distance from the heart, and this division is repeated many times until there are a very large number of small arteries, which convey the blood to the lungs and every other part of the

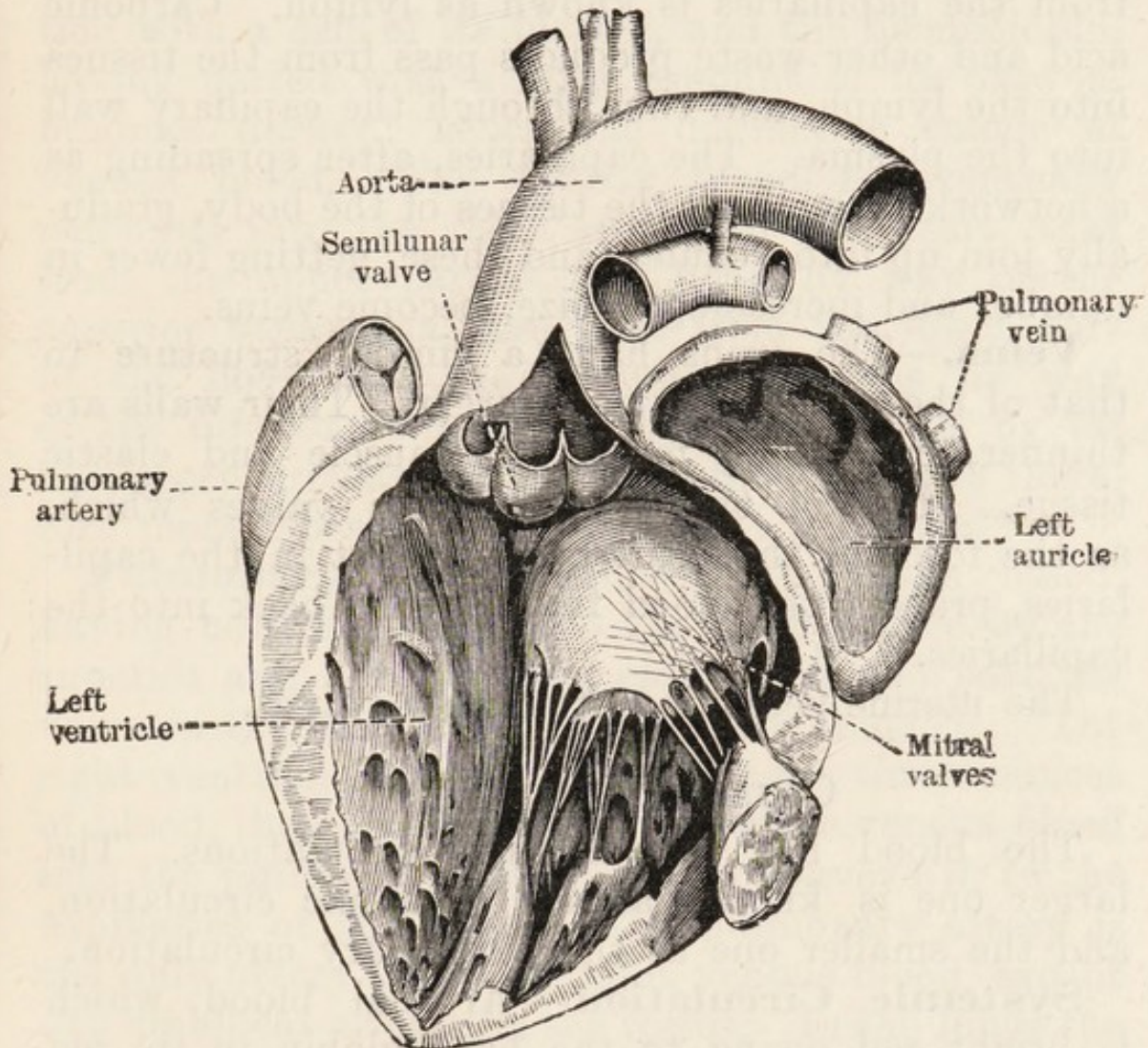


Fig. 3.—Left side of heart, with wall of auricle and ventricle removed.

body. The walls of these small arteries, or arterioles, consist very largely of muscle, and they contain much more muscle in proportion to their size than do the larger arteries. The importance of this will be seen when the subject of the regulation of the blood-flow is discussed.

Capillaries.—Capillaries are so small that they

can only be seen with the microscope. Their walls are composed of a very thin membrane through which some of the plasma of the blood, containing oxygen and other forms of nourishment, can escape and bathe the tissues. The plasma that has escaped from the capillaries is known as lymph. Carbonic acid and other waste products pass from the tissues into the lymph, and thus through the capillary wall into the plasma. The capillaries, after spreading as a network through all the tissues of the body, gradually join up into venules, and these, getting fewer in number and increasing in size, become veins.

Veins.—The veins have a similar structure to that of the arteries, but are larger. Their walls are thinner, containing much less muscle and elastic tissue. Most of the veins contain valves which, as the force of the heart-pump is lost in the capillaries, prevent the blood from flowing back into the capillaries.

The uterine veins do not contain valves.

COURSE OF THE BLOOD

The blood has two distinct circulations. The larger one is known as the systemic circulation, and the smaller one as the pulmonary circulation.

Systemic Circulation.—Arterial blood, which is bright red owing to the hæmoglobin in its red corpuscles being fully combined with oxygen, is delivered by the pulmonary veins into the left auricle. The pulmonary veins are the only veins which contain arterial blood, except the umbilical vein in the foetus. The left auricle contracts and forces the blood past the valve in the partition into the left ventricle. The left ventricle, which can hold three ounces of blood, then contracts and forces the blood into the aorta. From the

aorta it is conveyed by way of the arteries and arterioles to the capillaries, where, as we have seen, it gives up most of its oxygen and other nourishment to the tissues. As it flows through the capillaries, carbonic acid passes into combination with a salt of its plasma, and the hæmoglobin, having parted with a large amount of its oxygen, becomes darker: hence the distinctive colour of venous blood. The venous blood is eventually delivered into the right auricle of the heart, that from the upper part of the body by way of the superior vena cava, and that from the lower part of the body and the abdominal organs by way of the inferior vena cava. The systemic is by far the larger circulation, and the left ventricle is therefore more muscular than the right ventricle.

Pulmonary Circulation.—The venous blood, having been delivered into the right auricle by the superior and inferior venæ cavæ, is forced past the valve in the partition into the right ventricle. The right ventricle, which also can hold three ounces of blood, then contracts and forces the venous blood into the pulmonary artery, which conveys it to the capillaries of the lungs. The pulmonary artery is the only artery which contains venous blood, except the umbilical arteries in the foetus. In the lungs the plasma of the blood parts with its carbonic acid to the air in the air-sacs, and the red blood-corpuscles absorb the oxygen from the air. The blood, having thus been oxygenated, passes into the left auricle, and the pulmonary circulation is completed.

Rate of Heart-beat.—The heart beats normally about 72 times a minute. Its rate may be increased by emotion, hæmorrhage, and disease, while by disease it may also be decreased. The rate at which the heart is beating can be estimated by “taking

the pulse" or by listening to the heart. The rate is controlled by nerves which, starting from a certain spot in the brain, pass down the spinal cord, and, leaving it, end in the heart-muscle. The nerve that makes the heart beat faster is known as the *cardiac accelerator* or *sympathetic*, while that which causes it to beat slower is known as the *cardiac inhibitor* or *vagus*. During exercise the muscles require more nourishment, especially oxygen, and have to get rid of more waste products, especially carbonic acid; impulses therefore travel down the accelerator and hasten the beat of the heart to the required rate.

Heart-sounds.—There are two heart-sounds to every beat of the heart. One, made chiefly by the contracting ventricles, is a low sound; the other, made by the closure of the aortic and pulmonary valves, is a short, sharp sound.

Pulse.—As already stated, each time the left ventricle contracts it forces three ounces of blood into the aorta.

It will be remembered that the walls of the arteries are partly made up of elastic tissue, and when the blood is forced into the arteries, this elastic tissue is put on the stretch. The stretching is communicated to every artery in the body, with the result that the size of each artery momentarily increases. This increase in size is known as the pulse; it can be felt in any fair-sized artery near the surface of the body, and, for the sake of convenience, the radial artery at the wrist is generally felt. Not only can the rate of the heart-beat be determined by feeling the pulse, but also the strength of the heart, for if the left ventricle is contracting forcibly the amount of distension will be much greater than if it is only contracting feebly. An idea is thus obtained of the pressure or tension of the pulse.

Thus doctors talk of a pulse of "high tension" and a pulse of "low tension."

We have seen how the blood is conveyed to and from the tissues. If the matter is considered for a moment, however, it will be realized that the tissues will want a greater or smaller amount of blood, according to whether or not they are at work. To take instances which are quite easy to understand: If the muscles have to do an extra amount of work, as when a soldier charges the enemy, a coolie loads a steamer, or a woman has a labour-pain, more blood will have to be sent to the muscles thus brought into use than when they are at rest. After a meal, more blood will have to be sent to the alimentary canal to enable the food to be digested, while when digestion is complete less blood is wanted. If the weather is hot, more blood must be sent to the skin to enable the sweat-ducts to excrete perspiration and to cool the body. If the weather is cold, less blood is sent to the skin, the sweat-glands do not act so freely, and so the body is kept warmer. This regulation of the blood-flow is due to the action of the nervous system, and, fully to appreciate it, the matter must be discussed in rather more detail.

Nervous Mechanism of the Regulation of the Blood-flow.—The amount of blood supplied to any part of the body depends upon whether the arterioles are made larger, that is, dilated, or made smaller, that is, contracted. The arteriole is able to contract or dilate by reason of the large amount of muscular tissue of which its wall is composed. This power of contracting and dilating is regulated by that part of the nervous system known as the *vaso-motor* system. In the *vaso-motor* system there are two sets of nerves which pass from the brain

down the spinal cord and, escaping from this structure, end in the muscular coat of the arterioles. One set of nerves is known as the *vaso-constrictors*, and the other set as the *vaso-dilators*. If a certain part of the body requires more blood, nervous impulses pass from the brain down the vaso-dilators to the arterioles, and these vessels dilate. On the other hand, if any part of the body requires less blood, then nervous impulses pass to the arterioles through the vaso-constrictors, and these vessels contract. These nervous impulses, besides being governed by the requirements of the tissues, are also to some extent influenced by the emotions. Thus pleasure or confusion causes the cheeks to blush, while fear causes them to become pallid.

LYMPHATIC CIRCULATION

It will be remembered that, when the circulation of the blood was described, nothing was said about the destination of that portion of the plasma which had escaped from the capillaries. It is necessary now to discuss briefly the lymphatic circulation. It really forms an important part of the blood circulation, because not all the blood that leaves the ventricles of the heart returns to the auricles; a certain amount escapes from the capillaries and is returned to the heart in the form of lymph by the lymphatic vessels.

Lymph.—After the plasma has exuded from the capillaries into the tissues it is known as lymph. The composition of lymph differs according to how long it has left the blood-vessel. When it escapes it contains oxygen and other forms of nourishment which are quickly absorbed by the tissues. If the lymph is then analysed it will be found to contain carbonic acid and other waste products.

Lymphatic Vessels.—Lymphatic vessels commence in the tissues as minute tubes, which join up to form larger tubes, just as the capillaries join up to form veins; and the larger lymphatic vessels, like the veins, have valves. In the condition known as *white leg* the lymphatics of the leg along the course of the veins become inflamed. As a result of this lymphangitis the lymphatic vessels become obstructed, so that the lymph cannot return, and this leads to a solid œdema of the leg.

Thoracic Duct.—The thoracic duct is the largest lymphatic vessel in the body and opens into the left subclavian vein close to its junction with the internal jugular vein, and thus the waste products of the tissues are discharged into the blood, to be dealt with as will be seen later.

The lymphatics of the alimentary canal contain during digestion, in addition to waste products, minute drops of fat which have exuded into them from the alimentary canal. This fat gives the lymph a creamy appearance, and it is then known as *chyle*.

Lymphatic Glands.—During some part of their course all lymphatic vessels pass through lymphatic glands, structures which manufacture a certain kind of white corpuscle. These corpuscles mix with the lymph which passes on into the thoracic duct and thence into the circulation.

CHAPTER II

Respiration

THE oxygen that the tissues of the body require is carried to them from the red corpuscles in the arterial blood by the lymph. The carbonic acid which the tissues must get rid of is carried from them by a salt in the plasma of the venous blood called bicarbonate of soda.

The process in the lungs by which the red corpuscles obtain possession of the oxygen and the salt gets rid of the carbonic acid may be called pulmonary respiration, and that in the tissues, by which the oxygen is replaced by carbonic acid, may be called tissue respiration.

PULMONARY RESPIRATION

Pulmonary respiration is carried out—

1. By the chest and respiratory muscles.
2. By the air-passages.
3. By the lungs.
4. By the plasma and red corpuscles.

Chest and Respiratory Muscles.—The chest, or *thorax*, to give it its scientific name, may be regarded as an air-tight box, the roof and sides of which are formed by bones (ribs, collar-bones, and breast-bone) and the muscles attached to them, and the floor by muscle (the diaphragm). The size of this box can be enlarged by descent of the diaphragm and by the action of those muscles which raise the ribs, and it can be reduced by ascent of the diaphragm and

by the action of those muscles which lower the ribs. It is lined by a smooth membrane known as the *pleura*.

The *muscles of respiration* are divided into two sets, the one consisting of those used in ordinary respiration, the other of those used in extraordinary respiration, as when there is difficulty in breathing or some great muscular effort is being made. A good example of the latter use of the extraordinary muscles of respiration is seen in the bearing-down efforts of the second stage of labour. In such a case the woman fixes her shoulders by pulling on a towel; this enables the muscles which as a rule move the shoulders to lift up the ribs still further during inspiration. In this way, if a very deep inspiration is taken, the diaphragm is depressed to its lowest limit, and then, when the breath is held, the diaphragm is kept in this position and so presses on the fundus of the uterus and fixes it. At the same time, by pressing her feet against the end of the bed the woman fixes her pelvis, and is thus able to press on her abdominal contents, including the contracting uterus, by using those muscles which generally move the pelvis.

It will have been noticed that breathing is partly thoracic and partly abdominal. In civilized women it is mostly thoracic, owing to the curious custom of wearing corsets, which hinders abdominal respiration. This thoracic breathing is especially marked in pregnancy.

Air-passages.—The air-passages connect the interior of the air-sacs of the lungs with the outside air (Fig. 4). They are the nose, pharynx, larynx, trachea (windpipe), main bronchi and bronchial tubes.

The *nose* has several functions. Dry air, being injurious to the lungs, should be moistened before it

reaches them. This moisture is added by the glands in the lining membrane of the nose.

Cold air is injurious to the lungs. The internal

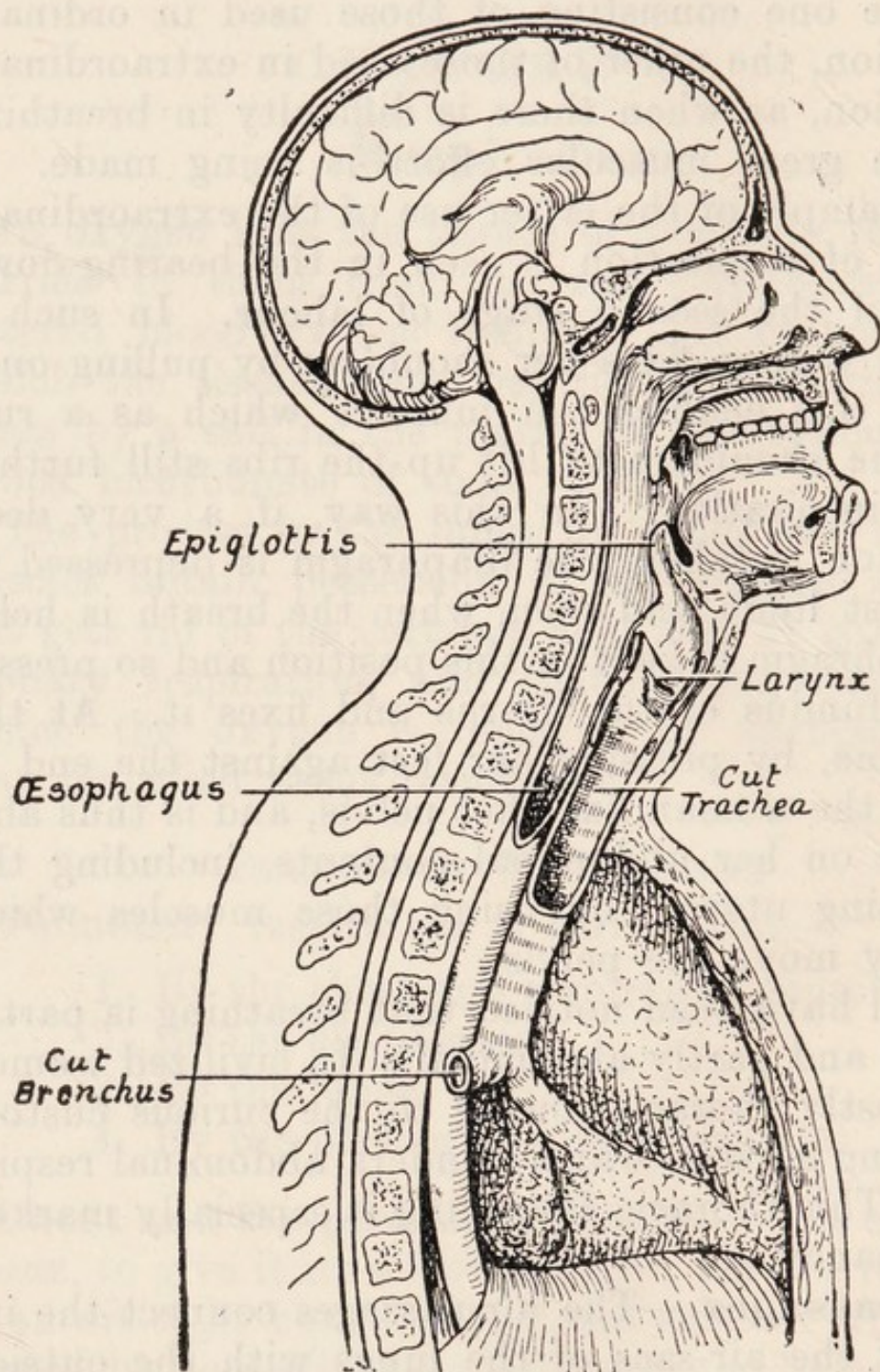


Fig. 4.—The air-passages.

bones of the nose are arranged so that they form several chambers. Covering these bones is a membrane very richly supplied with blood-vessels, and so,

as the inspired air circulates in these chambers, it is warmed by the blood.

Certain gases are injurious to the lungs. The nose by its sense of smell is able to detect the presence of many obnoxious and harmful gases, and thus warns the person against their inspiration. In addition, some of the nerves of the nose are in communication with the smaller air-pipes, and when these nerves are stimulated by injurious gases they cause the small air-tubes to contract, and so less gas, even if it has been inspired, is able to get to the lungs.

Microbes and particles of dust are constantly in the air. The glands in the membrane lining the chambers of the nose secrete a sticky fluid called mucus, which catches the dust and microbes before they can get to the lungs and harm them.

It will thus be easy to understand why it is correct to breathe through the nose and not through the mouth.

The *larynx* leads from the pharynx to the trachea or windpipe. The larynx contains the vocal cords.

The *trachea*, with the right and left bronchi, into which it divides, is lined by a membrane having thousands of microscopic filaments attached to it. These filaments, or cilia as they are called, keep up a movement towards the mouth, and so, if particles of dust and microbes have escaped the nose, they are swept away from the lungs and back into the mouth, and then, mixed with the secretion of the bronchial tubes, are expectorated in the sputum.

Each *bronchus* divides and subdivides in the lungs until the tubes become very small. These bronchial tubes, as they are called, divide in their turn, and their minute terminations lead into the air-sacs.

Lungs.—There are two lungs, a right and a left. Each is made up of millions of microscopic bags

called air-sacs (Fig. 5), which are bound together loosely by other tissue. The walls of these air-sacs are lined on the inside by a smooth membrane; next to this comes a network of capillaries, and outside this is elastic tissue, which allows the air-sac to become larger or smaller according to the amount of air that is forced out of it or sucked into it.

Plasma.—The oxygen passes from the air-sacs

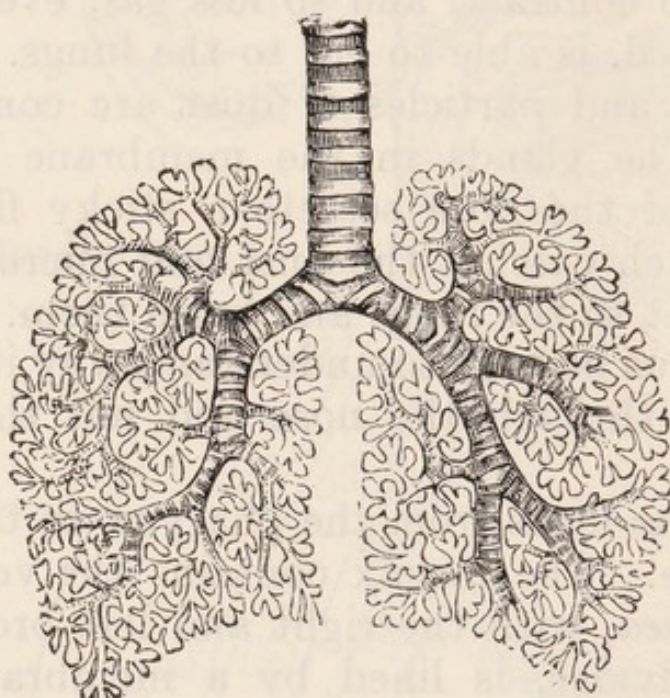


Fig. 5.—Lungs, bronchi, and trachea.

into the plasma of the capillaries, but does not stay there, being at once absorbed by the red corpuscles. The carbonic acid passes from the bicarbonate of soda into the plasma, but does not stay, escaping at once into the air-sacs and being expelled in the process of expiration.

Red Corpuscles.—The hæmoglobin in the red corpuscles absorbs the oxygen from the plasma in the capillaries and retains it for use in the tissues.

Mechanism of Respiration.—Normally the lungs are everywhere in apposition with the inside

of the thorax. If the thorax enlarges, therefore, the lungs have to enlarge with it, otherwise there would be a space between the thorax and the lungs, which there is not. As the lungs enlarge, the pressure of the air in the air-sacs becomes less than that of the atmosphere, and air is accordingly sucked through the air-passages into the air-sacs. This is called *inspiration*.

As the thorax gets smaller, its walls press on the lungs and so reduce their size. The pressure in the air-sacs is now greater than that of the atmosphere, and consequently a good deal of the air they contain is driven out. This is called *expiration*. This increase and decrease in the size of the thorax occurs in healthy people from 18 to 20 times a minute.

Composition of the Air of Pulmonary Respiration.

Inspired Air.—The atmospheric air contains oxygen, nitrogen, and carbonic acid. There is most nitrogen and least carbonic acid. The most important of these three gases, as far as respiration is concerned, is the oxygen. The amount of oxygen is sufficient to keep the tissues alive, and the amount of carbonic gas is too small to do any harm. The nitrogen acts merely as a diluter of the oxygen.

Expired Air.—The air expelled from the lungs also contains oxygen, nitrogen, and carbonic acid, but now the amount of oxygen is less and the amount of carbonic acid much more. The result of breathing expired air can be appreciated from the headache and feeling of lassitude that result from being in a crowded room with insufficient ventilation.

Method by which the Composition of Inspired Air is altered to that of Expired Air.—

It will be remembered that each air-sac is lined by a thin membrane which is itself surrounded by a network of capillaries, so that separating the air in the air-sac from the blood in the capillaries are two very thin membranes, one the lining of the air-sac and the other the walls of the capillaries. The three gases, oxygen, nitrogen, and carbonic acid, are able to penetrate these two membranes.

When the blood reaches the capillaries of the lungs it is known as venous blood, and contains an excessive amount of carbonic acid and an insufficient amount of oxygen. There being more carbonic acid in the blood than in the air-sacs, it escapes from the bicarbonate of soda into the plasma, and from the plasma through the two thin membranes into the air-sacs, and is then expelled in the act of expiration. On the other hand, the oxygen in the air-sacs is replenished by that in the inspired air, and, as the amount is greater than that in the plasma of the blood, some of the oxygen in the air-sacs passes through the two membranes into the plasma of the blood, and from the plasma into the red corpuscles, where the hæmoglobin combines with it and stores it up, the colour of the blood changing from dark to bright red.

With such a vast number of air-cells, and each air-cell surrounded by capillaries, it is evident that the air in the lungs must be brought into intimate relation with a very large surface of blood. It has been calculated that the surface presented by the capillaries to the air in the lungs is 100 times greater than the surface of the skin of the whole body.

It must be remembered that neither the expired nor the inspired air is brought directly into relation with the air-sacs. After as much air as possible has been expelled by all the muscles of expiration,

the lungs still contain a considerable quantity of air. It is in this air that the gaseous interchange of pulmonary respiration takes place, and it is kept at its proper level of purity by the inspired air mixing with it and the expired air leaving it.

TISSUE RESPIRATION

The pulmonary circulation of the blood being completed, the arterial blood, as it is termed, is sent to all the tissues of the body. When it arrives at the capillaries it is, as regards its gases, face to face with a condition exactly the opposite of that which obtained in the capillaries of the lungs, for there is now more oxygen in the blood than in the tissues. Accordingly, the oxygen in the red corpuscles escapes into the plasma, and some of the plasma, escaping as lymph from the capillaries, conveys the liberated oxygen to the tissues. The carbonic acid in the tissues, in its turn, passes into the plasma, and from the plasma into one of the salts contained therein, carbonate of soda. The mixture of carbonate of soda and carbonic acid forms bicarbonate of soda, and the blood now becomes venous. This interchange of gases is known as tissue respiration.

The venous blood is then hurried away in the veins to the right side of the heart, and thence through the pulmonary artery into the pulmonary capillaries, where the carbonic acid escapes from the bicarbonate of soda into the plasma, and from the plasma into the expired air.

CHAPTER III

Digestion, Absorption, Assimilation

1. DIGESTION

THE ALIMENTARY CANAL

THE alimentary canal is a muscular tube lined with a structure called mucous membrane. The name is not a good one, since the glands in this membrane are for the most part not mucous glands, but glands secreting various juices which have a prime importance in the digestion of the food. The alimentary canal, which commences at the mouth and ends at the anus (Fig. 6), varies in calibre and structure in different parts of its length, and these different parts lead into each other and have distinctive names, as follows :

Mouth.

Pharynx.

Esophagus.

Stomach.

Small intestine.

Large intestine.

Anus.

Mouth.—The teeth divide the food taken into the mouth into small portions, so that the digestive juices it will meet in the stomach and intestines are able to penetrate it with greater facility. The juice from the salivary glands coats the food with mucus, enabling it to be swallowed more easily, and it also starts digestion.

Pharynx and Œsophagus.—The pharynx and the Œsophagus act as conduction pipes to the

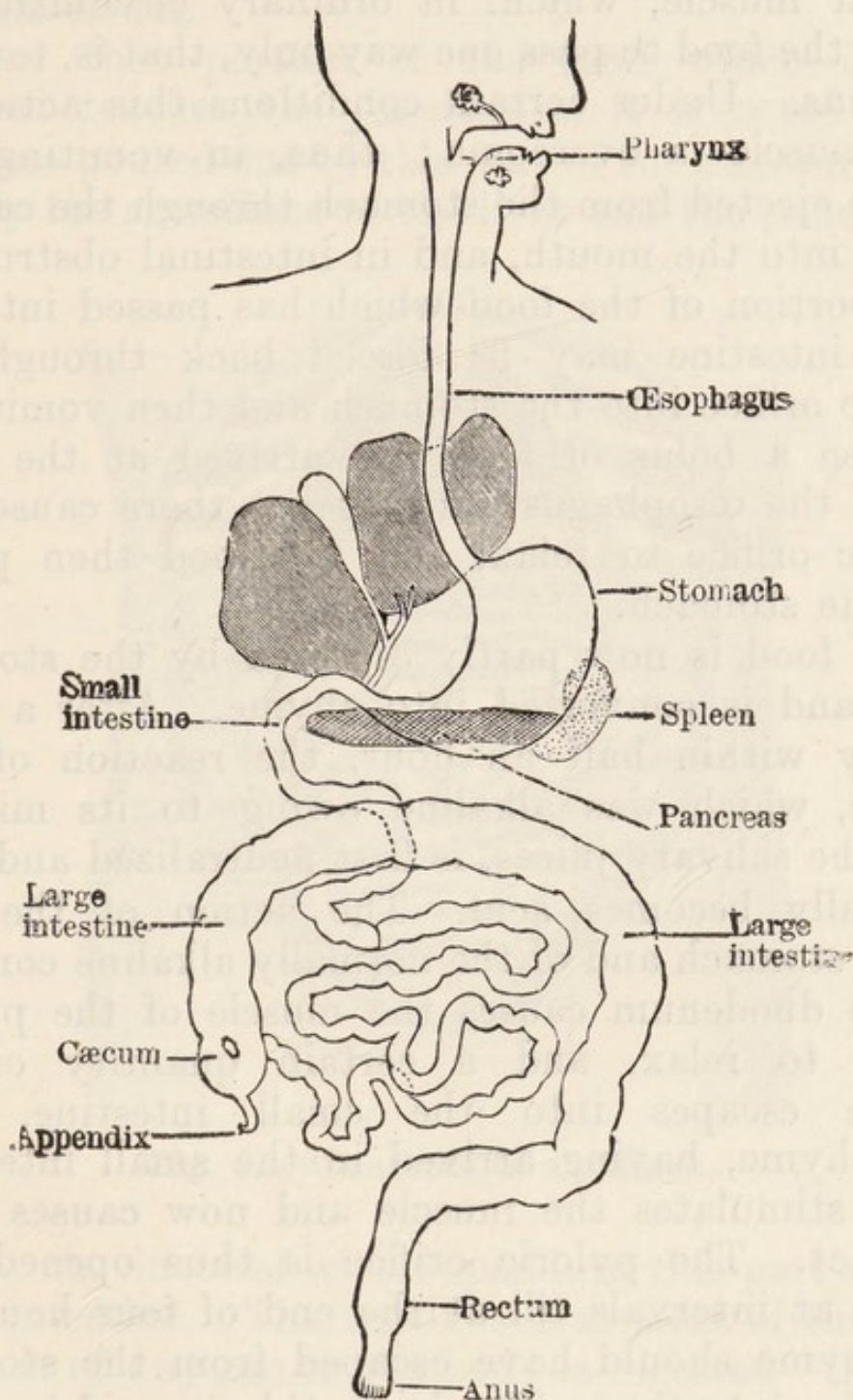


Fig. 6.—The alimentary canal.

stomach, and the passage of food along them is only a matter of seconds. Together they measure 15 inches.

Stomach.—The entrance to the stomach is

known as the cardiac orifice, and the exit as the pyloric orifice. Each orifice is guarded by a strong circular muscle, which, in ordinary circumstances, allows the food to pass one way only, that is, towards the anus. Under certain conditions this action of each muscle is overcome; thus, in vomiting, the food is ejected from the stomach through the cardiac orifice into the mouth, and in intestinal obstruction that portion of the food which has passed into the small intestine may be forced back through the pyloric orifice into the stomach and then vomited.

When a bolus of food has arrived at the lower end of the œsophagus, its presence there causes the cardiac orifice to relax, and the food then passes into the stomach.

The food is now partly digested by the stomach juice, and is converted into chyme. After a time, usually within half an hour, the reaction of the chyme, which was alkaline owing to its mixture with the salivary juices, is first neutralized and then gradually becomes acid. The action of the acid in the stomach and of the normally alkaline contents of the duodenum causes the muscle of the pyloric orifice to relax, and a certain quantity of the chyme escapes into the small intestine. The acid chyme, having arrived in the small intestine, again stimulates the muscle and now causes it to contract. The pyloric orifice is thus opened and closed at intervals till at the end of four hours all the chyme should have escaped from the stomach into the intestine. The hydrochloric acid secreted by the stomach is also inimical to any microbes of putrefaction or of disease with which the food may have been contaminated.

Small Intestine (Fig. 7).—This part of the intestine is 22 feet long and from 1 to 2 inches in

diameter. The first 11 inches is called the duodenum ; the remaining portion is divided up into the jejunum and the ileum.

When that portion of the food which is not digested reaches the duodenum, it is acted upon by juices poured out by this part of the intestine, and also by the secretions of the liver and the pancreatic

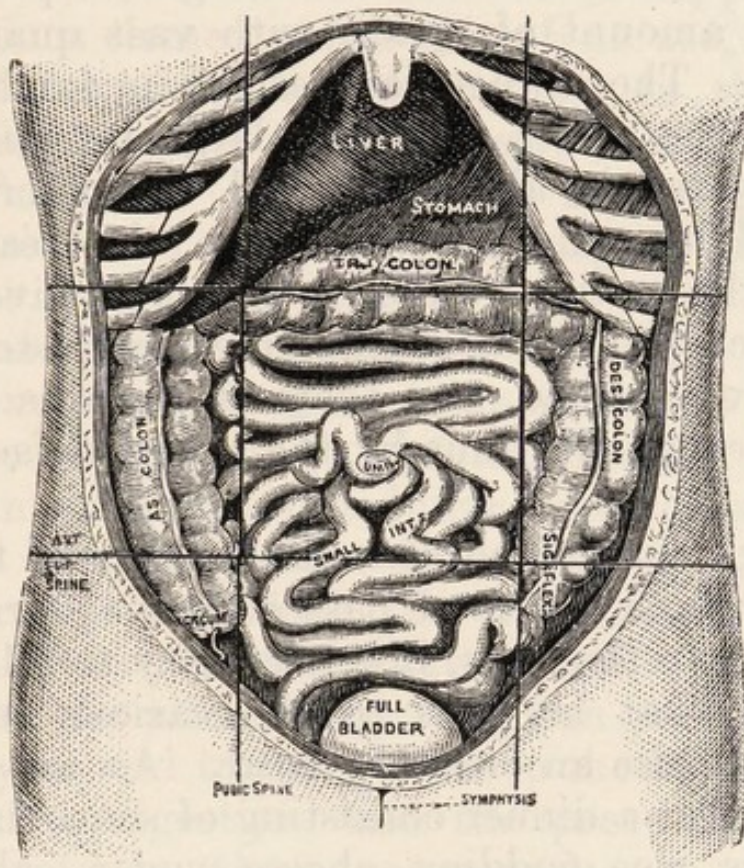


Fig. 7.—Contents of abdomen.

glands, the ducts of which open into this part of the small intestine. The result is that most of the food which is of any use to the body is digested—that is, rendered capable of being absorbed, and this absorption takes place along the whole length of the small intestine. As a rule, this process takes about four hours, by which time that portion of the food which has not been digested is ready to pass into the large intestine.

Large Intestine.—This part of the alimentary tube, called the colon, measures $5\frac{1}{2}$ feet in length and from $1\frac{1}{2}$ to 3 inches in diameter. It is markedly enlarged where the small intestine passes into it. This enlargement is known as the cæcum, and to the cæcum is attached the small blind tube called the appendix.

That remainder of the meal which reaches the large intestine consists of the undigested portion and a certain amount of water, with vast quantities of microbes. The undigested residue is further acted upon by the juices from the large intestine, some of the water is absorbed, and the microbes are mostly destroyed. By the time the residue has reached the rectum, which is the name given to the last 12 inches of the large intestine, twelve to eighteen hours have elapsed, and there it remains until expelled through the anus by the act of defæcation.

Having thus gained some knowledge of the canal through which the food passes on its journey from the mouth to the anus, it is necessary to follow more in detail what happens to the various substances which comprise an ordinary meal. As an example, we will select a dinner consisting of soup, fish, meat, vegetables, rice pudding, cheese, sugar, salt, water, bread, and butter.

CHEMICAL COMPOSITION OF FOOD

Food is composed of a number of chemical compounds, known as proteins, carbohydrates, fats, water, and salts. These are formed by a combination of various elements, which elements are substances that cannot by any known methods be split up into any other substances. The elements found in the body are carbon, chlorine, hydrogen, nitrogen, oxygen, phosphorus, and sulphur, in addition to

certain metals—calcium, iron, magnesium, potassium, and sodium. These elements are mixed together in various proportions to form blood, bone, muscle, nerves, glands, stomach, intestine, liver, kidneys, skin, and the other tissues of the body.

In order that the body may perform its various functions, repair its damaged or worn-out parts, and keep in health, its tissues have to be supplied with these various elements, but it is of no use, in fact it would be harmful, to supply them in their pure form; they must be given in various combinations. The combinations necessary for the purposes described are found in the air we inspire, the liquids we imbibe, and the food we eat.

Thus, oxygen is taken from the air; nitrogen, carbon, oxygen, hydrogen, and phosphorus from the proteins, carbohydrates, and fats; chlorine, calcium, magnesium, sodium, and sulphur from the salts; and iron from meat and other foods.

The process by which the chemical compounds taken in the food are rendered soluble, so that the cells lining the alimentary canal can pick them out of the chyme and transfer them to the blood-stream, is known as digestion, and the process by which the elements in these compounds are extracted therefrom and used by the tissues is known as assimilation.

The following table sets out how the various chemical compounds are distributed among the different articles of food mentioned:—

DISTRIBUTION OF CHEMICAL COMPOUNDS IN FOODS

Proteins are derived from the soup, fish, meat, milk and eggs in the rice pudding, vegetables, cheese, and bread. Principally from the fish and meat.

Carbohydrates are derived from the vegetables, bread, fish, rice, milk. Principally from the vegetables and bread.

Fats are derived from the fish, meat, milk, vegetables, eggs, cheese, and butter. Principally from the butter.

Salts are derived from salt used for cooking and eating, and from the meat, fish, vegetables, and milk. Principally from the salt used in eating and cooking.

Water is derived from the liquids drunk, and from the water in the foods taken.

CHANGES IN CHEMICAL COMPOUNDS IN THE ALIMENTARY CANAL

In the Mouth.—Some of the carbohydrates are partly digested in the mouth, being changed into a variety of sugar called maltose. This change is brought about by a substance called ptyalin, which is secreted by the salivary glands.

In the Pharynx and Œsophagus.—No digestive processes take place in this part of the alimentary canal other than that the digestion of the carbohydrates is continued until the food gets into the stomach and becomes acid.

In the Stomach.—There are three substances secreted by the stomach that are concerned with digestion—hydrochloric acid, pepsin, and rennin. When the food arrives in the stomach, the proteins, except those in the milk, are semi-digested by the pepsin, after they have been acidified by the hydrochloric acid. The protein in the milk called caseinogen is first curdled by the rennin and then semi-digested. The other protein in the milk, lactalbumin, is not curdled and so is more easily digested. The semi-digested proteins are known as peptones.

Gastric juice dissolves the covering of the fat globules so that the fat is set free. Those proteid foods which are rich in fat, such as the flesh of pigs and ducks, and cheese, are more difficult of digestion.

The carbohydrates, cane sugar and milk sugar are changed by the action of hydrochloric acid into glucose.

In the Small Intestine.—The juices affecting digestion which are poured into the small intestine come from the pancreas, from glands in the wall of the intestine, and from the liver, the secretion of the liver being called bile.

The pancreas secretes three enzymes—trypsin, amylopsin and lipase. The trypsin turns the proteins into amino-acids; the amylopsin turns the starches into sugar; the lipase emulsifies the fats and with the aid of the bile turns them into soap and glycerin. The liver contains a good deal of iron which is necessary for the well-being of the child. By its secretion of bile it aids digestion, splitting up the fats and helping their absorption. Glycogen is stored in the liver, urea is formed there, and poisonous substances absorbed from the alimentary canal are there destroyed.

The small intestine secretes the enzyme erepsin which assists trypsin to convert proteins into amino-acids.

As the result of digestion, therefore, the insoluble chemical compounds found in the food have been so altered that they are now soluble and can be absorbed.

In the Large Intestine.—The residue of the food that has passed into the large intestine consists principally of cellulose, an indigestible substance found largely in vegetables and which forms the covering of the nutritious parts. It is partly acted upon by

bacteria, but nearly all of it is discharged as fæces. The liquid which has been drunk and that which has been poured out in the juices of the glands is most of it absorbed by the large intestine.

The fæces consist of cellulose, bile-pigment, water, and dead bacteria, nearly 50 per cent. of the weight of dried fæces being represented by bacteria.

2. ABSORPTION

The amino-acids, glucoses, and fats have now to get into the blood-stream in order that they may be carried to the tissues requiring them. This happens in the following ways:—

Amino-acids from the Proteins.—The amino-acids are divided into a small and large portion. The smaller portion is absorbed by the cells of the lining of the canal and from thence is carried direct by the blood-stream to the tissues where it is built up into the particular protein the particular tissue requires. It is thus that tissue waste is compensated.

The larger portion passing, via the portal vein, into the liver, the cells of this organ split the amino-acids into a nitrogenous and a non-nitrogenous portion. The nitrogenous portion being of no further use is converted into urea and excreted by the kidneys. The non-nitrogenous portion is one of the sources of energy.

Certain amino-acids called lysine, cystine, tryptophane and tyrosine are essential for growth and development. It is obvious, therefore, that a proper diet must include a protein containing these four amino-acids. It is interesting to note, in connexion with infant feeding, that casein is rich in tyrosine and poor in cystine, while lactalbumin contains the chief amino-acids in a larger proportion than other animal proteins. The composition of lactalbumin is

very like that of the body-protein, and as the quantity of lactalbumin in human milk is nearly twice that of casein, this shows one of the reasons why breast feeding is so important. Vegetable proteins, as a whole, are not nearly so rich in the essential amino-acids.*

Glycerin and Fatty Acids from the Fats.—

The fatty acids, while in the intestine, combine with soda to form a soap. This soap, having been absorbed into the cells of the mucous membrane, splits again into fatty acids and soda, and the glycerin, which has also been absorbed, then combines in the cells with the fatty acids, and fat globules are again formed. The fat then passes into the thoracic duct and mixes with the lymph therein, the cream-coloured mixture being known as *chyle*.

The thoracic duct opens into the left subclavian vein, and thus the fats are poured into the circulation. The tissues use the fats they require, and the remainder is stored up in the body as adipose tissue.

Glucose from the Carbohydrates.—The milk sugar, cane sugar and starch which are consumed by the infant are converted in the process of digestion into glucose. The glucose is then absorbed by the cells of the mucous membrane and passing into the portal vein, is taken to the liver. When it reaches the liver the cells of this organ pick it out from the blood-stream and convert it into animal starch, or glycogen, as it is called. The liver, among its other uses, may therefore be regarded as a barn for glycogen (carbohydrates), and, when the tissues require glycogen, some of it is reconverted into sugar by the liver-cells and is taken by the hepatic veins into the general circulation.

* *The Principles of Infant Nutrition*, by K. H. Tallerman and C. K. J. Hamilton. Heinemann.

The ultimate destination of the amino-acids, fats, and glucose is considered in the next section.

3. ASSIMILATION

In order that the tissues may grow, and repair take place in the parts that are damaged or worn out, a certain amount of the amino-acids from the proteins has to be built up into the tissues. This can be done only by the living tissue, which builds up these non-living chemical substances into a living substance called *protoplasm*. As a result of the wear and tear, some of the protoplasm breaks down into waste products, and these are taken to the liver and there converted with the rest of the amino-acids into urea.

In order that the body may be kept at its proper temperature, the tissues have to split up the fats, and thus heat is produced. The fat is really one of the chief fuels of the body. As the result of this splitting, carbonic acid and water, which, as we have seen, are waste products, are formed.

Muscles, in order that they may be able to work, abstract the glucose from the blood-stream, via the lymph, and split it up. The result is that the muscle is able to contract, and further heat is generated. As the result of this splitting, more carbonic acid and water are formed, and these, as waste products, have to be got rid of.

Last of all, it is necessary to describe briefly how the waste products, carbonic acid, water, and urea, are got rid of by the body. This forms the subject of the next chapter.

CHAPTER IV

Excretion

THE waste products are known as water, urea, carbonic acid, salts, and bile, and they are removed from the body as follows: The water by the lungs, skin, kidneys, and alimentary canal. The urea mostly by the kidneys and a very small quantity by the skin. The carbonic acid by the lungs, and the salts by the kidneys and skin. The bile by the kidneys and bowel. The methods of removal must be shortly considered.

Lungs.—The method by which the lungs excrete the carbonic acid and water has already been described in connexion with respiration.

Kidneys.—The method by which the kidney removes the urea and water and a certain amount of salt from the blood, and so forms urine, is as follows:

The kidney is composed of a vast number of tubes lined with cells. Each tube is dilated and blind at one end, and the other end opens into what is called a collecting tubule. The collecting tubule, in its turn, opens into the pelvis of the kidney; this, as its name denotes, acts as a basin in which the urine collects before it passes down the ureter into the reservoir or bladder, to be expelled in the act of micturition by way of the urethra (Fig. 8). The kidney-tube does not, however, run as a straight line from its closed end to the collecting tubule, but is first very much convoluted, then straight, and then again convoluted.

The blood supply of the kidneys (Fig. 9) is as

follows : The renal arteries, one on each side, come off from the abdominal aorta. Each renal artery

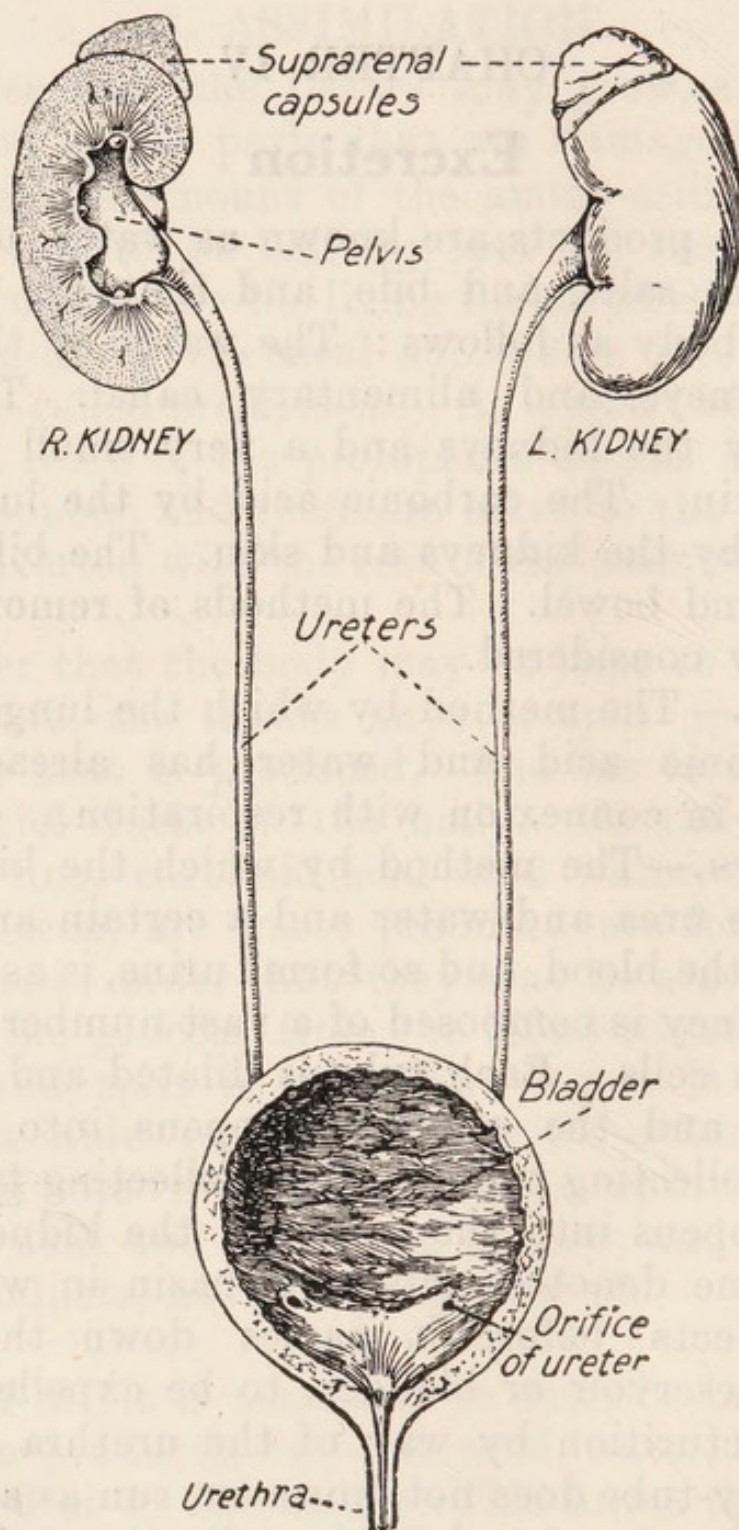


Fig. 8.—The kidneys, ureters, bladder, and urethra.

gradually breaks up into arterioles, and then into capillaries, which form a bunch known as the glo-

merulus that fits into a cup-shaped depression of the blind end of the tubule. From this glomerulus a small vessel comes off, which again breaks up into capillaries over the rest of the tubule. The capillaries pass into veins which, joining up, eventually form the renal vein, and this, in its turn, opens into the inferior vena cava.

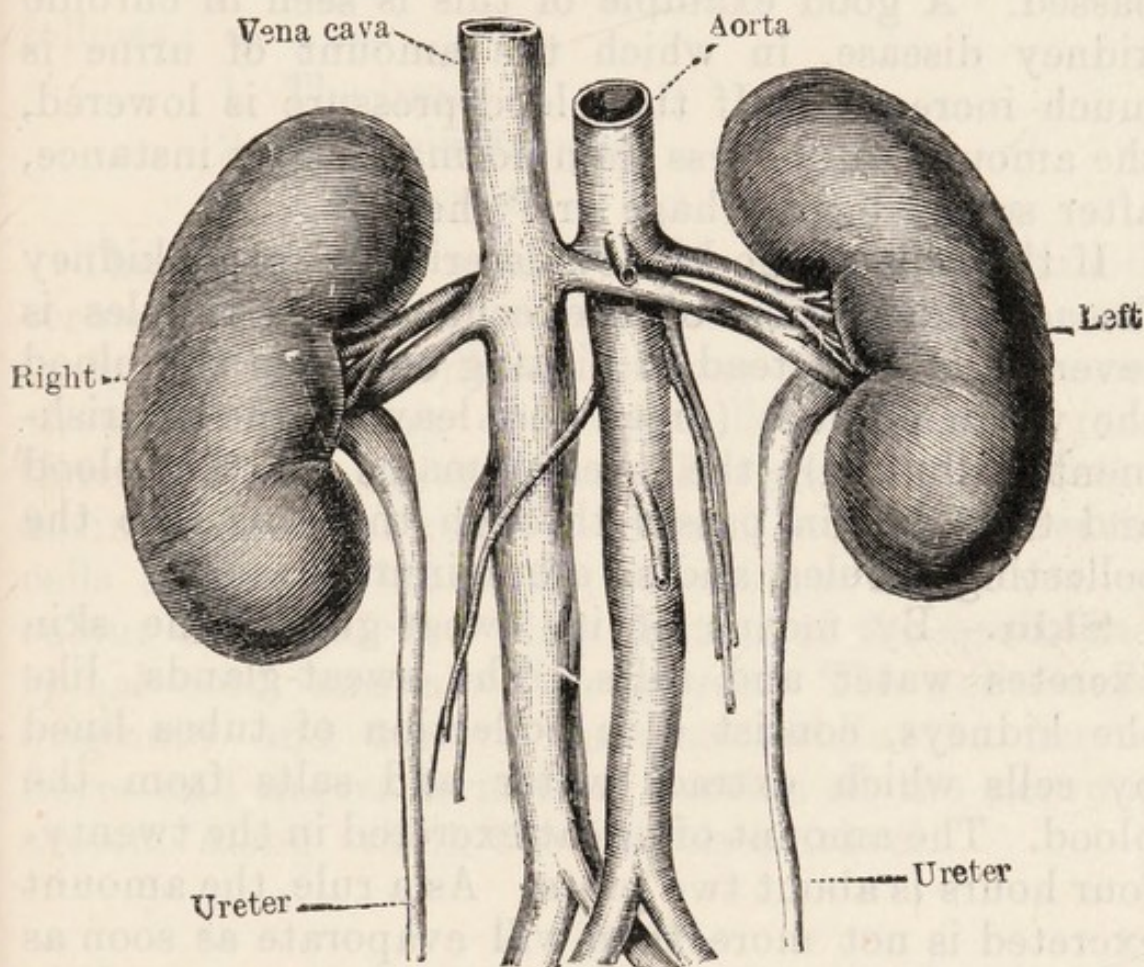


Fig. 9.—Blood supply of the kidneys.

Coming straight from the aorta, the arterial blood reaches the kidneys at a high pressure, while the venous blood enters the inferior vena cava, where the pressure is very low. This difference in the pressure causes a certain amount of water, together with most of the salts, to filter from the capillaries through the cells of the blind ends of the tubes. As this urine trickles down the twisted tubes, it

takes up into solution from the blood the urea which has been extracted by the cells lining these tubes, and also the altered pigment from the hæmoglobin of broken-down blood-corpuscles.

The normal amount of urine excreted in the twenty-four hours is 50 ounces. If the blood-pressure is greater than normal, then more urine will be passed. A good example of this is seen in chronic kidney disease, in which the amount of urine is much increased. If the blood-pressure is lowered, the amount will be less than normal, as, for instance, after severe hæmorrhage or "shock."

If the cells of the kidney deteriorate, as in kidney disease, the action of the cells of the tubules is reversed, and instead of picking out from the blood the waste product (urea) and leaving the nourishment (albumin), the urea remains in the blood and the albumin passes through the cells into the collecting tubules, and so albuminuria results.

Skin.—By means of its sweat-glands the skin excretes water and salts. The sweat-glands, like the kidneys, consist of a collection of tubes lined by cells which extract water and salts from the blood. The amount of sweat excreted in the twenty-four hours is about two pints. As a rule, the amount excreted is not more than will evaporate as soon as it reaches the surface. When sweat is excreted in excess of this, *sensible* perspiration results.

Excessive secretion of sweat is accompanied by diminished excretion of urine, and vice versa. Thus in hot weather, or if violent exercise is taken, the amount of urine passed is diminished, as it is in persons who are feverish.

Intestine.—The waste products removed in the form of fæces are inconsiderable, and consist chiefly of bile residues.

CHAPTER V

The Nervous System

THE nervous system is divisible into three parts, as follows :

1. The brain.
2. The spinal cord.
3. The nerves.

The brain and spinal cord constitute what is termed the *central nervous system*, and the nerves make up the *peripheral nervous system*. Nervous tissue is made up of nerve-cells and the nerve-fibres connected with them. The grey matter of the brain and spinal cord is formed largely of nerve-cells and their branches; the fibres are white in colour and form the white matter of the brain and spinal cord, and also the nerves. The nerve-cells originate and receive impulses, while the nerve-fibres and nerves form that portion of the nervous system along which the impulses travel.

1. BRAIN

For present purposes the brain may be divided into three parts :

- The cerebrum.
- The cerebellum.
- The medulla.

The **cerebrum** forms the largest part of the brain, and is that portion which can be seen when the top of the skull is removed. The outer surface of the cerebrum is covered with grey matter. The interior

of the cerebrum is made up of innumerable white nerve-fibres, some passing down into the spinal cord from the nerve-cells of the brain, and others passing up out of the spinal cord into these nerve-cells. The cerebrum is divided into two halves, the right and left cerebral hemispheres, and it is an interesting fact that the nerve-fibres from the cells of each cerebral hemisphere cross lower down in the brain, so that, for instance, the left side of the body is moved by impulses arising in the nerve-cells of the right cerebral hemisphere, and vice versa.

The nerve-cells that govern feeling, hearing, tasting, seeing, and movement are collected together at certain spots in the grey matter which are known as centres. There is only one speech centre, and that is in the left cerebral hemisphere in right-handed people, and in the right hemisphere in left-handed people.

The **cerebellum**, or little brain, is situated under the back part of the cerebrum. Its function is to co-ordinate muscular movements, and if it is diseased, the gait of the patient may resemble that of a drunken man.

The **medulla** is that part of the cerebrum which joins on to the spinal cord. It is a most important part of the brain, as it contains, in its interior, certain collections of nerve-cells known as *vital centres*, so called because if they are damaged the patient dies. These vital centres are the respiratory, cardiac, and swallowing centres, and they govern respiration, the beat of the heart, and deglutition. The medulla is situated just where the vertebral column joins the skull. In the process of hanging, the first two cervical vertebræ are dislocated or broken, and the resulting pressure on the respiratory and cardiac centres causes instant death.

2. THE SPINAL CORD

The spinal cord consists of a collection of nerve-cells in the middle, and nerve-fibres on the outside. The nerve-cells in the middle are connected on the one hand with the nerve-fibres passing from the brain to the spinal cord or from the spinal cord to the brain, and on the other hand with nerves passing from the spinal cord to the muscles or from the sensory organs to the spinal cord. Thus, by means of the nerve-cells in the spinal cord, motor impulses travelling down from the brain are able to be sent in many more directions than if there was only one set of nerve-fibres from the brain to the nerves. Similarly, sensory impulses from various sources are gathered up by these nerve-cells in the spinal cord and then transmitted as a whole along the nerve-fibres in the spinal cord to the brain.

There are also certain centres in the spinal cord governing the acts of defæcation, micturition, and parturition. If the back is broken and the spinal cord so injured that impulses cannot pass to and from the brain, these centres are able to act independently, and so the patient defæcates, micturates, or can give birth to a child without being aware of the fact.

3. THE NERVES

Nerves are divided into two sets—efferent nerves, or those conveying impulses from the central nervous system; and afferent nerves, or those which convey impulses to the central nervous system.

Efferent nerves comprise *motor* nerves, impulses along which make the muscles of the body contract; *vaso-motor* nerves, which cause the arteries to contract; *accelerator* nerves, which quicken the heart-beat and the respiration; *inhibitory* nerves, which

have the opposite effect ; and *secretory* nerves, which cause the various glands in the body to secrete.

Afferent nerves are the *sensory* nerves, and impulses along them enable the person to taste, hear, see, smell, feel, and experience pain.

ACTION OF THE NERVOUS SYSTEM

The action of the nervous system may be considered under three heads :

1. **Voluntary** actions, in which consciousness and the will are directly concerned. When a person decides upon a given action, impulses are sent along the motor nerves to the appropriate muscles in an orderly fashion, so that they may carry out the required movement.

2. **Automatic** actions, so called, which are originally voluntary, but have been performed so frequently that they are carried out without any direct exercise of consciousness. An example of this kind of action is walking. The child at first finds it difficult to walk, the necessary movements being voluntary, but when it becomes more expert the action is automatic.

3. **Reflex** actions, which are carried out without the intervention of any consciousness. They may take place during sleep, or in the lower part of the body when impulses along the spinal cord are arrested by injury or disease of this structure.

A *reflex arc* consists of a sensory nerve, a centre, and a motor nerve. In a reflex action, such as the movement of the foot if the sole is tickled, a message is sent along the sensory nerves of the foot to a centre in the spinal cord, which at once sends another message down the spinal cord along the motor nerves of the foot, causing it to move.

Reflex actions are of use in that they are pro-

protective. Thus, if the foot touches anything hot or sharp it is at once drawn away to protect it. If a person breathes injurious gases he endeavours to expel them by coughing. Nauseous material taken into the stomach is rejected by vomiting.

Such a reflex arc or path may be regarded as a beaten path which has been made, not during the individual's life but during the history of the race.

CHAPTER VI

The Muscular System and Temperature

1. THE MUSCULAR SYSTEM

THE muscles of the body are divided into two groups, voluntary and involuntary.

Voluntary Muscles.—These muscles comprise those which a healthy man can move when he so desires. Thus, the trunk, limb, and head muscles, the muscles of the tongue, mouth, and ears, and certain muscles of the eyes are voluntary muscles. Movement in voluntary muscles is brought about by impulses originating in the nerve-cells of the brain, which travel by the nerve-fibres to the nerve-cells in the spinal cord and are then redistributed to the nerves going to the muscles it is desired to bring into action. Thus, when, on awaking in the morning, one wishes to get up, impulses are originated in certain nerve-cells of the brain which, travelling to the muscles concerned, cause them to act, and so the clothes are thrown off, the trunk is raised, and the legs and arms lift the body out of bed. Voluntary muscles are also brought into movement by reflex action, in which a sensory impulse travels from the sensory nerves up the spinal cord to the brain and originates impulses in the nerve-cells contained therein. For instance, if a man sits down on a tin-tack, or puts a very hot piece of potato in his mouth, the various muscles stimulated act so that he jumps up from the chair, or spits the potato out of his mouth.

Involuntary Muscles.—The involuntary muscles

are found in the heart, œsophagus, stomach, intestines, and uterus. These muscles are not under the control, and they act or do not act irrespectively of the wishes, of their owners ; their action or inaction being determined, solely by the needs of the body, through the sympathetic system. The bladder and rectum also contain a large amount of involuntary muscle. Each of these organs, however, has a special mechanism involving voluntary muscles, which controls the discharge of their contents.

The impulses governing these involuntary muscles start from nerve-cells in the medulla and spinal cord. Although the involuntary muscles can and do act entirely apart from the will of their owner, yet the action of certain of them can be, and normally is, assisted by the voluntary muscles. For instance, in defæcation and micturition, additional power is given to the effects of the involuntary muscles of the intestine and bladder by the contraction of the voluntary muscles of the abdomen and thorax ; and in a similar way a woman can assist the involuntary contractions of her uterus during childbirth.

By **paralysis** is meant a condition in which the voluntary or involuntary muscles are unable to contract. From what has been said, paralysis must obviously be due to damage of the nerve-cells in which impulses are originated or to damage of the nerves or nerve-fibres along which the impulses travel. When a person first uses crutches he is apt to get "wrist-drop," that is, he loses the use of the voluntary muscles of his wrist. This is due to the head of the crutch pressing on certain nerves in the armpit and for the time being damaging them. In an attack of apoplexy, when a blood-vessel in the brain bursts, the effused blood ploughs up the nerve-tissues in its neighbourhood, so that the cells

cannot originate impulses nor can the fibres conduct them, and one set of muscles may be paralysed, a condition which is known as monoplegia, or the body on one side may be paralysed, which is known as hemiplegia. If the back is broken, so that the spinal cord is damaged, then the muscles below the site of injury are paralysed, and this condition is known as paraplegia; but, as has already been noted, if below the site of injury there are any collections of nerve-cells (centres) which govern involuntary muscles, the latter are not paralysed; thus a man who is bedridden from paraplegia can still micturate and defæcate.

2. TEMPERATURE

The normal temperature of man is 98.4° F., and in health it varies but little from this level. It is slightly higher at five o'clock in the afternoon and slightly lower at three o'clock in the morning, otherwise it remains at about 98.4° F. Man is classified with other mammals and with birds as a warm-blooded animal, in contradistinction, for instance, to frogs, fishes, and snakes, the temperature of which varies with that of the surrounding medium, and which are therefore called cold-blooded animals, their temperature being lower when it is cold and higher when it is hot.

How is the heat of the body produced, and how is it regulated?

Heat-production.—In dealing with the assimilation of food it was pointed out that the tissues of the body use the carbohydrates and fats to produce energy and heat. Carbohydrates and fats are composed of carbon, hydrogen, and oxygen in different proportions. The living tissues are able to split the

carbon and hydrogen apart, so that the oxygen which is in the lymph can combine with each separately, forming carbonic acid and water, which are waste products.

This splitting and rearrangement of the elements of carbon and hydrogen with oxygen results in the production of heat and of energy, and so the muscles are able to contract. In other words, the carbohydrates and fats in the food act as fuel for the body, much in the same way as coal does for an engine. The result of this combustion (burning with oxygen) is the same in each case, namely, heat and movement.

Nearly all the heat of the body is obtained from the carbohydrates and from this burning of the fats. The heat thus produced by the chemical changes in the various tissues of the body owes its origin mostly to the action of the muscles.

It is a common experience that exercise will increase the heat of the body, and active exercise will raise the temperature over half a degree.

Heat-regulation.—The heat, having been produced by the tissues, is regulated by the nervous system. When describing the circulation it was pointed out that the small arteries or arterioles are supplied with two sets of nerves, the one known as vaso-dilators, which enlarge the blood-vessels, and the other as vaso-constrictors, which make the blood-vessels smaller.

In cold climates it is necessary that the blood shall be kept from the surface of the body as much as possible, so that it shall not be cooled. The blood-vessels of the skin therefore contract, and those in the interior of the body dilate, with the result that most of the blood leaves the surface of the body and remains in the interior. Additional help in this respect is obtained by warm clothing, which prevents

loss of heat by evaporation. In hot climates the opposite obtains: the blood is now directed to the external surface of the body and leaves the interior. Coincidentally with this dilatation of the vessels of the skin the sweat-glands become very active, perspiration is poured out and, evaporating, cools the surface of the body and with it the blood, which, on its return to the interior of the body, absorbs heat, only to part with it when it again reaches the skin. This process is aided by the wearing of thin clothing.

Experience also regulates the production of heat in various climates. Thus, the inhabitants of cold regions partake largely of fat, while those of hot countries are able to obtain most of the heat they require from the carbohydrates which are their staple article of food.

The mechanism regulating heat can, however, be thrown out of gear by extremes, and thus people may die in the tropics of heat-stroke, and mountaineers overtaken by a storm may die of cold.

When the temperature rises, as the result of poisons produced by disease-causing microbes, Nature endeavours to combat the increased heat of the blood by the process of perspiration. This, however, is often not sufficient, and means have to be taken to lower the temperature by drugs such as quinine or salicylate of soda, or by cold sponging, which increases the amount of heat lost by evaporation. On the other hand, when the temperature falls as the result of shock, warmth has to be applied to the surface of the body.

PART II.—QUESTIONS AND ANSWERS FOUNDED ON THE RULES OF THE C.M.B. (1927, Section E)

CHAPTER VII

It is most important that the pupil-midwife should have a thorough knowledge of the Rules of the Central Midwives Board which relate to her duties, so that, when she is qualified, she may be able to carry on her occupation with credit to herself and safety to her patients. It is also well for her to remember that questions upon these Rules form an important part of the examination.

In the following pages a series of questions and answers dealing with most of the important Rules will be found. The numbers against the questions refer to the numbers of the Rules framed by the Central Midwives Board, under Section E. Explanatory remarks are appended, when necessary, to the answers, in larger type.

What are the conditions in which medical help must be sent for?

20. In all cases of illness of the patient or child, or of any abnormality occurring during pregnancy, labour or lying-in, a midwife must forthwith call in to her assistance a registered medical practitioner, using for this purpose the form of sending for medical help (*see* Rule 23 (a)), properly filled up and signed by her. The conditions referred to in this Rule shall be deemed to be emergencies for the purpose of Section 14 of the Midwives Act, 1918.

Also Rule 21. *See* pp. 56, 58, 60.

Note.—If a midwife has summoned medical aid in respect of any emergency and any other emergency occurs in the subsequent progress of the case it is her duty to draw the doctor's attention to such other emergency, and it is also desirable for her to send, or to hand to him the form of send-

ing for medical help properly filled up and signed by her. The Local Supervising Authority should of course be notified of each emergency in respect of which the doctor's advice is sought as required by Rule E. 22 (1) (a).

What a midwife must always have in her possession and take with her when called to a confinement.

3. In a metal case, or in a bag or basket kept for that purpose only, and furnished with a removable lining which can be disinfected—

(a) An appliance for giving vaginal injections, a different appliance for giving enemata, a catheter, a pair of scissors, a clinical thermometer, and a nail-brush.

(b) An efficient antiseptic or efficient antiseptics for such purposes as—

(1) Disinfecting the hands.

(2) Douching in special cases.

(3) Cleansing the infant's eyelids.

If the midwife uses a bag or basket, it should have two removable linings, so that when one is soiled she may always have another quite clean and ready for use.

Metal midwifery cases are now sold containing, among other articles, a spirit-lamp. After the contents have been removed, these cases can be used for the sterilization of instruments and as trays.

(a) When a douche-can is not available, the most convenient appliance for vaginal injections is the Penguin douche. This is of the siphon-tube pattern, requires no bulb, commences to act directly the end is dropped in the jug, and can be efficiently sterilized. This apparatus never allows air to enter the vagina or the uterus, as its action stops immediately air enters the suction-bulb.

(b) (1) Biniodide or perchloride of mercury (1 in 2,000). One soloid to one pint of water, or a solution of such a strength that a teaspoonful to a pint of water equals the required strength.

(2) Lysol, or monsol, a teaspoonful to a quart (1 in 320), may be used for this purpose.

(3) For cleansing the infant's eyelids, generally, boric-acid solution (1 ounce to a pint of water) should be used. A 1-per-cent. solution of silver nitrate should be carried in the bag, and, if the mother has a purulent discharge, a drop of this solution should be instilled into the infant's eyes after it has been bathed.

Silver solutions lose their power if not fresh. Unless the midwife knows that her solution is fresh, it will be safer in these cases to use a few drops of biniodide or perchloride of mercury (1 in 2,000). Very small quantities of silver nitrate solution are now put up in hermetically sealed tubes, and the solution will keep fresh until the tube is opened.

What precautions must a midwife take before passing the catheter ?

4. Before touching the generative organs or their neighbourhood, the midwife must on each occasion disinfect her hands and forearms.
5. All instruments and other appliances must be disinfected, preferably by boiling, before being brought into contact with the patient's generative organs.
8. The midwife must wash the patient's external parts with soap and water, and then swab them with an efficient antiseptic solution, before passing a catheter. For this purpose the midwife must on no account use ordinary sponges or flannels, but material which has been boiled or otherwise disinfected before use.

What precautions must a midwife take before making a vaginal examination ?

- 4, 8. The same precautions must be taken as mentioned above.
- The swabbing with antiseptic solution must be repeated before each further examination and before a douche is given.

9. No more internal examinations should be made than are absolutely necessary.

If these precautions are not taken, microbes may be introduced into the vagina or bladder, and so cause puerperal fever or cystitis, either of which diseases may kill the patient.

On what occasions, according to the Central Midwives Board, must a midwife make use of an antiseptic solution ?

4. Before touching the generative organs or their neighbourhood the midwife must on each occasion disinfect her hands and forearms.
6. Whenever a midwife has been in attendance, whether as a midwife or as a nurse, upon a patient or in contact with a person suffering from puerperal fevers or from any other condition supposed to be infectious, or is herself liable to be a source of infection, she must at once notify the Local Supervising Authority of the fact, must (unless the Authority relieve her from that obligation) disinfect herself and all her instruments and other appliances, and have her clothing thoroughly disinfected, to the satisfaction of the Local Supervising Authority, before going to any other maternity patient.
8. The midwife must wash the patient's external parts with soap and water, and then swab them with an efficient antiseptic solution, on the following occasions :
 - (a) Before making the first internal examination.
 - (b) After the termination of labour.
 - (c) During the lying-in period.
 - (d) Before passing a catheter.

The swabbing with antiseptic solution must be repeated before each further examination and before a douche is given.

For this purpose the midwife must on no account use ordinary sponges or flannels, but material which has been boiled or otherwise disinfected before use.

16. As soon as the child's head is born, and if possible before the eyes are opened, its eyelids must be carefully cleansed.

4. For the hands and forearms, biniodide or perchloride of mercury (1 in 2,000), one soloid to a quart of water.

6. For the hands and forearms, and the instruments that cannot be boiled, the mercurial solution noted under 4 may be used.

8. The antiseptic is the same as already noted under 4.

16. For the eyelids of the child in normal cases, boric acid, one ounce to one pint of water. If there is a vaginal discharge, a drop of 1-per-cent. solution of silver nitrate should be instilled into each eye. Biniodide or perchloride of mercury (1 in 2,000) can be used if the silver solution is not fresh.

The Local Supervising Authority is the County Council for midwives practising in a County area, and the City or Borough Council for midwives practising in a County Borough.

What precautions must a midwife take to prevent puerperal fever ?

2. The midwife must be scrupulously clean in every way, including her person, clothing, appliances, and house ; she must keep her nails cut short and preserve the skin of her hands as far as possible from cracks and abrasions. When attending to her patients she must wear a clean dress of washable material that can be boiled, such as linen, or cotton, and over it a clean, washable apron or overall.

The sleeves of the dress must be made so that the midwife can tuck them up well above the elbows.

3. Her bag or basket must have a removable lining which can be disinfected, and must be used only for confinements. She must not give vaginal injections with the enema syringe. She must use a nail-brush and an efficient antiseptic for the hands, and for douching if this is necessary.

4. Before touching the patient's generative organs or their neighbourhood, the midwife must on each occasion disinfect her hands and forearms.
5. All instruments and other appliances must be disinfected, preferably by boiling, before being brought into contact with the patient's generative organs.
6. If she has been in attendance upon a patient or in contact with a person suffering from puerperal fever or from any other illness supposed to be infectious, or is herself liable to be a source of infection, the midwife must notify the Local Supervising Authority of the fact unless the authority relieve her of that obligation, must disinfect herself and all her instruments and other appliances, and have her clothing thoroughly disinfected, to the satisfaction of the Local Supervising Authority, before going to any other maternity patient.

Unless otherwise directed by the Local Supervising Authority, all washable clothing must be boiled, and other clothing must be sent to be disinfected by the Local Sanitary Authority.

8. She must wash the patient's external parts with soap and water and then swab them with an efficient antiseptic solution on the following occasions :
 - (a) Before making the first internal examination.
 - (b) After the termination of labour.
 - (c) During the lying-in period, when washing is required.
 - (d) Before passing a catheter.

The swabbing with antiseptic solution must be repeated before each further examination and before a douche is given.

For this purpose the midwife must on no account use ordinary sponges or flannels, but material which has been boiled or otherwise disinfected before use.

9. No more internal examinations should be made than are absolutely necessary.
10. She must in all cases of labour examine the placenta and membranes before they are destroyed, and must satisfy herself that they are completely removed.
11. She must remove soiled linen, blood, faeces, urine, placenta and membranes from the neighbourhood of the patient and from the lying-in room as soon as possible after the labour, and in every case before she leaves the patient's house.

12. The midwife shall be responsible for the cleanliness, and shall give all necessary directions for securing the comfort and proper dieting of the mother and child during the lying-in period, which shall be held for the purpose of these regulations and in a normal case to mean the time occupied by the labour and a period of ten days thereafter.

If after ceasing to attend a case the midwife subsequently attends a mother or child suffering from illness connected with the confinement, all rules under Section E (in so far as they are appropriate to the case) shall apply.

14. The midwife shall take and record the pulse and temperature of the patient at each visit, entering her records in a notebook or on charts, which must be carefully preserved. The temperature must be taken by the mouth whenever possible. If not taken by the mouth a statement should be added saying where the thermometer was placed.

18. She shall not lay out a dead body, except in the case of a patient upon whom she has been in attendance at the time of death. After laying out a dead body for burial she must notify the Local Supervising Authority and undergo adequate cleansing and disinfection in accordance with Rule 6.

20. She must in all cases of illness of the patient or child, or of any abnormality of the patient occurring during pregnancy, labour, or the lying-in, forthwith call in to her assistance a registered medical practitioner, using for this purpose the form of sending for medical help (*see* Rule 23 (a)), properly filled up and signed by her.

(*See* note at end of 20, p. 49.)

What are the duties of a midwife if she has been in attendance upon a patient suffering from puerperal fever, or from some other illness supposed to be infectious, or is herself liable to be a source of infection?

6. She must disinfect herself and all her instruments and other appliances, and must have her clothing thoroughly disinfected, to the satisfaction of the Local Supervising Authority, before going to any

other maternity patient. Unless otherwise directed by the Local Supervising Authority, all washable clothing must be boiled, and other clothing must be sent to be disinfected by the Local Sanitary Authority.

22. (1) She must, as soon as possible, send notice on the prescribed form to the Local Supervising Authority,

(a) Whenever the advice of a registered medical practitioner has been sought.

(b) In all cases of the death of the mother or child.

(c) That she has prepared or assisted to prepare a dead body for burial. (d) That she has been in attendance upon a patient or in contact with a person suffering from puerperal fever or from any other condition supposed to be infectious, or is herself liable to be a source of infection.

The Medical Officer of Health is the Local Sanitary Authority, to whom all the clothing which cannot be boiled must be sent to be disinfected. To disinfect her instruments and other appliances she should boil those which can stand boiling, and those which cannot be boiled, if they are cheap, had better be destroyed; otherwise they must be sent to be disinfected by the Local Sanitary Authority.

Under what conditions is it necessary for a midwife to advise that a medical practitioner be forthwith sent for to see a woman who is pregnant?

20. In all cases of illness of the patient, or of any abnormality.

21. (1) In all cases in which a woman appears to be dying or is dead.

(2) When there is any abnormality or complication, such as—

Deformity or stunted growth.

Loss of blood.

Abortion or threatened abortion.

Excessive sickness.

Puffiness of hands or face.

Fits or convulsions.

Dangerous varicose veins.

Purulent discharge.

Sores of the genitals.

Note.—The foregoing list is not exhaustive and does not include all cases in which medical help should be summoned. According to Rule E. 20 “*any abnormality*” requires medical help. The instances in Rule E. 21 refer to some of the most striking and important abnormalities.

Stunted growth suggests a contracted pelvis.

Loss of blood may be due to abortion, miscarriage, accidental or unavoidable hæmorrhage, or cancer of the uterus.

Excessive sickness may be of the variety known as pernicious vomiting, which is a very dangerous condition, only cured, as a rule, by terminating pregnancy.

Puffiness of the hands or face suggests albuminuria, which may lead on to eclampsia.

Fits or convulsions are likely to be eclamptic.

Varicose veins may rupture and the patient bleed to death before help can be obtained.

Purulent discharge may be due to gonorrhœa, and, if so, may give rise to ophthalmia in the child, often causing total blindness. A gonorrhœal discharge may also infect the patient after labour, when “puerperal fever” will result.

Sores of the genitals suggest syphilis, and if the nurse be not careful she may herself become infected with this very serious disease.

A patient near full time complains of headache, vomiting, and swelling of the face and vulva. What danger would you expect? What is your duty under the rules of the Central Midwives Board, and what would you do for the patient in the meanwhile?

The symptoms and signs indicated above are associated with albuminuria, and, if the patient is not

efficiently treated, eclampsia may result ; in fact, it may supervene in spite of all treatment. This is the danger, therefore, that must be expected.

The midwife in attendance on such a case must at once send for medical assistance according to Rules 20 and 21 (2) of the Central Midwives Board, which state that in all cases of abnormality during pregnancy this must be done.

Until the arrival of the doctor the patient should be put to bed and kept quiet and warm. If any nourishment has to be given, it should only be in the form of milk. It is better to wait, if possible, for the doctor's arrival before giving food. The patient may have plenty of water to drink.

The amount of urine passed should be measured, and it is most important to keep a specimen thereof.

If a fit should occur before the doctor's arrival, the midwife must carry out the appropriate treatment.*

If the doctor lives so far away that it must be many hours before his assistance can be obtained, the midwife should give a strong aperient, and she may try and induce sweating in the patient by the methods she has been taught.

When must a midwife advise that a medical practitioner be forthwith sent for during labour at or near term ?

20. In all cases of illness or of any abnormality.

21. (1) In all cases in which the woman appears to be dying or is dead.

(3) When there is any abnormality or complication, such as—

Fits or convulsions.

Purulent discharge.

Sores of the genitals.

A malpresentation.

* See the Author's *Handbook of Midwifery* (Cassell & Co.), p. 161.

Presentation other than the uncomplicated head or breech.

When no presentation can be made out.

When there is excessive bleeding.

When two hours after the birth of the child the placenta and membranes have not been completely expelled.

In cases of serious rupture of the perineum, or of other injuries of the soft parts.

(See note, end of 21 (2), page 57.)

For comments on fits, purulent discharge, and sores of the genitals, see above, and pp. 57, 63.

Malpresentation, or presentation other than the uncomplicated head or breech, suggests a contracted pelvis, hydramnios, malformation of the child, placenta prævia, tumour of the uterus or ovary.

The presenting part cannot always be felt in patients with contracted pelves, or in hydramnios, or in infants with hydrocephalus, or in an oblique position.

Excessive bleeding is due to accidental or unavoidable hæmorrhage.

If the placenta and membranes have not been completely expelled within two hours from the birth of the child, as a rule, some part of them will be abnormally adherent.

A ruptured perineum, or other injuries, must be repaired, otherwise there is danger of infection leading to puerperal fever. Such injuries, if not repaired, may lead to "falling of the womb" later.

What are the duties of the midwife towards the patient in the matter of staying with her after labour has begun?

7. A midwife in charge of a case of labour must not leave the patient without giving an address by which she can be found without delay; and after the commencement of the Second Stage she must stay with the woman until the expulsion of the placenta and membranes, and as long after as may be necessary.

In cases where a doctor has been sent for on account of the labour being abnormal, or of there being threatened danger (*see* Rule 20), she must await his arrival and faithfully carry out his instructions.

If for any reason the services of a registered medical practitioner be not available, the midwife must, if the case be one of emergency, remain with the patient and do her best for her until the emergency is over.

After having complied with the Rule as to the summoning of medical assistance, the midwife will not incur any legal liability by remaining on duty and doing her best for the patient.

Note.—Midwives must not, except under a grave emergency, undertake operative procedure or any treatment which is outside their province. The question whether in any particular case such procedure or treatment was justified will be judged on the facts and circumstances of the case.

Under what conditions, after delivery, must a midwife advise that a registered medical practitioner be forthwith sent for ?

20. In all cases of illness of the patient or of any abnormality.

21. (1) In all cases in which a woman appears to be dying or is dead.

(4) When there is any abnormality or complication such as—

Fits or convulsions.

Abdominal swelling and tenderness.

Offensive lochia, if persistent.

Rigor with raised temperature.

Rise of temperature above $100\cdot4^{\circ}$ F. for a period of twenty-four hours, or its recurrence within that period.

Unusual swelling of the breasts with local tenderness or pain.

Secondary post-partum hæmorrhage.

White leg.

(*See* note, end of 21 (2), page 57.)

Fits or convulsions signify eclampsia.

Abdominal swelling and tenderness may be due to retention of urine or peritonitis. Also, if any pieces of placenta or membranes are retained in the uterus, this organ may be tender.

Offensive lochia suggests sapræmia.

Rigor with raised temperature suggests septicæmia or pyæmia ; more rarely sapræmia, or white leg.

Rise of temperature for more than twenty-four hours suggests sepsis, the quickening of the pulse-rate and the duration of the fever being important indications.

Engorged breasts may lead on to abscess.

Secondary post-partum hæmorrhage is most often due to some piece of placenta or membrane having been retained in the uterus.

Patients with white leg may die suddenly from pulmonary embolism.

What are the midwife's duties to the child ?

12. She must be responsible for the cleanliness, and should give all necessary directions for securing the comfort and proper dieting, of the child during the lying-in period, which shall be held for the purpose of these regulations and in a normal case to mean the time occupied by labour and a period of ten days thereafter. Should she continue her attendance after the tenth day, the fact must be noted in her register, with an explanation of the reason.

If after ceasing to attend a case the midwife subsequently attends an illness of the child connected with the confinement, all Rules appropriate under Section E shall apply.

- 12A. She must forthwith notify the Local Supervising Authority of each case in which it is proposed to substitute artificial feeding for breast-feeding.
15. In the case of a child born apparently dead, the midwife must carry out the methods of resuscitation, which have been taught her.

16. As soon as the child's head is born, and if possible before the eyes are opened, its eyelids must be carefully cleansed.

17. On the birth of a child which is in danger of death, the midwife shall inform one of the parents of the child's condition.

20. In all cases of illness of the child she must forthwith call in a registered medical practitioner.

21. *See* remarks on pp. 63, 64 under 21 (5).

12. The midwife should bath the child until the cord has separated, at any rate, and preferably till she gives up the case, unless there is a person who can do this properly, and even then the midwife should inspect the child from time to time to see that it is being kept clean.

12A. If the mother cannot feed her child the greatest care must be taken with the artificial feeding. The midwife must do all in her power to make the mother fully realize the importance of feeding her child naturally, and when breast-feeding cannot apparently be continued she should urge medical advice.

The wastage of life due to improper feeding is appalling, and is a matter of the greatest concern to the State. With the birth-rate falling as it is doing, it behoves every midwife to do all in her power to prevent the terrible infant mortality due to improper feeding.

In nearly all districts health visitors and Maternity and Child Welfare Centres are provided for the assistance of mother and child, and the midwife, when she ceases attendance, should advise the mother to avail herself of such help.

15. Artificial respiration should be persevered with for at least half an hour, and longer if the child's heart is beating.

16. This is to prevent ophthalmia, which is the commonest cause of blindness in the young.

When the head is born the eyelids should be swabbed with a little boric lotion. If the mother has a vaginal discharge a drop of 1-per-cent. nitrate of silver should be instilled into each eye. If this solution cannot be obtained fresh, a drop of perchloride of mercury (1 in 2,000) should be used.

Separate pieces of wool should be used for each eye.

17 So that the child may be baptized if the parents wish it.

Under what conditions in a new-born child must the midwife advise that a registered medical practitioner be forthwith sent for ?

20. In all cases of illness of the child.

21. (5) When there is any abnormality or complication, such as—

Injuries received during birth.

Any malformation or deformity endangering the child's life.

Dangerous feebleness in a premature or full-time child.

Inflammation of or discharge from the eyes, however slight.

Serious skin eruptions, especially those marked by the formation of watery blisters.

Inflammation about or hæmorrhage from the navel.

Note.—In cases in which the eyes are affected the duties of the midwife are—

(1) To call in to her assistance a registered medical practitioner, using for this purpose the form for medical help.

(2) To send notice to the Local Supervising Authority that medical help has been sought.

- (3) Also, when there is a purulent discharge commencing within twenty-one days from the date of birth and medical help has not been obtained for this discharge, to notify the Local Sanitary Authority.

Injuries received during birth, such as fracture of the bones or paralysis of the face or arms, if not early and properly treated, will lead to permanent disablement.

Such malformations as imperforate anus or urethra, unless quickly treated, will kill the child.

Inflammation of the eyes, however slight, may quickly become serious and lead to blindness. This is the commonest cause of blindness in the young.

Serious skin eruptions are generally due to syphilis, which is likely to be fatal unless properly treated. Also, if the child has syphilis, and is nursed by a wet nurse, the latter may contract the disease.

Inflammation about the navel may cause serious umbilical hæmorrhage, malignant jaundice, septicæmia, or pyæmia.

What are the directions of the Central Midwives Board with regard to the prevention of inflammation of the eyes in new-born children ?

Medical help must be sent for—

21. (2) In the case of a pregnant woman when there is any abnormality or complication such as a purulent discharge.
- (3) In the case of a woman in labour at or near term when there is any abnormality or complication such as a purulent discharge.
16. As soon as the child's head is born, and, if possible, before the eyes are opened, its eyelids must be carefully cleansed.

21. (2) and (3) The purulent discharge is due in most cases to gonorrhœa. This discharge is teem-

ing with microbes. If any of these microbes get into the child's eyes, inflammation of a severe type, known as ophthalmia neonatorum, may result. This inflammation is the commonest cause of blindness in the young, and, having started, may progress so quickly that in two or three days the child is hopelessly blind. A large number of children could be saved from blindness if this discharge were cured, or at any rate rendered harmless for the time being, and if the child's eyelids were properly cleansed directly the head was born, and later when the child was first washed.

For these reasons the rule directs the midwife to send for a doctor if the discharge is discovered during pregnancy, because he will probably be able to cure it; or, again, if the discharge is discovered for the first time during labour, because he will order anti-septic douches, which will have the effect of washing most of the discharge away and killing any microbes that remain behind, so that the head of the child may pass through the vaginal canal without so much fear of its eyes becoming infected.

16. This rule is framed to prevent any discharge that may have collected round the eyelids, and especially on the eyelashes, from getting into the eyes.

The midwife must remember—

(a) To use separate swabs of cotton-wool, lint, or rag to clean each eye with, since the swab used for the first eye may be contaminated, and so, if used for the second eye, may infect it.

(b) Carefully to clean and dry the hands of the child and to wrap them up, because children often rub their eyes with their hands, and if there are any microbes on the hands they might be conveyed to the eyes.

(c) To wash the child's face in clean water. The water that the body of the child is washed in is dirty, since it contains the discharges which have collected on the child's body during labour. If therefore the "body-water" is used to wash the child's face with, there is a danger of the child's eyes being infected.

Under what conditions must a midwife notify as soon as possible the Local Supervising Authority ?

A. When she is acting as a *Midwife* and therefore subject to the Rules.

(a) When she has been engaged to deliver the patient.

(b) When sent for in an emergency, no doctor having been engaged.

(c) When a doctor makes an arrangement with a midwife engaged as a maternity nurse that he is not to be sent for unless she requires him.

(d) When a doctor arranges with a midwife that she shall deliver patients for him.

(e) When a doctor has been engaged to deliver the patient and she has sent for him on the onset of labour but she leaves the house after delivery before he arrives.

Note.—The case should be entered in her Register in the usual way, and in (c), (d) and (e) the date on which the case is handed back to the doctor and her position as a nurse is resumed.

B. When she is acting as a *Maternity Nurse* and is therefore not subject to the Rules, except Rules E 6, 18, 22 (1) (d) and (e); 22 (2), 23 (d) and (e), and 28.

When a doctor has been engaged to deliver the patient and she has sent for him on the onset of labour and he arrives before she leaves the house.

If these conditions are not fulfilled she is subject to all the Rules.

22. (1) (a) *Medical help*.—Whenever under Rule 20 the advice of a registered medical practitioner has been sought.
- (b) *Deaths*.—In all cases of the death of mother or child.
- (c) *Stillbirths*.—In all cases of stillbirth where a registered medical practitioner is not in attendance at the time of birth.

Note.—A child is deemed to be stillborn when it has issued forth from its mother after the twenty-eighth week of pregnancy and has not at any time after being completely expelled from its mother breathed or shown any other signs of life.

- (d) *Laying out the dead*.—In all cases in which she has prepared, or assisted to prepare, a dead body for burial. (*See Rule 18.*)
- (e) *Liability to be a source of infection*.—Whenever a midwife has been in attendance, whether as a midwife or as a nurse, upon a patient or in contact with a person suffering from puerperal fevers or from any other condition supposed to be infectious, or is herself liable to be a source of infection. (*See Rules E 6 and E 23. Form (e), p. 34.*)
- (f) *Artificial feeding*.—Whenever it is proposed to substitute artificial feeding for breast-feeding.
- (2) *Change of name or address*.—All midwives, whether practising or not, must immediately notify the Local Supervising Authority of any change of name or address.

Notice of Intention to Practise.—Notice of intention to practise must be given in accordance with Section 10 of the Midwives Act, 1902.

By an “Act for the Notification of Births,” the father has to notify to the Local Supervising Authority, within forty-eight hours, in those districts in which the Act has been adopted, the birth of his child, together with the name and address of the parents.

What are the rules of the Central Midwives Board with regard to the laying out of the dead ?

18. No midwife shall lay out a dead body, except in the case of a patient upon whom she has been in attendance at the time of death.

After laying out a dead body for burial she must notify the Local Supervising Authority and undergo adequate cleansing and disinfection in accordance with Rule 6.

What are the duties of the midwife after using ergot or pituitary extract ?

19. A midwife must note in her Register of Cases each occasion on which she is under the necessity of administering or applying in any way any drug other than a simple aperient, the name and dose of the drug, and the time and cause of its administration or application.

Ergot is included in Rule 19, as also is pituitary extract.

What are the duties of a midwife when the eyes of the child are affected ?

20. (1) Immediately to advise medical help.

(2) To fill up and hand to the nearest relative or friend the form for medical help. [See Rules 20 and 23 (a).]

22. (1) (a) To send notice to the Local Supervising Authority that medical help has been sought.

Also—

When there is a *purulent* discharge commencing within twenty-one days from the date of birth, and medical help has *not* been obtained for this discharge, to notify the Local Sanitary Authority. [See Rules 20 and 21 (5), note.]

In order to ascertain who is the appropriate Sanitary Authority, the midwife should inquire of the Inspector of Midwives or of the Local Supervising Authority. [See Rule 6, note.]

What advice can a midwife give in the ante-natal management of her patients? What instructions of the Central Midwives Board guide her in this respect?

See the Author's Handbook of Midwifery (Cassell & Co.), pp. 93-104.

1. When engaged to attend a labour the midwife must interview her patient at the earliest opportunity to inquire as to the course of present and previous pregnancies, confinements, and puerperia, both as regards mother and child, and to advise as to personal and general arrangements for the confinements, and, with the consent of the patient, visit the house.

Local Authorities now provide Health Visitors, and Maternity Centres for the assistance of the mother before the birth of the child. The midwife should advise the patient to avail herself of such help.

Whenever illness or abnormality has occurred in the previous pregnancy, and whenever the previous pregnancy has ended in an abortion, a premature labour, or a stillbirth, the midwife, on being engaged to attend the patient in her next confinement shall explain that the case is one in which skilled medical advice is required, and shall urge the patient to seek advice from her medical attendant, or at a hospital or other suitable institution.

Note.—Midwives must keep notes of their ante-natal visits on the form approved by the Central Midwives Board.

What signs and symptoms would lead you to suspect that a patient was suffering from active syphilis? How may this disease affect the mother and child? How would you endeavour to protect yourself and others from this contagious disease?

See the Author's Handbook of Midwifery, pp. 177-181 and 493-494.

What is the importance of irregular bleeding from the vagina of a woman aged 50?

The normal change of life comes on between 45 and 50 years of age. The periods may gradually

get less till they cease, they may stop at a certain month and never again appear, there may be one or more attacks of flooding, or they may become irregular before stopping.

It is most important for the midwife, however, never to forget that irregularity or excess is not normal, and although no cause may be discovered, irregularity or excess between 45 and 50 years of age IS OFTEN DUE TO CANCER OF THE WOMB.

In such cases, therefore, the midwife must do all in her power to persuade the woman at once to seek medical advice.

What is the duty of the midwife according to the Rules if she finds a purulent discharge in the patient?

2. She must be scrupulously clean in every way, including her clothing and appliances; she must keep her nails cut short, and preserve the skin of her hands, as far as possible, from cracks and abrasions.

When attending to her patients she must wear a clean dress of washable material that can be boiled, such as linen or cotton, and over it a clean washable apron or overall.

The sleeves of the dress must be made so that the midwife can tuck them up well above the elbows.

5. All instruments and appliances must be disinfected, preferably by boiling, before being brought in contact with the patient's generative organs.
6. Whenever a midwife has been in attendance, whether as a midwife or as a nurse, upon a patient or in contact with a person suffering from puerperal fevers or from any other condition supposed to be infectious, she must notify the Local Supervising Authority of the fact, must (unless the Authority relieve her from that obligation) disinfect herself and all her instruments and other appliances, and have her clothing thoroughly disinfected to the satisfaction of the Local Supervising Authority before going to any other maternity patient. *See also Rule 21 (e).*

16. As soon as the child's head is born, and if possible before the eyes are opened, its eyelids must be carefully cleansed.
21. (2) (3) Medical help must be sent for in the case of a patient having a purulent discharge.
2. The discharge is perhaps due to gonorrhœa, it may be associated with syphilis, or the two diseases may be present in the same person at the same time. In either case the discharges are extremely infectious. The precautions to be taken under Rule 2 are necessary to prevent the midwife in such cases incurring one or other of the diseases herself or conveying it to others.
5. If vaginal douches are ordered, the douche nozzle must be boiled and the douche and tubing disinfected.
6. A purulent discharge is infectious.
16. A purulent discharge due to gonorrhœa, if it gets into the child's eyes, will certainly give the child gonorrhœal ophthalmia, and so may lead to blindness.
21. (2) (3) This Rule is made so that the doctor may treat the patient. During pregnancy he will probably be able to cure the disease. During the first stage of labour, by means of an antiseptic douche, such as 1-in-4,000 biniodide of mercury, and during the second stage of labour by swabbing the vagina with tincture of iodine, 2 per cent. in spirit, the discharge may be removed and the danger of the eyes of the child being infected during the passage of the head through the vagina lessened.

What may be the consequences to the mother suffering from a purulent discharge if treatment is neglected?

What may be the consequences to the child if the treatment is neglected?

After the birth of the child, if the discharge is due to *gonorrhœa*, the mother may have an attack of puerperal fever.

The disease may spread up into the Fallopian tubes and thence to the ovaries, with the result that

the patient may be rendered sterile, may become a chronic invalid, or may have to undergo a very serious operation to remove the diseased tubes and ovaries.

The disease may spread up the urethra into the bladder, causing cystitis, and thence to the kidneys. It may also affect the eyes and the joints.

If the disease is due to *syphilis* it may pass on to the tertiary stage.

If the disease is due to *gonorrhœa* the child may have ophthalmia and become blind or have very deficient eyesight.

If the disease is due to *syphilis* the child may become infected and have congenital syphilis.

The following Note has been added to the revised Rules of the Central Midwives Board:—

Midwives must not, except under a grave emergency, undertake operative procedure or any treatment which is outside their province. The question whether in any particular case such procedure or treatment was justified will be judged on the facts and circumstances of the case.

The midwife will know what is included in the expression "operative procedure." It is well for her to remember that the phrase "any treatment which is outside their province" might be held to include the administration of pituitary extract before the birth of the child.

Which doctor shall the midwife call in for assistance ?

20. She shall send for the registered medical practitioner desired by the patient, or, if the patient cannot be consulted, by the responsible representative of her family.

PART III.—POWERS, RESPONSIBILITIES, RIGHTS AND OPPORTUNITIES OF THE MIDWIFE *

It is of the greatest importance that the midwife should clearly apprehend her position in the social service of the country, and the following information, with respect thereto, has been brought up to date.

Notification of Births

Every birth and every still-birth must be notified in compliance with the provisions of the Notification of Births Act, 1907, within 36 hours, under a penalty of £1. The notification must be made to the Medical Officer of Health of the district in which it occurs, either by the parent, the doctor, the midwife, or any person in attendance on the mother. This notification does not relieve the parents of the necessity of registering the birth with the Registrar.

Midwifery

Supervision and Training of Midwives.—County Councils and County Borough Councils are responsible for the supervision of midwives in their respective areas. Unsatisfactory women are reported to the Central Midwives Board, which has power to strike their names off the Midwives Roll. Grants in aid of the training of midwives are payable by the Ministry

* As exemplified in the various Acts of Parliament having reference to such matters. The information appearing under this heading has been extracted by permission from the Handbook of Information, published by the National Council of Social Service, 33, Bloomsbury Square, W.C.1.

of Health to recognized training institutions at the rate of £20 in respect of each student completing an approved course of training of less than twelve months' duration and of £35 in respect of each student who, after the 30th April, 1926, completes an approved course of twelve months' training. These grants are payable only in respect of students who have declared in writing their intention of practising as midwives, or who are or have been in full-time employment as Health Visitors or who have successfully completed or declared in writing their intention of completing a course of training approved by the Minister of Health for the training of Health Visitors. Grants are also payable in respect of any practising midwife completing an approved course at a recognized residential institution which is designed to promote an improved knowledge of the theory and practice of modern midwifery. The course must be either a whole-time course intended mainly for teachers of midwifery or midwives desiring to qualify for senior positions, and lasting from four to six months, or a whole-time course lasting from a fortnight to two months. A grant not exceeding £20 is payable in respect of each midwife who completes one of the longer courses, and a grant at the rate of £1 a week in respect of each midwife who completes one of the shorter courses.

Provision of Midwives.—Many Local Authorities and voluntary agencies undertake the provision of a midwife, reducing or remitting the fees to patients when the circumstances of the case warrant it. In rural districts midwives are usually provided by District Nursing Associations, and Local Authorities for Maternity and Child Welfare have power to contribute towards the establishment and maintenance of such District Nursing Associations, and the pro-

vision of trained midwives. The Ministry of Health itself also makes grants for this purpose through the County Nursing Associations to which District Nursing Associations are affiliated (in Scotland grants are made through the Local Authority).

Medical Fees.—All local supervising authorities (i.e. County Councils and County Borough Councils) are required by the Midwives Act, 1918, to pay the fees of doctors called in by midwives in cases of emergency under the rules of the Central Midwives Board, the rate of payment being fixed by the Minister of Health (or, in Scotland, by the Scottish Board of Health) under that Act. The supervising authorities have power to recover the fees from the patient or her husband, or from any other person liable to maintain the patient, unless they are satisfied that these persons are unable by reason of poverty to pay the fees.

Nursing

Powers of Local Authorities.—Local Authorities are empowered to provide home nursing for expectant mothers, maternity nursing, and nursing for puerperal fever and ophthalmia neonatorum. For this purpose they may either appoint nurses themselves or contract with a body such as a District Nursing Association.

Training for Health Visitors

A Memorandum (101/M.C.W.) has been issued by the Ministry of Health prescribing the training to be taken by persons desirous in future of becoming Health Visitors, and the grants payable in respect of such training. A whole-time course lasting for a minimum period of six months is prescribed for fully-trained nurses who have obtained or declared in

writing their intention of obtaining the certificate of the Central Midwives Board, and a grant at a rate not exceeding £15 is payable in respect of each student who completes an approved course of this kind.

Maternity and Child Welfare Centres and Clinics

In nearly all populous districts there are now Maternity and Child Welfare Centres to which expectant and nursing mothers can go with their infants for hygienic and medical advice, and in many places Ante-natal Clinics are also provided to which expectant mothers can be sent for a similar purpose. In England and Wales there are approximately 2,400 Maternity and Child Welfare Centres, and in Scotland about 200.

Hospitals

Most Local Authorities having Maternity and Child Welfare schemes make some provision for in-patient accommodation for cases of confinement. In some districts this is done by contracting with a voluntary institution; in some the Local Authority itself provides a Home for the reception of women who cannot with safety be confined in their own homes. Arrangements are usually made for abnormal cases to be received in the larger Maternity Hospitals. In confinement cases when there is need of a person to look after the house during the lying-in period, whether the confinement takes place at the home or elsewhere, a Home Help may be supplied for the purpose. The duties of a Home Help are the ordinary domestic duties undertaken by the mother and should not include any work which properly belongs to the sphere of the trained nurse or midwife.

Food and Milk

Local Authorities are empowered, with the sanction of the Minister of Health, to provide food and milk at less than cost price to expectant and nursing mothers in cases in which the Medical Officer of Health or the Medical Officer of a Centre certifies that such provision is necessary on grounds of health, and when the woman cannot afford to pay the full cost. The quantity must not, ordinarily, exceed one pint *per diem* per person ; the supply is to be ordered for one month only.

Grants in Aid

The Ministry of Health pays to Local Authorities a grant amounting generally to half the expenditure incurred in connexion with the provision of the following services :

1. The salaries and expenses of Inspectors of Midwives.
2. The salaries and expenses of Health Visitors and Nurses engaged in Maternity and Child Welfare Work.
3. The provision of a midwife for necessitous women in confinement and for areas which are insufficiently supplied with this service.
4. The provision for necessitous women of a doctor for illness connected with pregnancy and for aid during the period of confinement for mother and child.
5. Hospital treatment for complicated cases of confinement or complications arising after parturition, or for cases in which a woman to be confined suffers from illness or deformity, or for cases of women who cannot with safety be

confined in their homes, or such other provision for securing proper conditions for the confinement of necessitous women as may be approved by the Medical Officer of Health.

Maternity Benefit

Definition.—Maternity Benefit (in cash, or otherwise) is payable to the mother on confinement or to some person specially authorized by her to receive it.

Rates of Benefit.—Payment is made as follows:—

1. A woman who is not an insured person is entitled to receive in respect of her husband's insurance Normally 40s.
2. An unmarried woman who is an insured person is entitled to this benefit Normally 40s.
3. A married woman who is herself an insured person, but whose husband is not, is entitled to two benefits from her own Society Normally 80s.

When, however, a woman has given up work on marriage and has come under the special scale of benefits for married women (*see* p. 79), she is not in any circumstances entitled to more than a single maternity benefit (normally 40s.) from her own insurance.

4. A woman who is herself, and whose husband also is, an insured person, is entitled to two benefits, one from her own and one from his Society if he is fully qualified, or otherwise, both from her own Society Normally 80s.

Arrears.—Arrears are not reckoned, in the case of a woman who is herself an insured person, during the two weeks before and four weeks after her confinement, nor in the case of a posthumous child, for the period following the death of the husband.

Conditions of Eligibility.—A person in respect of whose insurance Maternity Benefit is claimed must have been insured 42 weeks and have paid at least 42 weekly contributions. A form of claim must be obtained from the Society, and should be returned within seven days of the confinement. Many Societies require the production of a marriage certificate, and the Registrar will furnish a copy for this purpose for a reduced fee of 1s. if the requisite form supplied by him is filled up.

When the double maternity benefit is payable no remunerative work must be done by the mother during the four weeks following confinement. The rules of Societies require that a woman should be attended by a duly qualified medical practitioner, or a duly qualified midwife.

Method of Payment.—Under ordinary conditions the benefit is paid in cash, and the woman pays her own doctor or midwife, but the Society has discretion as to the form the benefit shall take. It may, if arrangements have been previously made, pay the doctor and pay the remaining portion of the benefit (if any) to the woman.

Married Women : Special Benefits.—An insured woman who marries ceases to be entitled to the ordinary benefits as soon as she has been away from work, otherwise than on account of illness, for 8 consecutive weeks within a year from the date of her marriage. She then becomes entitled to a special scale of benefits, viz. :—

- (1) Sickness or disablement benefit at the rate of 7s. 6d. a week for not more than 6 weeks in all during the year following the end of the 8 weeks of unemployment.
- (2) Maternity benefit of 40s. (subject to reduction for arrears) on her first confinement after the end of the 8 weeks of unemployment and within 2 years of the date of her marriage.
- (3) Medical benefit up to the 30th June or 31st December, whichever first occurs, after the expiration of a year reckoned from the end of the 8 weeks of unemployment.

If, however, she keeps at work after marriage and does not complete 8 consecutive weeks of unemployment within a year from the date of her marriage, she will continue to be entitled to the ordinary benefits, and will, on giving up work after a year has elapsed since marriage, be in the same position as any other insured person who ceases insurable employment—*i.e.*, she will become entitled to a free year's insurance and to medical benefit until the expiration of six months from the end of the half-year in which her insurance terminates.

Sickness Benefit is not necessarily payable in respect of pregnancy, but would normally be payable where satisfactory evidence was submitted that the woman's condition rendered her incapable of work. In any such case the rules of the Society, as to conduct during sickness, would have to be complied with.

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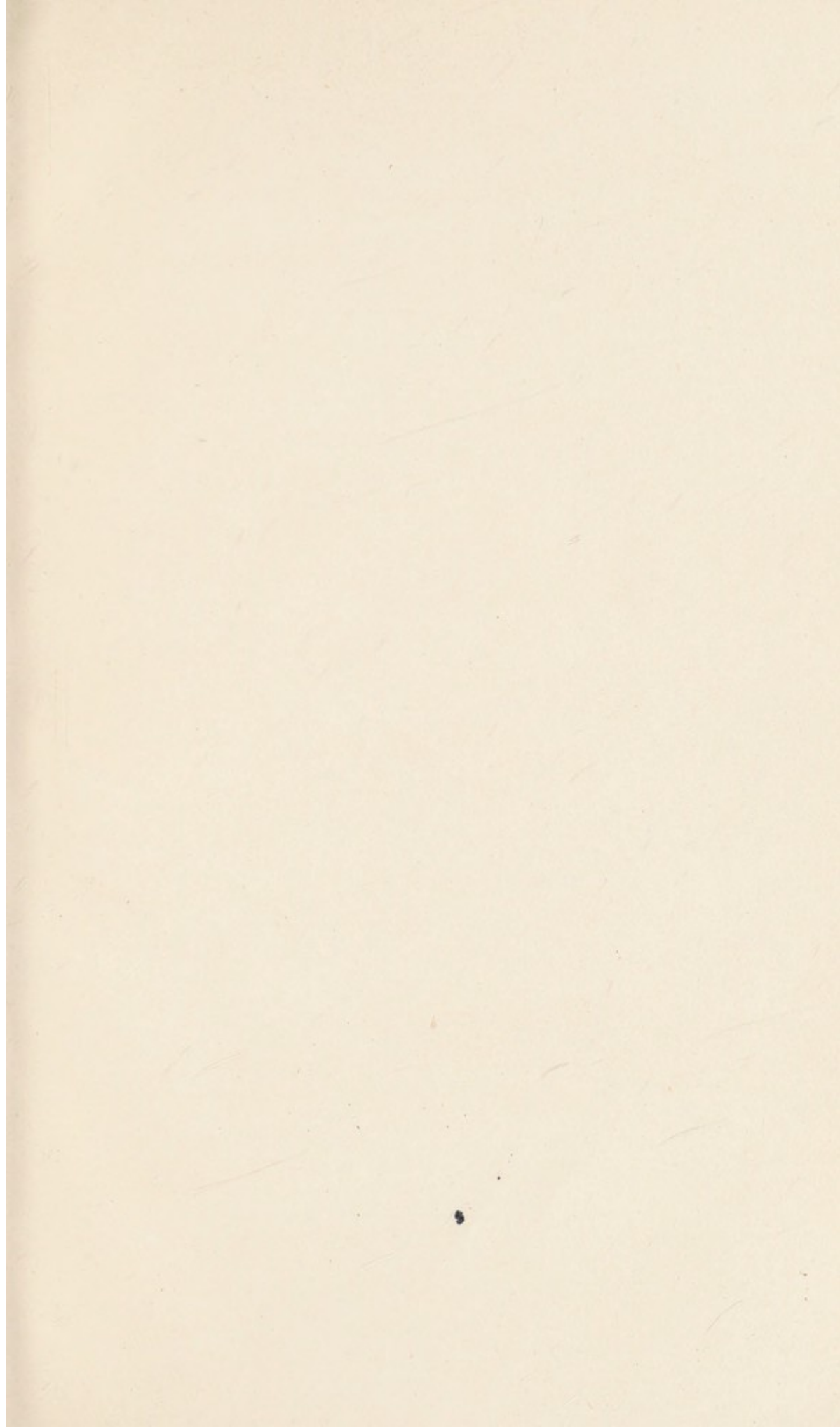
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