Domestic Economy

PAUL

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A TEXT-BOOK

OF

DOMESTIC ECONOMY

(COMPLETE)

ADAPTED FOR USE IN TRAINING COLLEGES, SCHOOLS AND NURSING INSTITUTIONS, AND AS A DOMESTIC BOOK OF HEALTH

BY

F. T. PAUL, F.R.C.S.

Surgeon to the Liverpool Royal Infirmary, Professor in Medical Jurisprudence Victoria University, and Lecturer in Domestic Economy at the Edge Hill Training College, Liverpool

WITH 175 ILLUSTRATIONS

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PREFACE

The general scope and arrangement of the instruction contained in this text-book on Domestic Economy are founded upon experience gained by the author in delivering annually a course of lectures on the subject at the Edge Hill Training College, Liverpool, the outline of which was originally suggested by Mr. Samuel Greg Rathbone, for many years the Chairman of the Liverpool School Board. It is hoped that the book may prove useful to other Training Colleges, as well as to High Schools, Elementary Schools, Nursing Institutions, and to housewives generally.

The section on Physiology, with which the subject is introduced, pretends only to give a very short and elementary sketch, the object being rather to convey a general conception of the structure and working of the human body, than to teach the details of any part of it.

The next sections on Food and Clothing are more complete; but none of the available space has been taken up with work which can only be properly taught in practical classes, such as the practical details of cooking, dressmaking, and laundry work.

Regarding Health as the first principle of Domestic Economy, somewhat more attention than is usual in a work of this class has been devoted to the teaching of subjects specially concerned with it. Thus Domestic Sanitation has been fully treated of under the headings The Home, Air, Ventilation, Heating, Lighting, Water Supply, and Removal of Waste Matters, and much space has been occupied with a popular consideration of the Causes and Prevention of Disease, Home Nursing, and First Aid in Emergencies.

For much help in preparing the chapters on Thrift, I am indebted to Miss Dewhurst, the teacher in this subject at the Edge Hill Training College.

The book is illustrated with a hundred and seventy-five engravings, of which fifty-one have been specially drawn for it. The remainder have been liberally supplied by Messrs. LONGMANS, GREEN, & Co. from various of their illustrated publications, chiefly QUAIN'S 'Anatomy,' FURNEAUX' 'Animal Physiology,' WILSON'S 'Health Science,' and CORFIELD'S 'Laws of Health.'

F. T. PAUL.

UNIVERSITY COLLEGE, LIVERPOOL.

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DOMESTIC ECONOMY

PART I

CHAPTER I

INTRODUCTORY

The meaning of 'domestic economy.'—The title 'Domestic Economy' is derived from the Latin word *domus*, a house or home, and the Greek words *oikos*, a house, and *nomos*, law.

The word 'economy' by itself means the regulation and management of a house or home; but it is generally used in the sense of care and prudence in the expenditure of money. On this account, when we use it in any other sense it has become necessary to put before the noun a distinguishing adjective, as in political economy, animal economy, and domestic economy.

Health should receive the first care in home management.—The management of the household expenses and the details of cooking used to be regarded as the most important branches of our subject. Now, however, we believe that the guiding principles in the management of the home should be founded upon the laws of health. Comfort and prosperity will largely depend upon a good and wise use of the money provided for the support of the family; but neither can be enjoyed without health. Let health, then, be the first consideration.

The conditions needed for a healthy home.—Health, happiness, and contentment generally go together, and for the very good reason that the conditions which make a home really pleasant and comfortable are much the same as those which make it healthy. Let us see what these conditions are. First, the house must be bright, sunny, airy, and clean; it must be warmed, ventilated, and drained in such a way as to be neither stuffy, draughty, nor given to bad smells. Second, the food must be wholesome and nourishing, sufficient, but not too much. Third, the water must be pure and the supply free. Fourth, the people must be clean and well clothed, their work must be suitable to their strength, and their rest sufficient. These are the chief things needed for health, and do we not seek them also for our pleasure and comfort?

Domestic economy teaches how to make the home healthy, happy, and contented.—The knowledge which enables a woman to make her home healthy, happy, and contented is the real domestic economy, the true household science. If you know what is wanted for your home, and how to perform your household duties, you will need to spend less money than many of your less fortunate neighbours, while you will be sure to get more comfort. It is ignorance that is wasteful. Through ignorance we buy the wrong sort of food, or we spoil good food by bad cooking, or good clothes by bad washing, and do a hundred other things which end in bringing poverty, discomfort, ill-temper, and ill-health into the home.

The requirements of health are not expensive.—The conditions required for a healthy home are not expensive; they cost no more than you will pay for a home without these conditions, and they are all within the limits of the wages of any steady working man. Sunshine, fresh air, pure water, and cleanly habits are fortunately not a question of money; they are free to rich and poor alike.

Food of some kinds is very dear, of others very cheap; but price bears very little relation to the nutritive value of the food. The poor man's wife, if she understands the use of the various food-stuffs, can buy for her family for about ten shillings a week food as valuable for the purposes of nutrition as the rich man's wife will pay ten times that amount for. Not only will the cheaper food, if properly chosen, yield as much nourishment, but it will probably be more wholesome; for the body keeps in the best health and does the best work on the simplest fare.

The same is true of clothing. If we understand the necessary and useful purposes served by clothing, we shall know that they are best fulfilled by the simplest garments.

Even a bright, cheerful, healthy house to live in, with proper conveniences and safe drainage, is more often a matter of knowledge than rent. She who knows the conditions which make a house healthy will find one having these wholesome characters quite as cheap as many others without them.

Subjects to be studied in domestic economy.—The actual things to be studied in domestic economy are the daily necessaries of life. First and most important is food—its varieties, digestion, preparation, and uses. Then there are other personal matters, such as clothing, cleanliness, work, and rest. Next comes the house—its site, aspect, ventilation, warming, lighting, water-supply, and drainage; then its furnishing and cleaning. Lastly must be considered sickness, accidents, and nursing.

Under each of these heads there is much to learn, yet it will be neither difficult nor irksome, because it deals with the common facts of everyday life.

There is also one other subject which has not yet been mentioned, a subject which, until recently, has only been taught to doctors and other students of science, a thing that some people still think it is better to know nothing about, and that even most clever, well-educated people do know nothing about. This subject is ourselves, our actual bodies.

Have you ever seen some fine piece of modern machinery at work? Say, a newspaper printing machine. At one end a tremendous roll of blank paper is rapidly unwinding and passing into the machine; at the other end, newspapers, printed, folded, and quite ready for use, are being turned out in vast numbers every minute. Is it not wonderful? How interesting to watch it; to have every part of the process explained, and to understand this marvellous feat of printing whole newspapers with such extraordinary rapidity from one set of type! Yes, this is indeed wonderful; but in the body of the humblest animal is machinery more delicate and wonderful than can be reached by the highest invention of man's genius. Most marvellous and beautiful of all is the machinery of the human body, and though it is not easy to understand, the pleasure of knowing something of the most perfect work of the Creation well repays the study. Thus, first of all, before learning how man's wants should be supplied, let us try to learn something of the human body—this living machine which needs so much care in food, clothes, and house.

CHAPTER II

THE HUMAN BODY—ITS RELATION TO OTHER THINGS—FEATURES CHARACTERISTIC OF ANIMAL LIFE

Man's body is like that of the higher animals.—The human body is composed of the same materials, and is formed upon the same plan as the bodies of the higher animals. Beneath our skin, as in a sheep or an ox, is the flesh or muscles which clothe the bones. In the abdomen we have stomach, bowels, liver, sweetbread, kidneys, and other parts like an animal, and intended to serve the same general purposes. In the chest are the heart and lungs, and in the head the brain. Indeed, man forms the highest species of the animal kingdom.

The three kingdoms.—Everything in the world belongs to one of the three great kingdoms. They are called the mineral, the vegetable, and the animal kingdom.

The mineral kingdom.—The mineral kingdom includes all things which have no life, and which have not been derived from living things, such as minerals, rocks, water, and air.

All things which have life are either plants or animals.

The vegetable kingdom.—The vegetable kingdom includes all those living things which are able to draw their nourishment from the mineral kingdom. Plants can by the influence of sunlight alter mineral substances in such a manner as to change them into the living or *organic* matter forming their stems, leaves, and fruits. Thus the mineral kingdom is the food of the vegetable kingdom.

The animal kingdom.—The animal kingdom comprises the rest of the living or organic world. Animals cannot nourish their bodies with mineral or *inorganic* matter as plants do. Directly or indirectly they draw their nourishment from the vegetable kingdom. That is to say, all animals are either vegetable feeders or they feed on animals whose bodies have been formed and sustained by vegetable food. Sheep and oxen are examples of vegetable feeders. A tiger is a flesh-eating animal. It cannot eat grass itself, so it nourishes its body with the flesh of animals like sheep, whose bodies have been formed from grass.

Order in the appearance of plants and animals on the earth.—This teaches us that the mineral kingdom must have been formed first, the vegetable kingdom next, and the animal kingdom last; for animals could not live until after plants came upon the surface of the earth for them to feed on, whilst plants feeding upon earth, air, and water could exist in the presence of sunlight and minerals alone. Of animals the vegetable feeders must of course have existed before the flesh feeders; whilst man being formed last, as the highest type of creation, naturally draws his food from both kingdoms, his proper diet being a mixture of animal and vegetable food.

Nutrition in plants and animals.—We also learn that the first great distinction between animal and plant life is the way in which **nutrition** is carried on in each.

In a plant certain parts or organs in its roots are capable of sucking up moisture and mineral substances from the earth. Other organs in the leaves absorb gases from the air. Together these organs form the sap, which runs through the plant and nourishes it.

An animal has a stomach in which its food is digested before it passes into the substance of the animal. The blood-vessels suck up the digested food which is contained in the stomach and bowels after a meal. It then circulates with the blood throughout the body and nourishes every part of it. Thus the *digestion of food* is one of the special features of animal life.

No living thing can exist without nourishment, therefore nutrition is common to both animal and plant life, though, as we have just learnt, animal nutrition is quite different from plant nutrition.

Motion and sensation in animals.—Other features which are special to and characteristic of animal life are **motion** and **sensation.** Motion is due to the action of the muscles or flesh of animals. Plants have no muscles. Sensation is situated in the brain and nerves, which, again, occur only in animals. Nutrition, motion, and sensation are the three great features or problems of animal life, which we are going to study as they occur in our own bodies.

CHAPTER III

HUMAN WORK—THE BODY A LIVING MACHINE—THE PARTS FOR WORKING AND THE PARTS FOR SUPPLYING POWER

Work of the body.—Having learnt in the last chapter some of the general features of animal life, and the relation of man to other things in the world, let us now look at the way in which man's work is done.

Two kinds of human work.—Human work is of two kinds—muscular and intellectual. A machine can be made to copy man's muscular work; but only an intelligent animal can give infinite variety to the work which it is able to perform. An ordinary animal or a stupid man works very much like a machine, doing the same kind of muscular work over and over again. A girl who is only capable of sewing together prepared work may be said to work like a mere machine; but one who can cut out and make articles of clothing, or design and make fancy work, is using brain as well as muscles, and is working with the intelligence characteristic of what may be called the human machine.

The body a living machine.—If we allow for the great difference which there must be between a machine constructed of brass and iron and one of flesh and blood, it is more easy to understand the working of the human body as a living machine than as a thing by itself and unlike anything else. Moreover, it really is a living machine, working on the same general principle as other machines.

The parts of a machine.—If we examine any kind of machine we shall see that its works may be regarded as belonging to two distinct parts. One of these is intended to execute the work, the other to supply it with power.

The water-mill.—In a water-mill there is the great wheel and its shaft to gather the force of the falling water and convey it to the other part which does the work, such as grinding corn, sawing wood, or whatever it may be.

Steam-engine.—In a factory there is the driving engine, with its furnace and boiler, to gather force from the burning coal and the steam, and there is the machinery for spinning and weaving.

Plough.—In a plough there is the horse to draw, and the plough to till the soil.

Sewing-machine.—In a sewing-machine there is the human hand or foot to turn the wheel, and the parts connected with the needle for sewing.

In every machine it is the same: one part supplies the power, and the other does the special work. The working part is motionless and useless without the power. Supply the power, and it will convert it into useful work.

Human work and human power.—The work which the human machine does is, as has been stated, of two kinds, muscular and intellectual; therefore the parts of the body required for human work are those concerned with motion and sensation. For **motion**: the muscles, with the bones and joints; for **sensation**: the brain, the spinal marrow, the nerves, and the organs of special sense. But the brain and muscles would be dead and useless if they were not supplied with life and power. This is the duty of the other part of the human machine—that which digests the food and causes the blood to circulate; for the blood carries life and power with it.

The lesson which this chapter teaches is that human work is performed by the parts of the body concerned with motion and sensation, and that human power is supplied to the muscles and brain by those parts concerned with nutrition.

CHAPTER IV

FOOD THE SOURCE OF HUMAN POWER—FOOD AS FUEL—PARTS OF THE BODY SYSTEMATICALLY ARRANGED IN GROUPS

The source of human power.—Whence comes the force or energy which enables us to work with mind and body? We learnt in the last chapter that no machine can work without a supply of power. Our bodies are like other machines in this respect. If we are not constantly supplied with the material from which power can be obtained, our strength fails and we die. Some machines get their power from falling water, some from electricity, some from horse or human power; but mostly it is obtained as in the steam-engine, from fuel. Anything that will burn gives heat, and heat gives power; for heat can be changed into motion, and motion is the form of power or energy which works the machine.

Food is fuel.—Food is the fuel of the human machine, and the source of human power. Most kinds of food are only a variety of fuel, and will burn readily. Fat, sugar, flour, and all farinaceous foods burn easily; so do all vegetables when dried, and even meat burns, though less readily.

Combustion of food.—It may seem strange at first to be told that vital heat and force are derived from the burning or combustion of food in our bodies, yet such is the case. Human work is quite as dependent upon the combustion of food as the work of the engine is dependent upon the combustion of coal. Now, it must not be supposed that a great heat is produced in any one part of the body by this combustion. The difference between us and the engine in this matter is that in the engine all the coal is burnt at one place in the furnace, causing a great heat, much of which is wasted; whilst in us the food is carried by the blood to the actual spot where the force is wanted, and nothing is wasted. If we only move a finger it requires some force, and that force is supplied by a little food which the blood gives to the muscle working the finger at the time that it moves. When we take a quick run a good deal of food is rapidly burnt in the muscles, and we presently begin to feel both hot and exhausted. We see now the important relation that food bears to the work and life of our bodies, and we know now why it is that we cannot live for more than a short time without food.

Parts of the body for obtaining force and heat from food.—As the engine has furnace, chimney, boiler, cylinder, valves, wheels, and other parts which are requisite to collect the energy from the burning coals, so the body has many parts for obtaining energy from burning food. These parts are those already referred to as concerned with *nutrition*. They may be arranged in four groups:—

(1) **The digestive system.**—The mouth, stomach, and bowels, where the food is dissolved and added to the blood.

(2) **The circulatory system.**—The heart and blood-vessels, which carry the digested food in the blood over the body.

(3) **The respiratory system.**—The windpipe and lungs, which supply air for the combustion of food.

(4) **The waste-removing system.**—The skin and kidneys, and partly the lungs and bowels, which remove the various waste products derived from food and from the wear and tear of the body.

Parts of the entire body arranged in groups.—We are now in a position to group together the parts of the whole body in their proper order.

1st. The internal parts concerned with *nutrition*: the digestive, circulatory, respiratory, and waste-removing systems just mentioned.

2nd. Those concerned with *motion*, and called the **locomotive system**: the muscles, bones, and joints.

3rd. Those concerned with *sensation*, and called the **nervous system**: the brain, spinal marrow, nerves, and the organs of special sense for sight, hearing, smell, taste, and touch.

The work of each group.—Let us recall here that the locomotive and nervous systems are the machinery which performs human work. All capacity to think, study, talk, write, walk, dance, swim, play music, or work in any way is done by these parts. Also that the digestive, circulatory, respiratory, and waste-removing systems are the parts which supply the others with power; and that the power is obtained from food.

CHAPTER V

THE DIGESTIVE SYSTEM—ITS VARIOUS PARTS—THE MOUTH—THE TONGUE, TEETH, AND SALIVARY GLANDS

Common knowledge about digestion.—We begin the description of the structure of the body with those parts concerned in the digestion of food. This is a process about which we all know something, though not perhaps very much. We know, for instance, that (1) we first of all chew the food, breaking it up with our teeth into small fragments; (2) we swallow it, and it goes down into the stomach; (3) we feel that some of it passes into our blood and strengthens us.

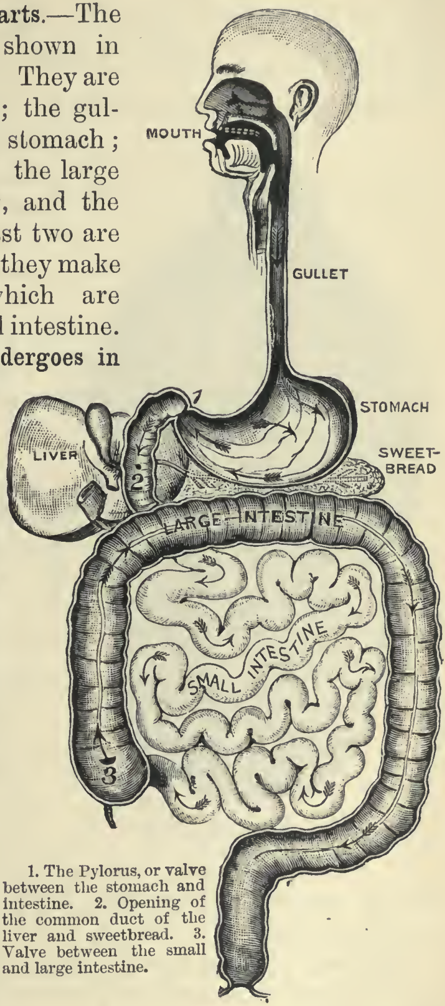
Deductions from the above.—This knowledge is not in itself very great, but it leads on to more. Thus, if food passes through us, there must be a pipe or canal for it to travel along. Again, if food enters the blood, as it does, it must be completely dissolved, for of course bread and meat could not circulate as such in the blood. Now, the digestive system is a tube or canal which passes through the body, and it is often called the digestive canal. And the process of digestion is a process of dissolving food so as to render it fit to enter the blood. Thus, by making use of the little knowledge we all possess we get a good general idea of the subject to start with. The idea is: (1) The digestive system is a tube or canal, beginning at the mouth and passing through the body, and (2) the digestion of food is its solution in the juices of the digestive canal.

Alimentary canal.—The digestive canal, or, as it is more commonly called, the alimentary canal (L. *alo*, to feed), is a long complicated tube in some places wide and in others narrow, in some straight and in others coiled up.

Its various parts.—The various parts are shown in the diagram (fig. 1). They are called: The mouth; the gullet or swallow; the stomach; the small intestine; the large intestine; the liver, and the sweetbread. The last two are solid and flesh-like; they make digestive juices which are poured into the small intestine.

Changes food undergoes in the mouth. — The mouth. — Food is submitted to three processes in the mouth. It is tasted, chewed, and mixed with saliva. Thus the tongue, teeth, and the glands which make the saliva are the most important structures in connection with it.

The tongue.—The tongue is a muscular organ, capable of moving very freely in every direction. The under side is soft and smooth, but



1. The Pylorus, or valve between the stomach and intestine. 2. Opening of the common duct of the liver and sweetbread. 3. Valve between the small and large intestine.

Fig. 1.—Alimentary Canal.

the top is covered with small rough points which have hardened tips to protect it from friction with the food (fig. 2).

Its papillæ.—It is these points, called papillæ, which become furred in illness, and which are so much rougher in the tongues of some animals, as, for instance, the cat. The larger spots, especially those arranged in a V-shape at the back, are endowed with the special senseof taste.

Fig. 2.—The Upper Surface of the Human Tongue.

Its uses.—The uses of the tongue are: (1) For taste; (2) to move the food about in the mouth for chewing and swallowing; and (3) for forming some of the sounds in speaking.

Teeth.—The teeth are of three kinds (fig. 3).

Incisors.—The front, or incisor, teeth are four in number in each jaw. They have a cutting edge shaped like a chisel, and are intended to bite or cut off mouthfuls of food.

Canines.—Next come the dog or canine teeth, one on each side of the incisors, making two in each jaw. They are strong, pointed teeth, and are always present in flesh-eating animals.

Molars.—Behind the canines are the grinders or molars; teeth with an irregular flat surface, intended for crushing food into small fragments (fig. 4). These teeth, when the grinding surface is large, are characteristic of vegetable feeders.

Number of teeth.—In young children there are only two molars behind each canine, making eight in the two

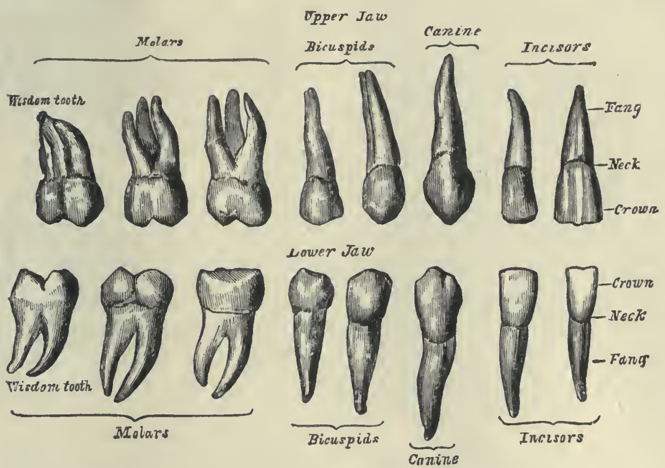


Fig. 3.—The Permanent Teeth removed from the Jaws.

jaws. In adults there are two small and three large molars, making twenty in all. Thus children have altogether only twenty teeth: eight incisors, four canines, and eight molars, whilst adults have thirty-two: eight incisors, four canines, and twenty molars.

Temporary set.—A new-born baby has no teeth. The first are cut when it is about seven months old, and the others from that time up to two or two and a half years old. This is called the temporary set of teeth (fig. 5).

Permanent set.—At the age of seven years the front teeth begin to drop out, and are replaced by the permanent incisors. Later on all the temporary set are similarly replaced by permanent teeth, whilst the larger

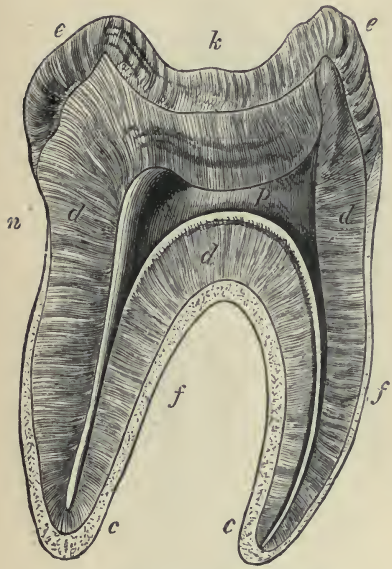


Fig. 4.—Longitudinal Section of a Molar Tooth (magnified).

k, crown ; *n*, neck ; *f*, fangs ; *e*, enamel ; *d*, dentine ; *c*, cement ; *p*, pulp cavity.

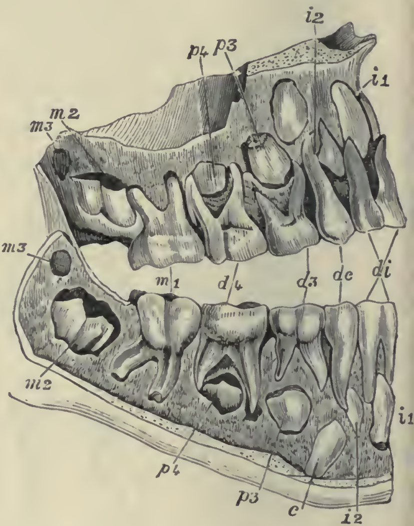


Fig. 5.—Section of the Jaws of a Child of 6½ years, showing the Milk or Deciduous Teeth ; also the Permanent Teeth in Process of Formation.

di, the milk incisors; *dc*, the milk canines; *d* 3 and *d* 4, the milk molars; *i* 1 and *i*2, the permanent incisors ; *c*, the permanent canines ; *p* 3 and *p* 4, the permanent bicuspids ; *m* 1, the first permanent molars, which have already made their appearance ; *m* 2 and *m* 3, the second and third permanent molars.

molars come up behind the first set as the jaws increase in size. The last or wisdom teeth do not come into place until full growth has been attained, at about twenty-one years of age.

Salivary glands.—The salivary glands are soft pieces of flesh like sweetbread to look at. They are six in number, three on each side of the face (fig. 6).

FIG. 6.—The Salivary Glands.

One side of the lower jaw has been removed, and the face dissected, in order to show the salivary glands of the right side.

Use of a gland.—A gland is a piece of flesh which manufactures from the blood some particular kind of juice or fluid required for purposes like digestion. The liver, for example, makes the bile, and the salivary glands make the saliva.

Position of salivary glands.—One gland is placed in front of and below the ear. A tube or duct passes from it across the cheek and enters the back part of the mouth, to carry the saliva from the gland to the mouth. This is the gland which becomes hard and painful in the disease called mumps. The second gland is placed under the edge of the jaw, and the third under the tongue.

Uses of saliva.—The use of saliva is to moisten dry food, and bind it into a bolus so that it can be swallowed, and to digest some part of the starchy substances.

CHAPTER VI

DIGESTIVE SYSTEM (*cont.*)—THE GULLET—STOMACH—SMALL INTESTINE—LARGE INTESTINE—LIVER—SWEETBREAD

The Gullet: Swallowing.—The food is swallowed down a long tube which leads from the mouth to the stomach (fig. 1). It is called the gullet. The wall of the tube is composed of muscle, and it is by the action of this muscle that food or drink is pushed down the tube. Muscle is the flesh of the body which has the power to cause movements. There are two kinds of muscle, one like that in the arms and legs which only moves when we make it, and another which moves of its own accord.

The muscular coat of the gullet.—The top of the gullet is made of the muscle over which we have control, the lower part of that which acts without the will. We can please ourselves whether we begin to swallow or not; but once commence the act, and we cannot stop half-way. All the rest of the digestive tube is surrounded by the kind of muscle over which we have no control, so that when once food is fairly in the gullet, it passes slowly along the rest of the tube of its own accord.

The Stomach (fig. 7) is a bag-like enlargement of the digestive tube into which the chewed food is received from the gullet. Here it remains until it is reduced to a soup-like fluid.

Coats of the stomach.—The stomach has three coats, an outside slippery one to enable it to move easily, a middle layer of muscle (fig. 8), and an inside coat of soft membrane. The latter is full of little glands called

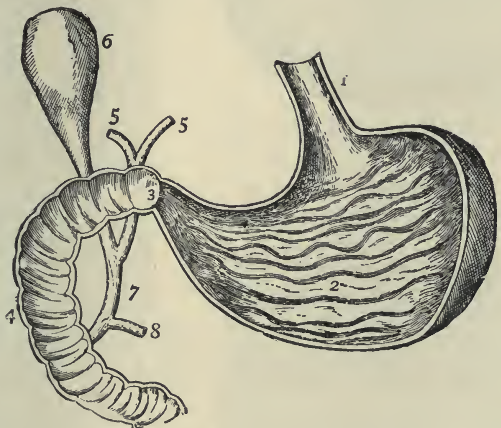


Fig. 7.—The Stomach and the Intestine, laid open to show the Lining Membrane.

1, gullet; 2, lining membrane of the stomach; 3, pylorus; 4, intestine; 5, the ducts which convey the bile from the liver; 6, gall-bladder; 7, common bile duct; 8, the sweetbread duct.

the peptic glands (figs. 9 and 10), which make the gastric juice to dissolve the food.

Valve of the stomach.—The stomach leads on into the intestine, but between the two is a valve, the pylorus (figs. 1 and 7). The valve is closed during digestion, but when that is completed it opens, and the soup-like contents of the stomach are squeezed out by the muscular coat.

The small intestine.—The small intestine is a narrow tube about twenty feet long, down which the food passes after leaving the stomach. It is gathered up into folds

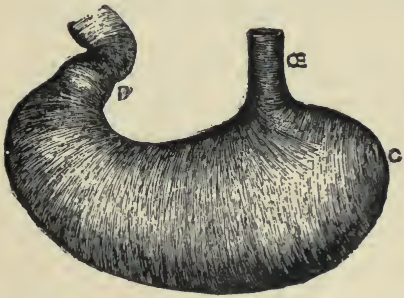


FIG. 8.—Muscular Coat of the Stomach.
Middle layer of circular fibres.

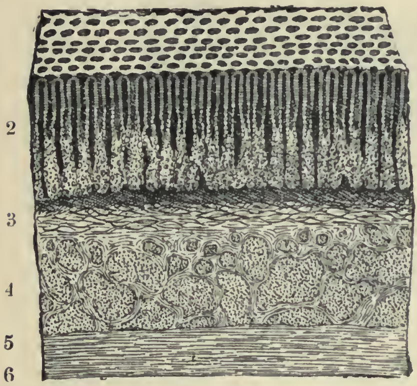


FIG. 9.—A Section through the Walls of the Stomach (magnified 15 diameters).

1, surface of the lining membrane, showing the openings of the peptic glands; 2, the glands; 3, subglandular tissue; 4, transverse muscular fibres; 5, longitudinal muscular fibres; 6, outside coat.

FIG. 10.—Peptic Gland from the Mucous Membrane of the Stomach (highly magnified).

or coils, and ends by opening into the large intestine through a valve (fig. 1).

Ducts of liver and sweetbread.—The ducts from the liver and sweetbread open into the small intestine near its commencement (fig. 7). These ducts convey the juices formed by these parts, to be mixed with the food as soon as it leaves the stomach.

Coats of the intestine.—The intestine, like the stomach, has three coats: an outside slippery one, a middle muscular coat to move the food slowly along, and a

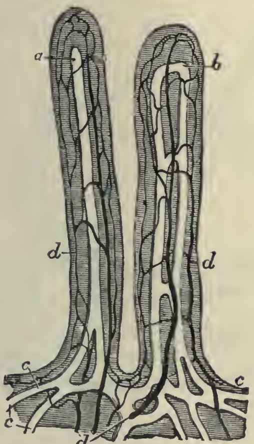


Fig. 11.—Two Intestinal Villi (magnified 100 diameters).
a, *b*, and *c*, lacteals for absorbing fat; *d*, blood vessels.

Fig. 12.—The Ileo-cæcal Valve.

lining membrane. The last, however, does not make a digestive fluid, but is covered with a velvety fringe of small points called villi (figs. 11 and 14), the object of which is to absorb the digested food into the blood.

The large intestine.—The large intestine (fig. 1) is only four feet long. It is the last part of the digestive tube. It is about two or three times as wide as the small intestine, which it otherwise resembles except that it has no villi.

The valve.—It commences at the valve leading from the small intestine, which allows the contents to pass in an onward direction only (fig. 12). It is not coiled up like the latter, but is arranged in a single fold around it.

The liver (fig. 13) is a large gland.

Bile.—It makes the bile, which is poured into the small intestine near the stomach, and helps to continue

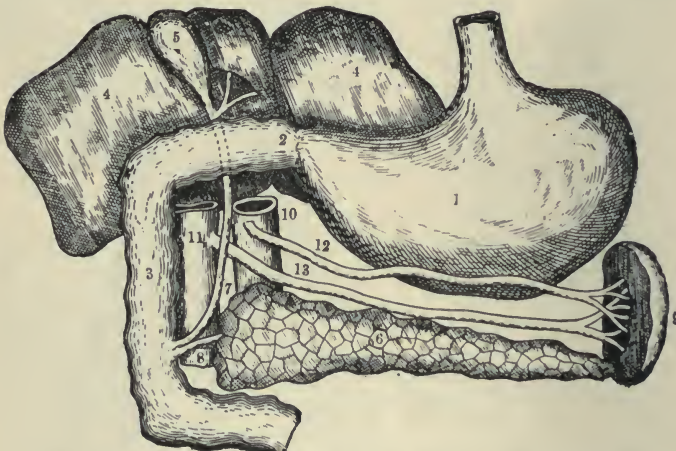


Fig. 13.—The Stomach, Intestine, Liver, Spleen, and Sweetbread.

1, stomach; 2, pylorus; 3, intestine; 4, liver (under surface); 5, gall-bladder; 6, sweetbread; 7, bile duct; 8, sweetbread duct; 9, spleen; 10, 11, 12, and 13, blood vessels.

the digestion of the food. The liver has some other duties of greater importance, which will be referred to later on.

The sweetbread.—The sweetbread (fig. 13) also makes a digestive fluid, which is poured into the intestine at the same place as the bile. This fluid is one of the most important aids to digestion, and the only duty which the sweetbread performs is to supply it.

Summary.—The digestive tube or alimentary canal consists of five parts: 1. The mouth. 2. The gullet. 3. The stomach. 4. The small intestine. 5. The large intestine.

In the mouth the food is chewed and mixed with the saliva.

It is next swallowed down the gullet.

It remains in the stomach until it is reduced to the consistence of pea soup.

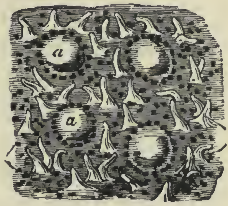


FIG. 14.—A small portion of the Lining Membrane of the Small Intestine (magnified 12 diameters to show the Villi).

In this liquid state the food escapes through the valve of the stomach into the small intestine.

There it is mixed with the juices of the liver and sweetbread, and when completely digested is absorbed by the villi.

The remains pass on through the valve into the large intestine.

CHAPTER VII

THE DIGESTION OF FOOD—THE DIGESTIVE PROCESSES—THE FOOD PRINCIPLES

Digestion a complicated process.—From what has been learnt in the two previous lessons, it will be understood that the process of digestion can be by no means a simple one. The digestive tube is long, and consists of many parts; and the digestion of food in it is a proportionally prolonged and complicated process.

Chief parts used for digestion.—Of the parts that have been described, the teeth, salivary glands, stomach, and sweetbread are the most important for digestion.

Chewing or mastication.—The teeth perform the first process, which is chewing or mastication of the food, This is very important, as the stomach is not formed to digest solid mouthfuls of food. When food is swallowed without being properly chewed, too much work is thrown upon the stomach, which sooner or later suffers in consequence from indigestion. Chewing is not only necessary for the purpose of grinding up the food, but also to mix it with the saliva, which digests certain parts of it.

Action of the digestive juices upon food.—Saliva acts upon one kind of food substance, namely starch; it digests starch by converting it into sugar. The stomach with its gastric juice acts only upon another kind of food substance, and therefore before these processes can be explained, it is necessary to know the different kinds of food substances.

Kinds of food.—Foods are classified in two ways: first, into substances as we eat them, such as bread, meat, potatoes, and so forth; and secondly, into the so-called principles of which they consist. For example, meat consists of fat and lean. Bread consists of starch, and a flesh-like substance called gluten. Potatoes consist almost entirely of starch. It is this second kind of classification of food which we must know to be able to understand digestion.

The food principles.—There are three kinds of food principles. 1. Flesh-like substances; 2. Fat and oil of all kinds; 3. Starch and sugar.

The flesh-like substances are contained more or less in all our foods, especially in lean meat, eggs, and milk; and to a less extent in wheat, oats, barley, rye, and vegetables.

Fat is derived chiefly from fat meat, butter, cream, and yolk of eggs, and to a less extent from some vegetable substances. Starch is almost pure in arrowroot, and is the chief constituent of bread, oatmeal, cornflour, rice, sago, and potatoes.

Digestion of the three food principles.—By digestion we mean that these substances are converted into a thin fluid which can be taken into the blood for nutrition. Flesh-like substances are dissolved to form a kind of meat juice. Fat and oil are made into a cream, and starch, as has been said, is changed to sugar. Thus the result of digestion is to convert food substances of all kinds into meat-juice, cream, or sugar, in which condition they are added to the blood for nutrition.

CHAPTER VIII

DIGESTION OF FOOD (*continued*)—THE DIGESTIVE JUICES—THEIR ACTION ON FOOD—SUMMARY OF DIGESTION

Four digestive juices.—There are four digestive juices poured into different parts of the digestive tube: the saliva, the gastric juice, the bile (liver juice), and the sweetbread juice.

Saliva acts on starch.—The saliva is formed at the time of eating by the salivary glands already described. It is mixed with the food as the latter is chewed, and begins at once to act on the starch contained in each mouthful. If a piece of bread, which is about one-half starch, is chewed for a long time, a sweetish taste is observed. This is due to the action of the saliva in digesting the starch by converting it into sugar.

Gastric juice acts on flesh-like substances.—The gastric juice is made by the lining membrane of the stomach. It is only poured out when fresh food is swallowed. It is of a sour nature, and as it soaks into the mouthfuls of food, it stops the action of the saliva. Gastric juice dissolves all flesh-like substances, such as lean meat, the meshes of fat meat, but not the oil, eggs, the curd of milk, and the flesh-like substance contained in small quantity in bread and all vegetable foods. Food is kept in the stomach by the valve for from one to four hours, according to the digestible nature of it. Fluids like water, tea, or beer are absorbed by the blood vessels of the stomach and, with them, that part of the food which has been digested.

Changes in the food in the stomach.—By the time that stomach digestion is finished the following changes have occurred in the food: 1. Some starch has been converted into sugar by the saliva. 2. Some flesh-like substances have been dissolved by the gastric juice. 3. These, together with any fluid swallowed with the food, have been absorbed, or taken into the blood, by the blood vessels of the stomach.

Then (1) the rest of the starch and vegetable matter escapes through the valve into the intestine.

(2) The rest of the flesh-like substances, softened and very much broken up, does the same.

(3) The fat, released from its meshes, passes into the intestine as globules of oil.

Bile removes the sourness of the gastric juice.—As the sour soup-like contents of the stomach escape into the small intestine, they cause a flow of bile and sweetbread juice, which mixes with them. These juices, like the saliva, are the opposite of sour, so they, especially the bile, correct the acidity of the gastric juice. The chief use of the bile is to kill the acid of the gastric juice, so that the sweetbread juice may act, for it cannot act while any sourness remains.

Sweetbread juice digests all food substances.—The sweetbread juice is the most perfect digestive fluid of the four. It digests all the food principles. It converts starch into sugar. It dissolves flesh-like substances; and it, with the help of the bile, turns fat into a cream. The sweetbread juice continues to act slowly while the food passes along the whole length of the small intestine. As the substances are digested they are absorbed by the villi; the sugar and meat juice by the blood vessels, and cream or fat emulsion by the lacteals.

Summary of digestion.—Food is digested by being first ground up by the teeth, and then dissolved in the digestive juices. There are four digestive juices: 1. saliva; 2. gastric juice; 3. bile; 4. sweetbread juice.

The saliva acts on starch, converting it into sugar.

The action of the saliva is stopped by the sourness of the gastric juice.

The gastric juice acts on flesh-like substances, converting them into a kind of meat juice.

Food remains in the stomach from one to four hours.

The bile kills the acid of the gastric juice, and stops its action in the intestines.

The sweetbread juice converts starch into sugar, flesh-like substances into meat juice, and fat into cream.

Fluids and substance *completely* digested in the stomach are absorbed by its blood vessels.

But most of the digested food is absorbed by the villi of the small intestine.

CHAPTER IX

THE CIRCULATION OF THE BLOOD—BLOOD—SITUATION—CHARACTER—CORPUSCLES—USES

Blood penetrates every part of the body.—If we happen to cut or prick any part of the body, it always bleeds. This shows that the blood vessels penetrate everywhere. They are so small and so close together that even a pin cannot enter the flesh without wounding some of them, and permitting the blood to escape.

Fig. 15.—This diagram shows the great artery called the *aorta* separated from the heart.

1 is the part of the artery that is fastened to the left side of the heart, where all the pure blood is held; 2 and 2 are the arteries which carry the pure blood into the arms; 3 and 3, those that carry the blood into the head; 4, artery which divides into three branches to feed the stomach, liver, and spleen; 5, arteries that go to the kidneys; 6 and 7, arteries supplying the bowels; 8, 8, arteries that carry the blood to the legs.

The blood is in tubes or vessels.—The blood vessels begin as one main vessel, like the trunk of a tree (figs. 15 and 21). It comes from the left side of the heart, and divides again and again into thousands and even millions of branches, which run between all the fibres of the body. The blood is never loose in the tissues; it always keeps inside the little tubes or vessels; but their walls are so thin that through them the muscles, brain, and glands can, as it were, suck the nourishment out of the blood as it passes along them.

Coagulation of the blood.—If you prick your finger and let the drop of blood which escapes remain at rest for a minute or two, it will set into a jelly. This is called the clotting or coagulation of the blood.

Uses of coagulation.—It is due to this natural change that the wounded vessels become plugged up, and the bleeding ceases. When a waterpipe bursts, the water goes on running till the hole is soldered up. The same thing happens in bleeding: when a vessel is wounded it bleeds until the blood clots and stops the hole. If the blood did not clot, the person would gradually bleed to death, from even so small a wound as a cut in the finger.

Nature of blood.—Blood, as we all know, is a rather thick red fluid. When a drop of it is magnified under the microscope (fig. 16), the red colour is seen to be due to a number of minute red particles in it, the fluid itself being really like thin white of egg.

Blood corpuscles.—The particles are called the blood corpuscles: amongst the red ones are a few white ones, so they are called the red corpuscles and the white corpuscles. Blood, then, consists of a fluid like thin white of egg, in which are myriads of red corpuscles and a less number of white ones. The reason why it looks like a red fluid to the naked eye is that the corpuscles are too small to be distinguished, except when magnified.

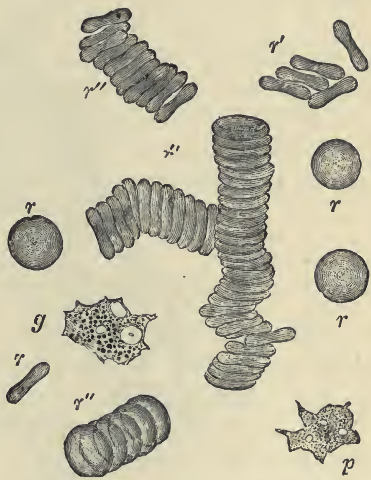


Fig. 16.—Blood Corpuscles, as seen under a powerful microscope.

r, red corpuscles lying flat; *r*′, red corpuscles on edge and viewed in profile; *r*″, red corpuscles arranged in rouleaux; *p* and *g*, colourless corpuscles.

Size of the corpuscles.—The red ones are so small that it takes 3,500 placed side by side to make an inch, and as they are shaped like coins, it takes more than 10,000, one on the top of another, to make a pile an inch high.

The white ones are a little larger, and are globular like peas, or of various irregular shapes.

Uses of the blood.—The uses of these different parts of the blood are as follows:—

(1) The egg-like fluid nourishes the tissues of the body, and carries the digested sugar and fat to the brain and muscles for their work.

(2) The red corpuscles carry fresh air from the lungs to the tissues, and foul air back from the tissues to the lungs. They are the air carriers.

(3) The white corpuscles heal up all injuries such as cuts, ulcers, and broken bones. They destroy disease germs, and are the general agents of repair.

CHAPTER X

CIRCULATION OF THE BLOOD—HEART, ARTERIES, AND VEINS

The heart keeps the blood in constant motion.—The blood is always in a state of motion in the blood vessels. It does not rest for a single moment. The heart (figs. 17, 18, 19) is the cause of its moving on or circulating in the vessels. At each beat the blood is forced along for a certain distance, and as the heart beats sixty or seventy times a minute it makes the blood flow on rapidly.

The blood flows in a circle.—The reason why the current of blood is called circulation is that it flows in a circle. It is pumped out of the heart through one pipe or blood vessel, and comes back to the heart by another. This is repeated over and over again, and thus the blood is always circulating round and round, from the heart, through the tissues of the body, and back to the heart again.

Object of the circulation of the blood.—The chief object of the circulation of the blood is to supply all parts of the body with food and fresh air. To do this it goes from the heart charged with nutrition and fresh air; but it returns impoverished and charged with foul air instead. Now, before the blood is fit to go round again

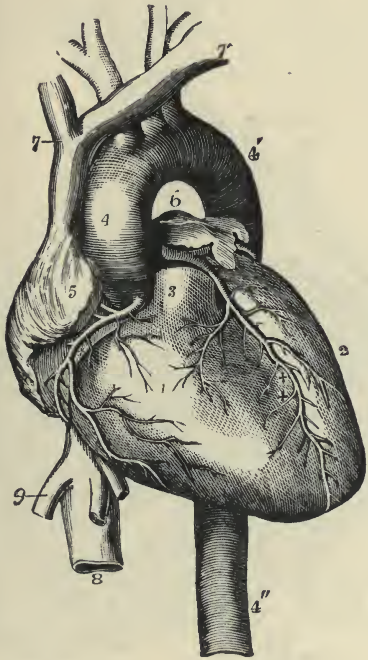


Fig. 17.—The Human Heart and its Vessels, viewed from before.

1, right side; 2, left side; 3, root of artery to the lungs cut short; 4, 4′, and 4″, the aorta; 7, veins which unite from the upper half of the body; 8, veins from lower half of the body.

it must take up a fresh supply of food from the digestive system, and change the foul air for fresh in the lungs. Herein is the difficult part of the circulation, for it is easy to understand the blood being pumped from the heart to the tissues and supplying them with all they need, but it is not so easy, without the help of a diagram,

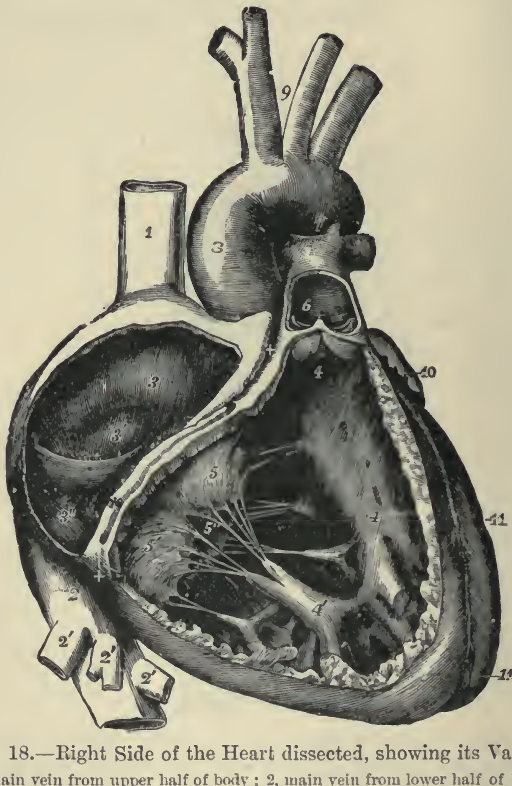


Fig. 18.—Right Side of the Heart dissected, showing its Valves.

1, main vein from upper half of body ; 2, main vein from lower half of body ; 6, pulmonary artery supplying the lungs ; 8, aorta, or main artery, supplying the body.

to follow the circulation as the blood picks up fresh food and fresh air.

The circulation of the blood. — Figure 20 is intended to represent the principle of the circulation only, for of course it would be impossible to draw all the actual vessels.

The heart.—The heart is a double pumping organ with valves. The left side pumps the blood into the main vessel going to the body shown at the arrow (1) fig. 20.

Circulation through body.—It passes through this vessel into all the minute branches supplying every tissue of the body (2). Then back by the main vein (3), return-

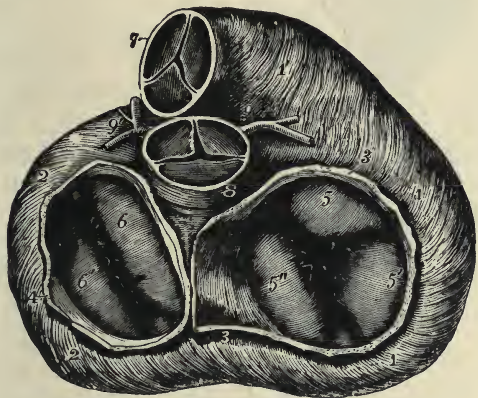


Fig. 19.—The Base or Upper End of the Heart, showing all the Valves.

5 and 7, valves of the right side; 6 and 8, valves of the left side.

ing to the right side of the heart (5). On its way it is joined by the vein (4), bringing fresh nutrition from the digestive system through the liver.

Circulation through lungs.—From the right side of the heart the blood is driven into the main vessel (6), going to the lungs (7). Lastly, back by the main vein from the lungs (8) to the left side of the heart again (9).

Rate of circulation.—This course of double circulation through body and lungs is always going on, and it is

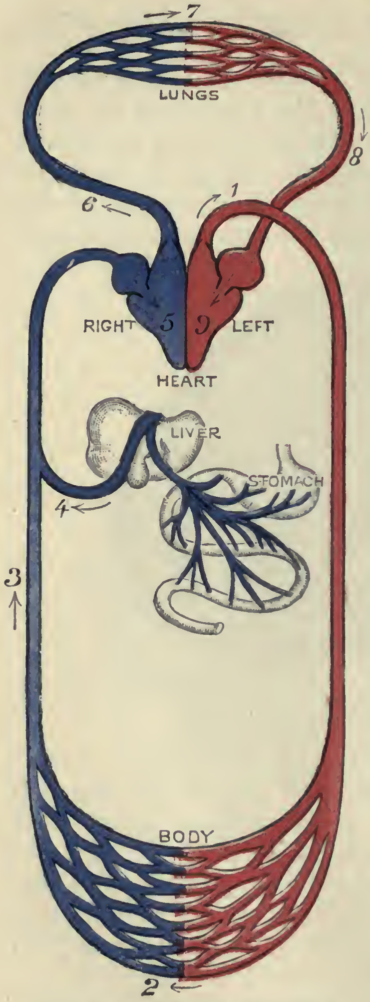


Fig. 20.—Scheme of Circulation.
Arteries red, veins blue. For reference to numbers see text.

estimated that the whole blood in the body completes the double round twice a minute.

The arteries. — The chief force of the heart is expended in the main vessel and its branches, going from the heart (fig. 21). These are called the arteries, and they pulsate at each beat of the heart. The pulse at the wrist is one of the smaller arteries which supplies the hand with blood.

The veins.—The returning vessels do not pulsate, they are thin-walled and soft, and are called veins. They usually run side by side with the arteries (fig. 21). The blue-looking veins can be seen and felt on the back of the hand, and on the arm.

Arterial and venous blood.—The blood in the arteries is of a bright red colour, being charged with pure air, and bounds along at a rapid pace. That in the veins is dark and impure, and flows more slowly.

Summary of circulation.—The circulation is maintained by the heart, which is a double pumping organ with valves.

The object of the circulation is to carry food and air to the tissues.

The left side of the heart pumps pure blood to all parts of the body.

The blood returns to the right side impure, picking up a fresh supply of digested food on the way.

The right side of the heart pumps the impure blood through the lungs, and it returns pure again to the left side. This double circulation is completed by all the blood in the body twice a minute.

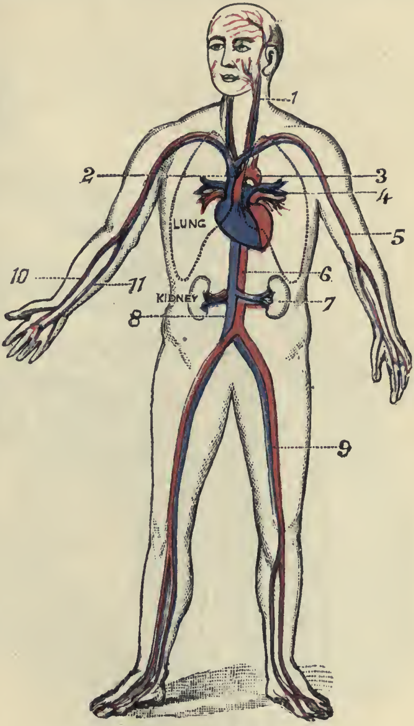


Fig. 21.—Diagram of Main Arteries (red) and Veins (blue).

3 and 6, aorta, or main artery of the body; 2 and 8, main veins of the upper and lower halves of the body; 1, vessels of the head and neck; 4, of the lungs; 5, of the arm; 7, of the kidney; 9, of the leg; 10, the radial artery or pulse; 11, artery of inner side of the arm.

The arteries are the vessels carrying the blood from the heart to the tissues. They contain bright red blood, and pulsate with each beat of the heart, 60 to 80 times a minute. The veins are the vessels returning the blood to the heart, and the blood which they contain is dark and impure.

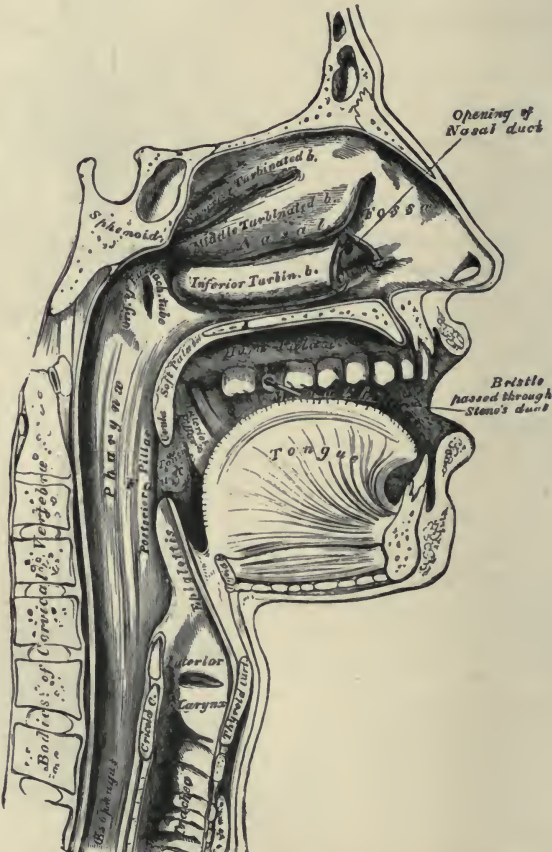


Fig. 22.—The Mouth, Nose, Windpipe, and Gullet seen in Section.

CHAPTER XI

RESPIRATION — RESPIRATORY ORGANS — CHANGES BETWEEN THE BLOOD AND AIR—THE CHEST—INSPIRATION AND EXPIRATION

Respiratory organs.—The parts of the body used for breathing are: (1) the nose; (2) the windpipe; (3) the lungs; (4) the chest.

The nose (fig. 22) is the proper channel for breathing, not the mouth. Most animals breathe constantly through the nose, as for example the horse. One advantage of breathing through the nose is that the air becomes warmed and is less liable to cause cold on the chest. Another is that dust adheres to the inside of the nose, instead of being carried down into the lungs, where it acts as an irritant and may cause disease.

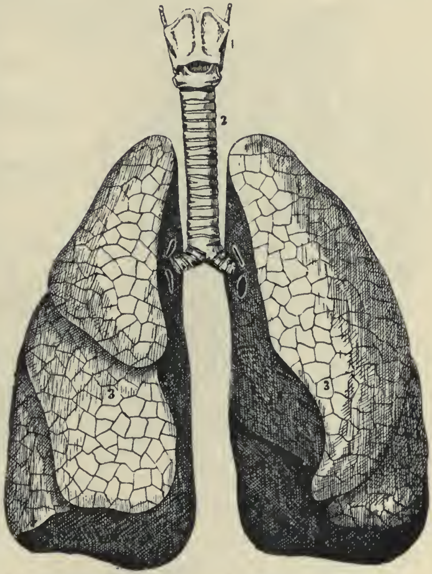


FIG. 23.—Front View of the Windpipe and Lungs.
1, larynx; 2, trachea (windpipe); 3, lungs.

Windpipe.—The windpipe (fig. 23) is the air tube passing from the back of the mouth to the lungs. It is a large hard tube which is easily felt in the neck, where it is placed in front of the gullet (fig. 22). The most prominent part is sometimes called Adam's apple; this is the larynx where the vocal cords are placed, which cause the voice. The hardness of the windpipe is due to rings of gristle in its wall, which are intended to keep it open as the spiral wire keeps open a rubber gas tube. If the windpipe did not keep open, of course we should die at once for want of breath.

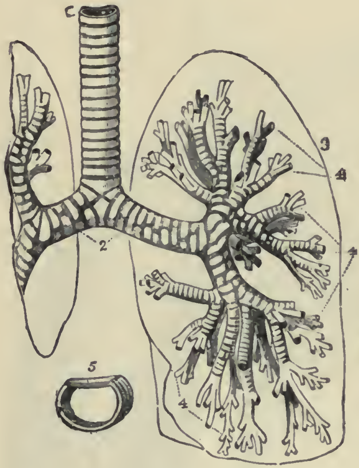


Fig. 24.—The Air or Bronchial Tubes of the Lungs.

Fig. 25.—Air Cells of the Lungs (magnified).

Lungs.—The lungs (fig. 23) are two spongy organs which with the heart between them fill the chest. Air enters the lungs through the windpipe and bronchial tubes (fig. 24), and it is in these organs that it is brought into contact with the blood.

Changes between air and blood in the lungs.—The changes which take place in the air cells of the lungs (fig. 25) between the blood and the air are: (1) Oxygen

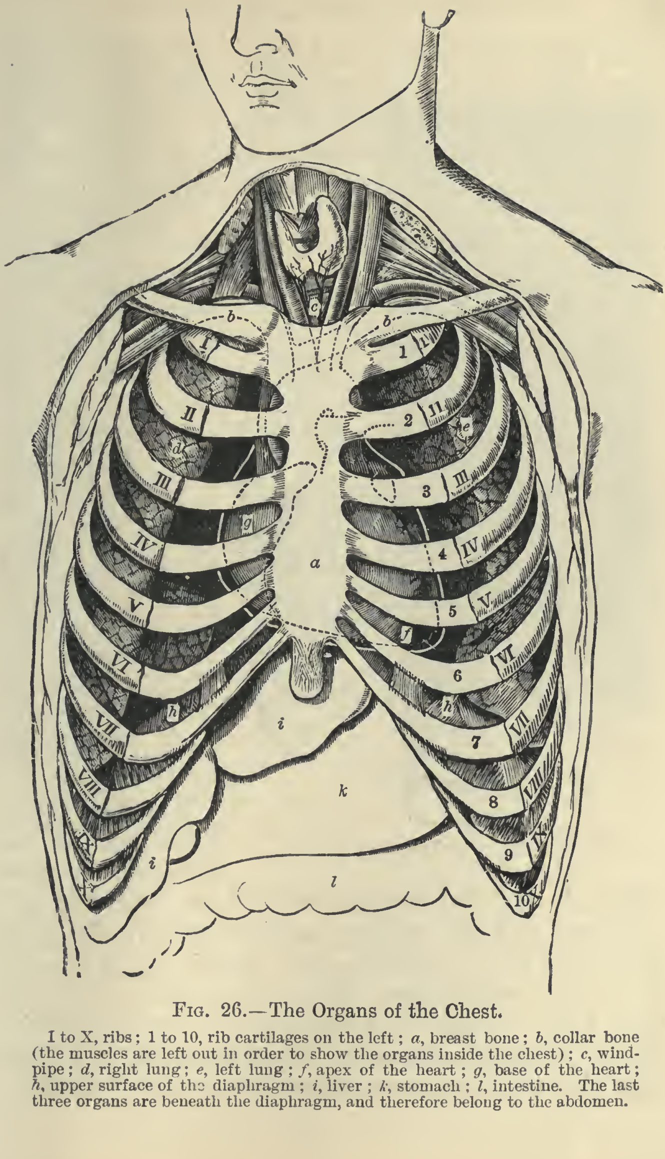


Fig. 26.—The Organs of the Chest.

I to X, ribs; 1 to 10, rib cartilages on the left; *a*, breast bone; *b*, collar bone (the muscles are left out in order to show the organs inside the chest); *c*, windpipe; *d*, right lung; *e*, left lung; *f*, apex of the heart; *g*, base of the heart; *h*, upper surface of the diaphragm; *i*, liver; *k*, stomach; *l*, intestine. The last three organs are beneath the diaphragm, and therefore belong to the abdomen.

(pure gas of the air) is taken into the blood; (2) carbonic acid gas (foul gas of combustion), warmth, and moisture pass out from the blood. So the blood loses foul gas, warmth, and moisture with the air breathed out, and takes up pure gas from the air breathed in.

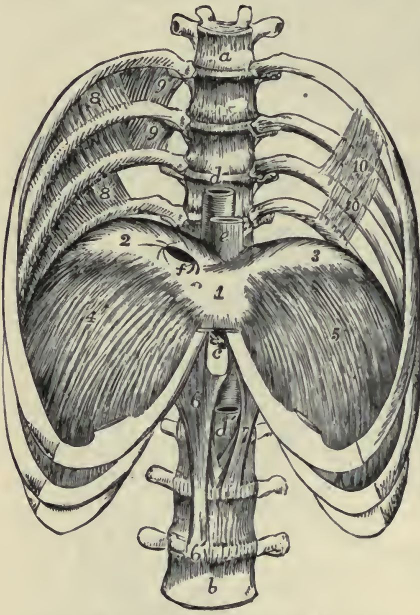


Fig. 27.—The Diaphragm or Midriff.

Chest. — The chest (fig. 26) is a box-like part of the body shaped like a cone. The sides are formed by the ribs, and the skin and muscles over them. The bottom is closed by the midriff or diaphragm (fig. 27), a flat leaf of muscle between the chest and abdomen. The windpipe enters at the top, and the lungs expand and fill the inside.

Respiration.—Breathing in, *inspiration*, is a muscular act. It is due to the muscles of the chest causing it to enlarge, and thus making the lungs expand. The chest is enlarged in two ways (fig. 28). One is by the muscles of the ribs raising them, and thus deepening the chest from before backwards. The other is by the midriff, which is arched upwards, being flattened, and thus deepening the chest from above downward. When the chest is enlarged in this way, air rushes in to fill the lungs. Breathing out, *expiration*, is an elastic recoil. The lungs are elastic and the ribs are elastic, so when the muscles used for inspiration relax, the air is at once squeezed out again.

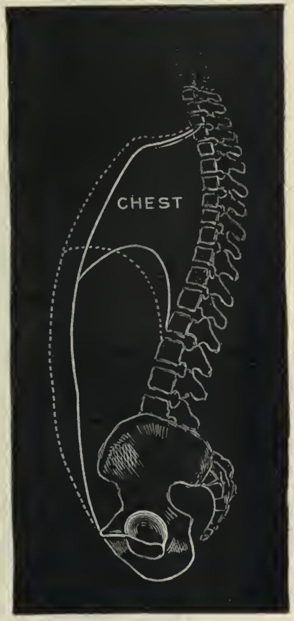


Fig. 28.—Inspiration and Expiration (*after Huxley*).
The dotted line shows the effect of a full *inspiration*.

Summary.—The nose, windpipe, lungs, and chest are the parts used for respiration.

The changes which take place between the blood and air in the lungs are, that the blood gains oxygen, and loses carbonic acid gas, warmth, and moisture.

Inspiration is a muscular act, causing enlargement of the chest and expansion of the lungs. The chest is enlarged by the ribs being raised, and the midriff lowered.

Expiration is an elastic recoil of the ribs and the lungs.

CHAPTER XII

THE REMOVAL OF WASTE MATTERS—SOURCE OF WASTE MATTERS—SKIN—KIDNEYS

Work causes waste products.—Wherever work is going on there must be some destruction of matter.

Two sources of waste matters.—This usually occurs in two ways: (1) the substance from which the power is obtained is changed to refuse; and (2) the machinery

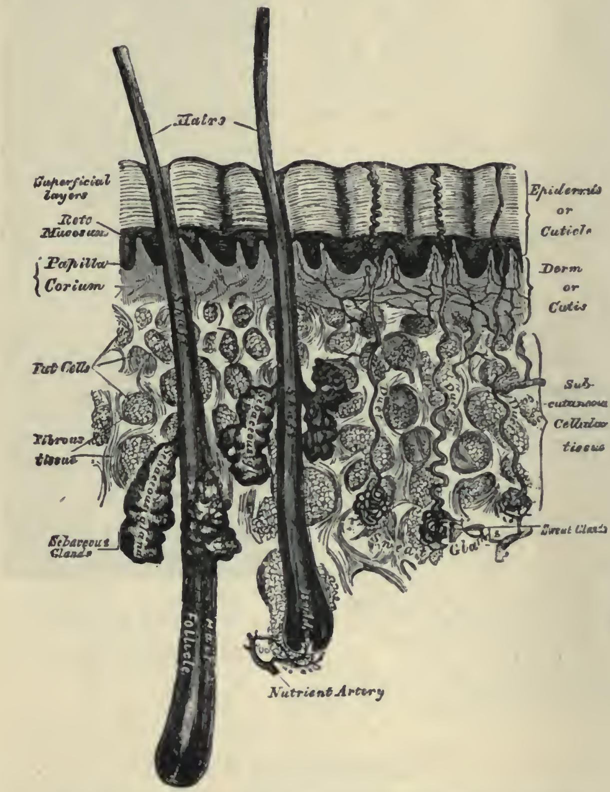


FIG. 29.—Vertical Section of the Skin (highly magnified).

more or less quickly wears away, causing waste particles, which would clog its action if not removed.

Waste in the engine.—In the steam engine, what we may call its food leaves on the one hand a large refuse of cinders, dust, smoke, foul gases, and waste steam to be got rid of; and, on the other, there is a small quantity of worn brass and iron from the friction of its machinery.

Human waste matters. — In the human body also the food causes the larger amount of refuse, and the wear and tear the smaller.

The refuse matters may be stated as follows: (1) the

Fig. 30.—Magnified View of the Surface of the Skin, showing the Pores.

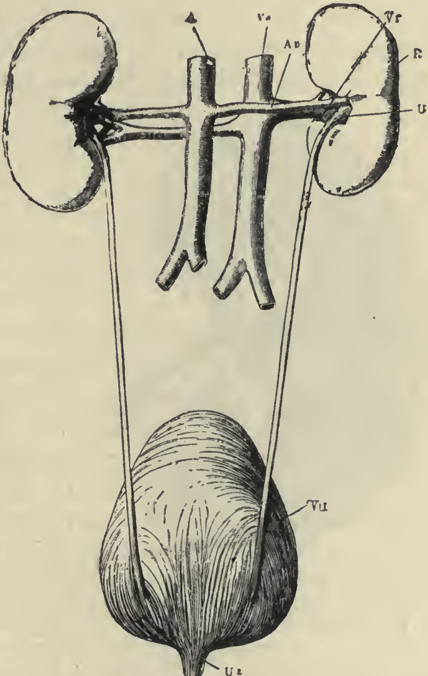


Fig. 31.—The Kidneys, Bladder, and their Vessels (viewed from behind).

A, Ar, arteries; Ve, Vr, veins; U, ureter; R, right kidney; Vu, bladder; Ua, neck of the bladder.

indigestible parts of food (chiefly vegetable); (2) the excess of water, removed by the kidneys, skin, and lungs; (3) the foul gas of combustion, removed by the lungs; (4) urea, a chemical substance due (*a*) to excess of flesh-like foods, and (*b*) to wear and tear of tissues, removed by the kidneys; (5) saline substances, removed by the kidneys.

It is not necessary to add anything here in reference to the waste matters of the digestive and respiratory systems, as the work of these parts has already been explained; but we have yet to learn about the action of the skin and kidneys.

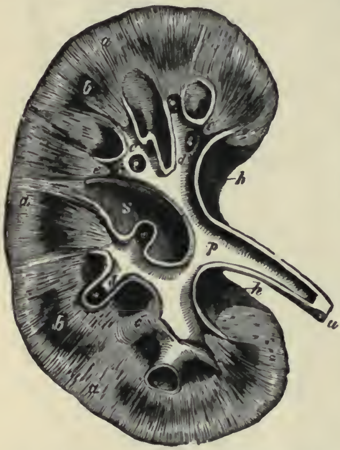


FIG. 32.—Longitudinal Section of the Human Kidney (one-half the natural size).

Structure of the skin.—The skin (fig. 29) is the protecting tissue which covers all the more delicate parts beneath. It is formed in two layers. The outside one has a somewhat horny nature, whilst the under layer is tough and fibrous. In the skin are numerous glands; some of these, the sweat glands, make the fluid of the perspiration, and open on the surface through the pores (fig. 30), which can be seen with a magnifying glass. Others, the sebaceous glands, make an oily fluid, and open beside the hair roots. They keep the surface soft and supple.

Uses of the skin.—The skin has three duties to perform, all more or less necessary to life: (1) Protection of the body. (2) The sense of feeling. (3) Regulation of the bodily heat. The chief substance removed from the body by the skin is water. In this work the skin and kidneys act together. When water is removed in the form of perspiration, it has a great cooling effect on the body. Thus in hot weather the skin acts freely, whilst in cold weather nearly all the water is removed by the kidneys. The skin also helps the lungs to purify the blood to some extent.

The kidneys.—The kidneys (figs. 31, 32) are two well-known fleshy bodies, one placed in each loin. Each is connected by means of a pipe, called the ureter, with the urinary bladder.

Urine.—Urine consists of water, saline substances, such as common salt, and the poisonous substance called urea. This is one of the most important waste products of the body, and it is the chief duty of the kidneys to remove it.

Urea a poison.—If they ceased to act, urea would collect in the blood and cause death like a poison.

Secretion of Urine.—The kidneys separate the urine continuously, drop by drop, night and day. As it is produced it trickles down the pipe to the bladder, where it collects in quantity.

Summary.—There are two sources of waste products: (1) from the food or fuel; (2) from wear and tear of the machinery. The direct waste products from food are: (1) undigested food; (2) water removed by skin, kidneys, and lungs; (3) salines removed by kidneys.

Indirect products are: (1) foul air, the result of combustion, removed by the lungs; and (2) urea, from excess of flesh-like foods. Urea also results from wear and tear of tissues. It is removed by the kidneys.

The duties of the skin are: (1) protection; (2) sense of feeling; (3) regulation of heat; (4) purification of the blood. The duties of the kidneys are: the removal of (1) excess of water; (2) salines; and (3) urea.

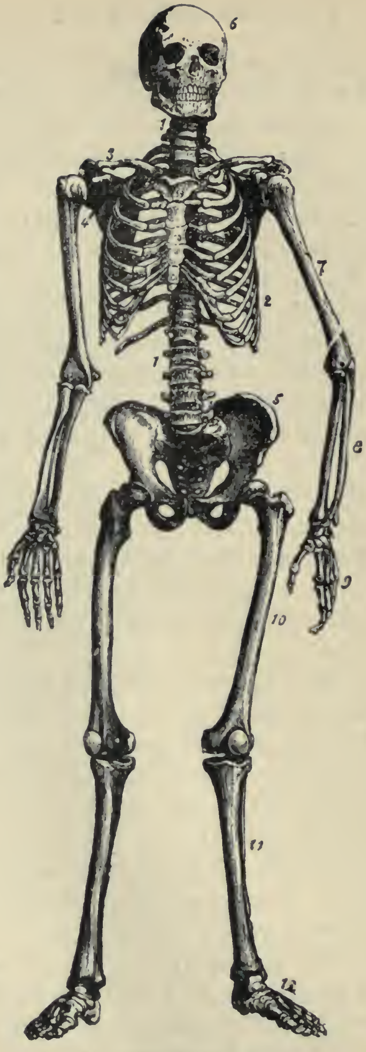


Fig. 33.—The Human Skeleton.

1, the backbone; 2, ribs; 3, collar-bone; 4, shoulder-blade; 5, hip-bones, forming the pelvis; 6, skull; 7, upper arm; 8, forearm; 9, wrist and hand; 10, thigh; 11, leg; 12, ankle and foot.

CHAPTER XIII

THE SKELETON—THE SKELETON OF VARIOUS ANIMALS—THE USES OF THE SKELETON—THE STRUCTURE AND CHARACTERS OF THE BONES

The skeleton.—The body of any animal may be roughly divided into hard parts and soft parts. The

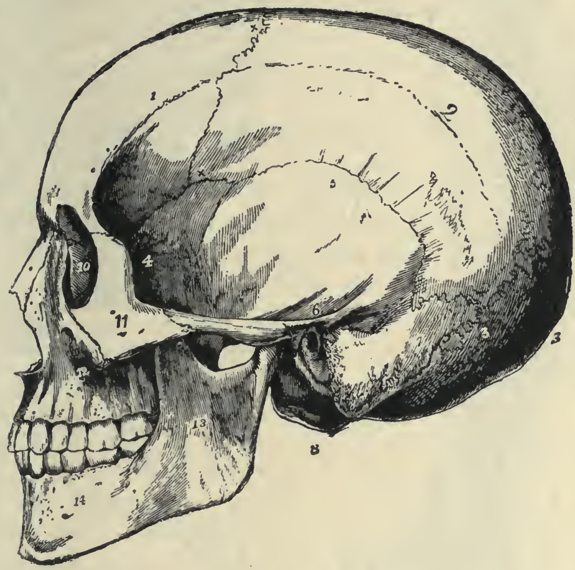


Fig. 34.—Side View of the Skull.

hard parts are the skeleton, and serve to support and protect the soft parts.

Varieties of skeleton in lower animals.—In us the skeleton is composed of bones; but in lower animals it is often quite different. In insects the skeleton is horny, and entirely on the outside of the body. In crabs, lobsters, and all shell-fish, it is also on the outside of the

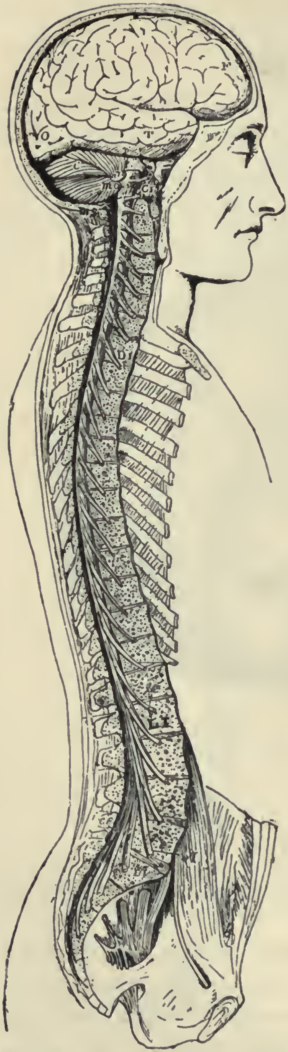


Fig. 35.—Part of the skull and backbone has been cut away to show the position of the Brain and Spinal Marrow.

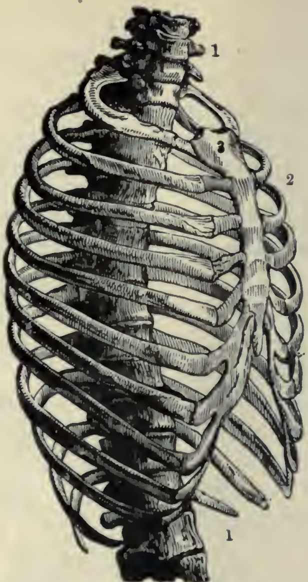


Fig. 36.—The Bony Framework of the Chest, viewed from the right side.

1, backbone; 2, ribs; 3, breast-bone.

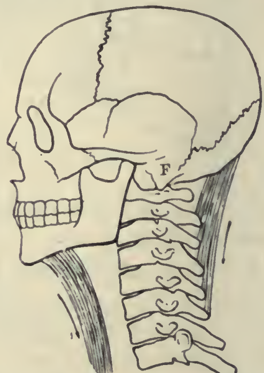


Fig. 37.—The Head rocking on the Spine, illustrating the First Order of Levers.

body, and is composed of shell. In many fish it consists of gristle. Whatever kind of skeleton an animal has, whether outside or inside, bone, shell, or gristle, it is intended for the same purposes.

Uses of the skeleton.—These are: (1) to support the soft parts; (2) to protect important organs; and (3) to act as levers by which the animal moves.

The skeleton supports the soft parts.—The shape of the body is maintained by the bones. If a bone is broken the limb appears misshapen; and in animals like jellyfish, in which the framework is soft, the shape can only be maintained when supported by water. One use of the skeleton, then, is to support the soft parts and maintain the shape of the body.

The skeleton protects the soft parts.—In those animals whose skeleton is on the outside, like the crab, all the soft parts are protected. But in the higher, quicker, and more intelligent animals, which are able to take greater care of themselves, the more important soft parts only are protected by bones. The brain is the most important, and is encased in the skull (figs. 34, 35). The spinal marrow is protected in a long canal in the backbone (fig. 35). The heart and lungs are guarded by the ribs (figs. 26, 36). And the other internal organs are all more or less protected by bones.

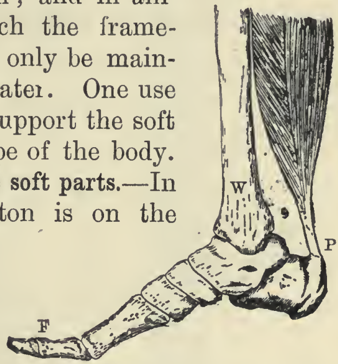


Fig. 38.—Raising the Body on the Toe.

Bones act as levers.—Nearly all the bones singly or combined act as levers; but the most characteristic are the long bones of the limbs. These are connected by freely moving joints, and numerous muscles are attached to them. The muscles, under the direction of the will, pull on the bones like strong pieces of elastic, causing them to move, and when the bone moves of course the limb moves with it.

Levers of first order.—The bones act as levers of all kinds. An example of the *first order* is a simple movement, like throwing the head backwards or forwards (fig. 37). Here the fulcrum is the top of the spine under the middle of the head.

Levers of second order.—To raise the body on the toes (fig. 38) is an example of the *second order*, when

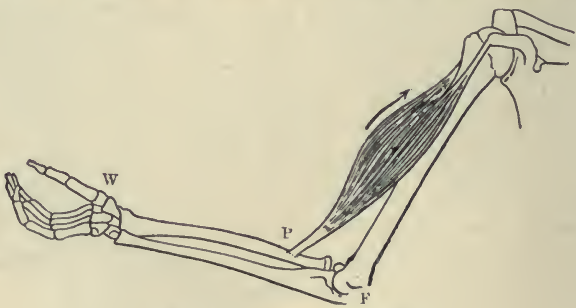


FIG. 39.—Raising the Forearm.

the weight of the body is in the middle at the ankle-joints.

Levers of third order.—To raise the forearm (fig. 39) is an example of the *third order*, as the power here is between the weight of the hand and the fulcrum at the elbow-joint.

All the movements of the limbs and trunk are actions of this kind; but each bone has so many muscles attached to it on all sides, that it can act one moment as a lever of the first order, and the next as a lever of the second or third order. Suppose, instead of raising the body on the toe, the toe is made to tap the ground, then the same bones represent a lever of the first instead of the second order. The weight is the front part of the foot, the power is attached to the heel, and the fulcrum is between them at the ankle-joint (fig. 40).

Long, short, and flat bones.—The bones differ very much in shape. Those of the limbs are called long bones; those of the ankle, wrist, and back, short bones; and those of the skull, shoulder-blades, and hips, flat bones.

A long bone.—A long bone (fig. 41) is enlarged at each end, and covered with a smooth layer of gristle (fig. 45). This is to give plenty of room for the attachment of the muscles to move the bone, and to form a strong, smoothly working joint. The shaft of the bone

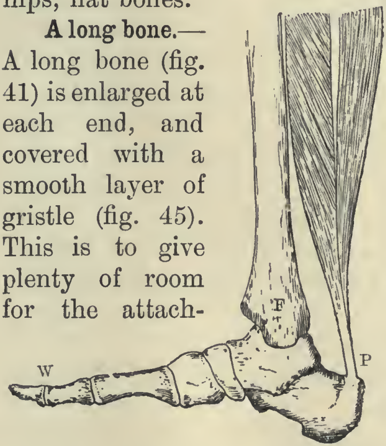


Fig. 40.—Tapping the Toe on the Ground.

Fig. 41.—Longitudinal Section of the Thigh-bone, showing the Compact and Cancellous Tissues, and the Cavity in the Shaft for the Marrow.

is hollow, like the iron pillars which support bridges, this being much stronger than a solid rod of the same weight. In a fresh bone the hollow is filled with fat, which is called marrow, and the outside is covered with a membrane in which are the blood vessels to nourish the bone.

Short and flat bones.—The short and flat bones, and the expanded ends of the long bones, are not hollow. They consist of an outer shell of compact bone, enclosing a bony trellis-work called cancellous tissue, the spaces of which are filled with marrow (fig. 42).

FIG. 42.—Section through part of the Spine, showing the Cancellous Structure of Short Bones.

The general appearance and position of the bones of the entire human skeleton are shown in fig. 33.

Summary.—The uses of the skeleton are to support the soft parts, to protect delicate organs, and to act as levers.

The entire skeleton is used for support.

The skull, spine, ribs, breast-bone, and hip-bones protect the internal organs.

The bones act as levers of the first, second, and third orders for muscular movements.

The long bones consist chiefly of compact tissue, the short bones of cancellous tissue.

CHAPTER XIV

JOINTS—IMMOVABLE, ELASTIC, AND GLIDING—THE MOVEMENTS AND ESSENTIAL PARTS OF GLIDING JOINTS

Three kinds of joints.—The joints by which the bones of the skeleton are attached to each other are of three kinds: (1) immovable joints; (2) joints allowing slight elastic movement; (3) joints allowing gliding movement.

Immovable joints.—The first kind of joint is best seen in the bones of the skull (fig. 43), which are dovetailed together in such a manner as to form a strong-box for the brain.

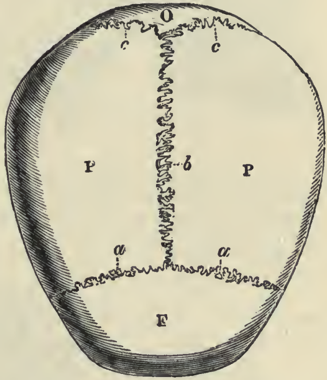


Fig. 43.—Top View of the Skull, showing the Immovable Joints by which the Bones are dovetailed together.

Elastic joints.—The second kind is observed in the joints between the different pieces of the backbone (fig. 44). Here a thick piece of elastic gristle joins one short bone with another, allowing an elastic bending of the whole spine in any direction, though only a very slight movement of one bone upon its neighbour.

Gliding joints.—The third, or gliding, kind of joint is that which unites all the lever-like bones of the limbs. Most of these joints have only a hinge movement, like the elbow, wrist, knee, ankle, fingers, and toes. The hip and shoulder have a ball-and-socket movement; and a few, like the head on the top of the spine, rotate on a pivot.

The parts of a gliding joint.—In all gliding joints the ends of the bones are covered with gristle, and they are lubricated with a white-of-egg-like fluid, commonly called the joint oil. This enables them to move very smoothly one upon the other. The bones, outside the smooth, gristle-covered part, are firmly bound together by strong fibrous ligaments to prevent the joint from becoming accidentally displaced, or, as it is called, dislocated.

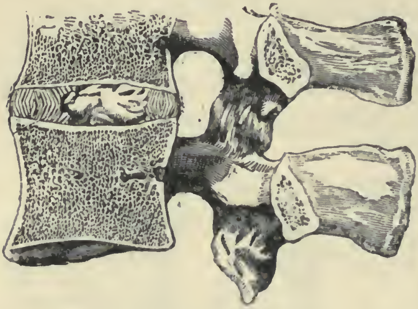


FIG. 44.—Section through part of Spine, showing the Elastic Joint which unites the numerous Bones of which the whole Spine is composed.

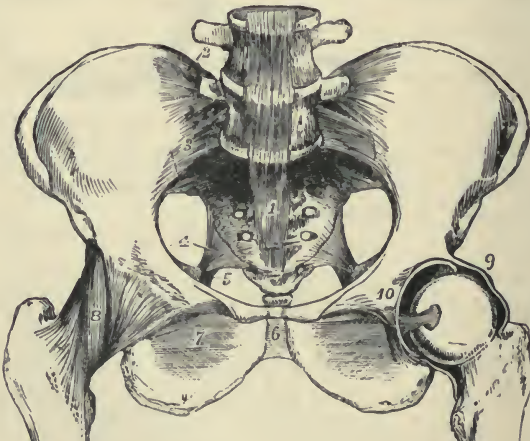


FIG. 45.—The Ball-and-Socket Hip-Joint.
8, the capsular ligament of the right hip-joint: 9, the left hip-joint, with the ligament removed to show the smooth head of the bone.

Summary.—The joints are of three kinds: (1) immovable; (2) elastic; and (3) gliding.

The gliding joints have three movements: (1) hinge; (2) ball-and-socket; (3) pivot.

There are three essential parts in all gliding joints: (1) smooth gristle covering the ends of the bones; (2) the lubricating fluid; (3) the uniting ligaments.

CHAPTER XV

THE MUSCLES—MUSCLES THE CAUSE OF MOVEMENTS—VOLUNTARY AND INVOLUNTARY MUSCLES—MUSCULAR ACTION

Muscles are the cause of movements.—Muscles are the active cause of all movements. They are of two kinds, as was explained in the lesson on the digestive system: (1) voluntary muscle; (2) involuntary muscle.

Voluntary and involuntary muscles.—The voluntary muscle is what is generally known as the red flesh of animals, and forms the bulk of the body (fig. 46). It acts under the influence of the will. The involuntary muscle is that which surrounds the stomach and intestines, and causes the food to move along the digestive canal. It is not under the influence of the will, but keeps up gentle and continuous movements without our knowledge.

Flesh consists of muscles.—Flesh, when carefully examined, is found to consist of distinct separate pieces (fig. 47), which pass from one bone to another. These pieces are called the muscles. They are usually thick and fleshy in the middle, and thin and fibrous at either end, where they are attached to the bones.

Leaders.—These fibrous parts are called the leaders, or tendons.

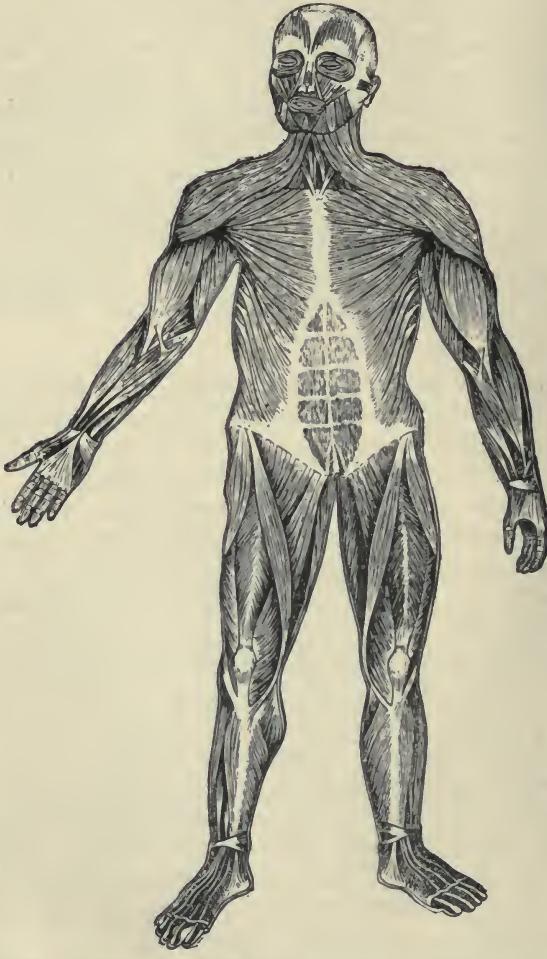


Fig. 46.—The Superficial Muscles of the Body, viewed from before.

The use of muscles. — Each fleshy or muscular part of the body has a great many separate muscles of various shapes and sizes. Their object is to pull on the bones, and so move the part or limb in any direction required by the will. Some small muscles are attached to soft parts instead of bone, such as the muscles of the tongue, the eyes, and the muscles of expression. The latter are attached to the skin of the face, and cause expression by moving the skin in various ways.

Muscular action.—When a muscle acts it becomes shorter and thicker, and that is how it pulls upon the bone or skin to which it is attached (fig. 48).

Action due to nerve-force of will. A muscle can be thrown into action at any moment by the nerve-force of the will, or by the electric force of a galvanic battery. When stimulated in this way, food is burnt in the muscle, and this is how the muscular power is obtained.

Muscular power due to combustion of food.—The combustion of food in the muscle as the source of its power is proved by analysing

Fig. 47.—The Muscles and Tendons of the Forearm, viewed from before.
1 to 5, muscles; 1′ to 5′, their respective tendons.

the blood going into and coming out of a muscle in action. (1) The blood going in contains carbonaceous food (sugar and fat) and fresh air. (2) The blood coming out has lost some carbonaceous food, and the fresh air is replaced by carbonic acid gas, the product of combustion. (3) Heat and force are developed in the muscle.

When we see the smoke and steam coming out of an engine at work, we know that its fire is burning without looking into the furnace; so when we see a muscle developing heat and force, using up carbonaceous food, and giving off carbonic acid gas, we know the food is being burnt without seeing it in the act of burning. We must remember that the heat accompanying the combustion of food in the body is very much less than that caused by

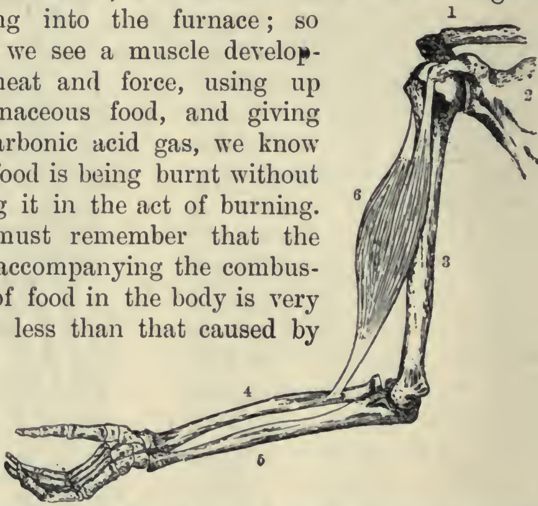


FIG. 48.—A Single Muscle, the Biceps, raising the Forearm.
1, collar-bone; 2, shoulder-blade; 3, arm-bone; 4 and 5, bones of forearm; 6, the biceps.

the burning of coal; but the result in the production of force is the same.

Summary.—Muscles are the cause of movements. There are two kinds of muscle, voluntary and involuntary. The muscles are pieces of flesh attached to the bones by leaders. When they act they become shorter, and by pulling on the bones, move them. Their action is caused by the stimulating force of the will. Muscular power is obtained by the combustion of food.

CHAPTER XVI

THE NERVOUS SYSTEM—THE PARTS OF THE NERVOUS SYSTEM—NERVE FORCE LIKE ELECTRICITY—DEPENDENCE OF ONE PART UPON ANOTHER.

Three parts of the nervous system.—By the nervous system are meant all the parts of the body concerned in sensation. These may be divided into three groups:

Sense organs.—(1) The parts or organs affected by outside impressions; such as sensations of light, sound, scent, taste, and touch. These are the eyes, ears, nose, tongue, and skin.

Brain and spinal marrow.—(2) The central parts where such impressions are received, understood, and acted upon. These are the brain and spinal marrow.

Nerves.—(3) The communicating fibres which carry the impressions from one part to another. These are the nerves which connect the sense organs with the brain on the one hand, and the brain with the muscles on the other.

The action of the nervous system.—Nerve force is very much like electricity, and the working of the nervous system may be explained by comparing it with the more easily understood process of transmitting an ordinary telegraphic message. As an example, suppose you telegraph to town for something from a shop. You hand the message in at the local office where you live. It is telegraphed to the central office in town. Here the message is read, understood, and acted upon. A messenger is sent with it to the shop, and your order is executed.

Again, suppose when out walking you see a shilling on the ground. Naturally you at once stoop and pick it up.

Fig. 49.—Diagram to illustrate the Transmission of an Impression from the Eye to the Brain, and of a Message from the Brain to the Muscles.

Here the eye sees the shilling; it is the local office where the message or impression is handed in. The nerves carry the picture of the shilling to the central office, or brain. In the brain the picture is received, understood, and acted upon; for the brain causes the muscles to make the body stoop and the hand to pick the shilling up.

In this way all the combined actions of the nervous and muscular systems may be explained. First, an impression from outside. Second, the reception of this impression by the centre. Third, the responsive muscular action caused by the brain or spinal marrow.

Thus in describing the nervous system we have first to describe the sense organs: the local offices where all outside impressions are handed in.

Next, the brain and spinal marrow, where the impressions affecting the eyes, ears, nose, tongue, and skin are received, understood, and acted upon, and lastly the nerves, which carry the impressions from the sense organs to the centres, and the orders from them to the muscles.

Dependence of one part of the nervous system upon another.—These three parts of the nervous system are entirely dependent upon each other. If we had no sense organs the brain and nerves would be useless, as the former would have no means of communication with the outside world. Under such circumstances the brain could form no conception as to what anything was like, and we should occupy no higher or more intelligent position than a plant. The brain and sense organs would be equally useless if the communicating nerves were severed; and without a brain of course the functions of life would be impossible.

If therefore sight is lost, not only are the eyes useless, but the nerves which connect them with the brain, and that part of the latter concerned with the sense of sight. Moreover, muscular actions in response to sight would become impossible.

Sight may be lost in the eyes, nerves, or brain.—Sight may be lost by destruction of the eyes; or of the nerves between the eyes and the brain; or of that part of the brain designed to receive impressions of sight. And the same is true of each of the other sense organs and their connection with the nerve centres.

Summary.—The parts of the nervous system may be divided into three groups: the sense organs, the nervous centres, and the nerves.

The sense organs receive impressions from outside, and the nerves carry them to the centres where they are appreciated and acted upon.

The three parts are dependent upon each other, so much so that if one part fails the whole is useless.

A sense may be lost by the destruction of the sense organ, or of its nerves, or of the part of the brain connected with it.

CHAPTER XVII

THE SENSE ORGANS—THE EYE AND EAR

The eye is like a camera.—An eye is a piece of optical apparatus constructed on the same principle as a photographic camera. It produces a perfectly focussed image of anything looked at on a delicate nerve spread out over the back part of it, just as the camera forms the picture on the sensitive plate at the back.

Mechanical parts of the eye.—The mechanical parts of the eye and of the camera are the same (fig. 50). Each has a focussing lens in front to form the picture; a diaphragm, called the iris in the eye, to sharpen the image, and regulate the amount of light; and a sensitive plate or nerve in a dark chamber on which the focussed image is received.

Sight.—Thus sight is due to the clear glassy lens forming a small but bright picture of what is looked at on the delicate nerve spread out over the back of the eye. This layer of nerve matter is called the retina, and whatever is focussed on the retina is carried at once to the brain by a large nerve, the optic nerve, connecting it with the brain (fig. 51).

Summary.—The chief parts of the eye are (1) the crystalline lens, (2) the diaphragm (iris), (3) the dark chamber (globe of the eye), and (4) the nerve screen (retina). Things seen are pictured on the retina, and carried to the brain by a nerve.

The ear.—The ear is a mechanical contrivance for bringing the vibrations of sound into contact with the nerves.

Sound vibrations.—By vibrations is meant a wave-like shaking of any substance. Sound produces vibrations in air, or fluid or solid. Thus air, water, and solid substances all conduct sound; but water and solids conduct it better than air. To try a solid substance, tap a table with your finger. You hear the sound well conducted to your ear by the air. Now put your ear on the table and tap again, you hear it twice as loud, because the sound is conducted better by the solid table than it was by the air. To try water, when you are in a bath, tap the side, first with your ear above and then

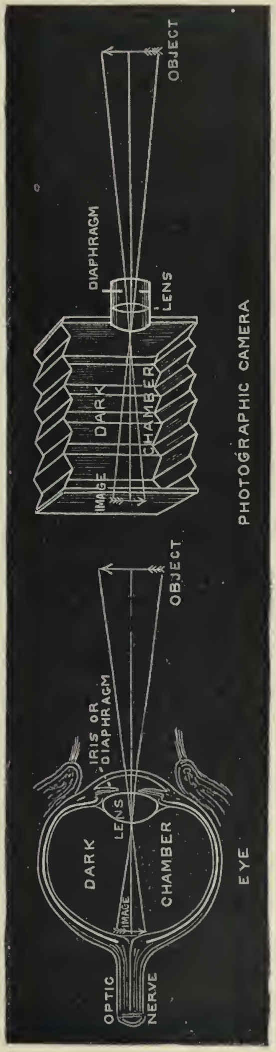


FIG. 50.—The Mechanical Parts of the Eye compared with those of a Photographic Camera.

under water. You will hear the sound much better when the ear is under water, because water conducts sound better than air.

The vibrations or shaking of the air produced by

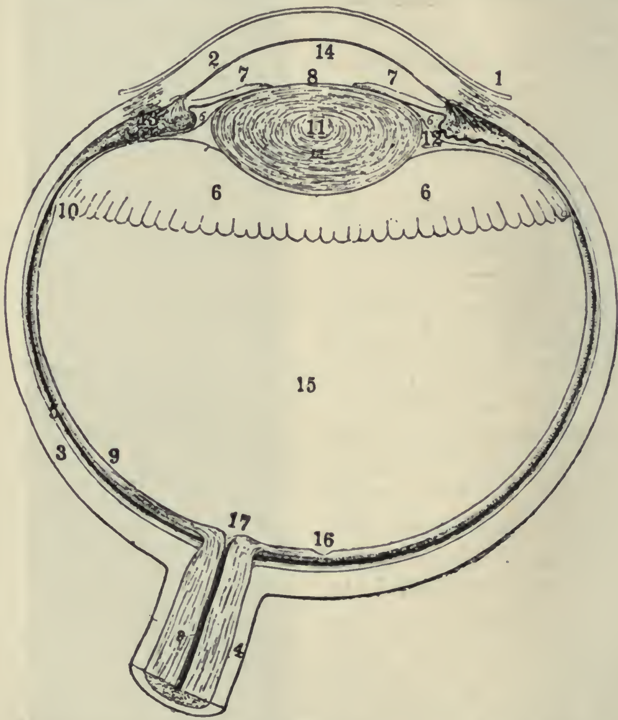


Fig. 51.—View of the Human Eye, divided horizontally through the middle.

2, the clear part, and 3, the opaque part, of the outside coat of the globe; 5, the black lining; 15, the central clear jelly; 7, the iris; 11, the lens; 17, the optic nerve; 4, its sheath.

sound are communicated to other substances, especially to tense membranes like a drum-head, or tight strings as in a harp or piano. If you shout into a piano, the wires vibrate and give out a musical sound. If a cannon is fired near a house, the windows are broken by the vibrations of the air.

To understand the ear we must know: (1) that sound causes vibrations; (2) that a tense membrane

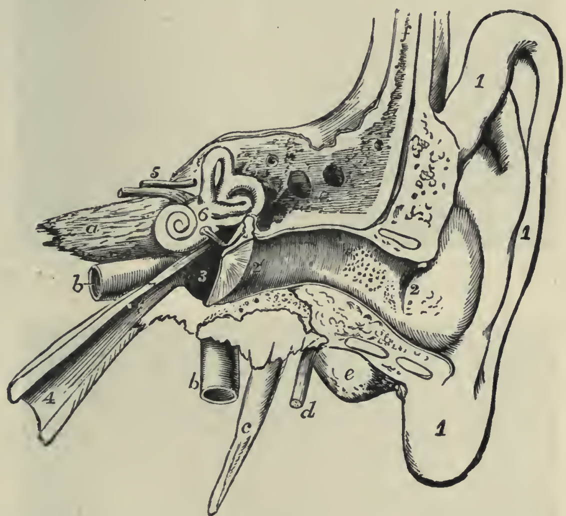


FIG. 52.—Front View of the Left Ear. A portion of the bone has been detached.

1, external ear; 2, the auditory canal; 2′, drum; 3, air chamber; 5, auditory nerve; 6, fluid chamber.

vibrates when the air vibrates; (3) that water and solids are good conductors of vibrations.

The ear.—The ear consists of two parts: (1) the external ear; (2) the internal ear (fig. 52).

External ear.—The external ear is the well-known outside part which collects the sound vibrations, and carries them down to a tense membrane called the drum of the ear.

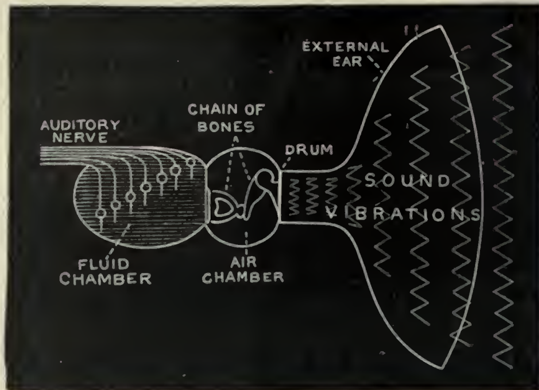


Fig. 53.—Diagram illustrating Mechanical Construction of Ear.

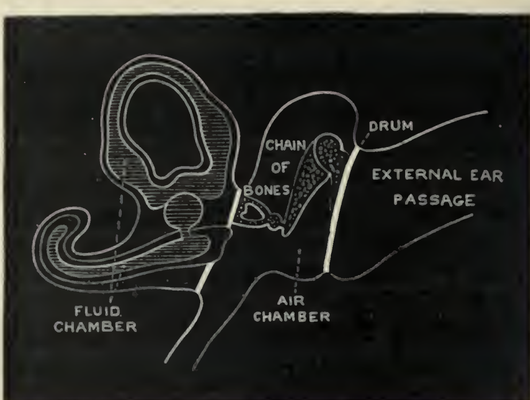


Fig. 54.—Parts of Internal Ear to compare with preceding diagram.

Internal ear.—The internal ear consists first of an air chamber, and secondly of a water chamber (figs. 53, 54).

The air chamber commences on the other side of the drum, and it contains a chain of little bones placed across it from the drum to the water chamber. When the drum vibrates the little bones are made to shake, and they shake the fluid in the water chamber.

Nerves of the ear.—In this fluid the nerves end in delicate hair-like fibres, which feel the slightest vibration of the fluid, and conduct this sensation to the brain.

Hearing.—Thus the delicate nerves for hearing are securely and deeply placed in the bones of the head. Sound is brought to them through the vibration of the drum, the little bones, and the fluid in which they end.

Summary.—The ear consists of (1) an external part to collect sound vibrations, (2) a drum, (3) an air chamber with a chain of little bones across it, which take the vibrations from the drum to the fluid; (4) a fluid chamber in which the nerves end in hair-like fibres; and (5) the nerve which carries the sound to the brain.

CHAPTER XVIII

THE SENSE ORGANS (*continued*)—THE ORGANS OF SCENT, TASTE, AND TOUCH

Structure of the nose.—The nose is the organ for the sense of smell. It is of much simpler construction than the eye or ear. The nose is divided by a partition down the middle into two nostrils, and each nostril is partly subdivided into a lower channel for breathing, and an upper chamber for smelling (fig. 55). When we want to smell anything, we sniff the air into this upper chamber to bring it to the nerves of smell, which are placed in the membrane lining the chamber (fig. 56).

The smell chamber is only partly cut off from the breathing channel, so that we naturally smell the air breathed, and are thus guided as to its purity. It also communicates with the back of the mouth (fig. 22), so that we smell the food as we are eating it, and what we call the sense of taste is largely the sense of smell.

Smell in the dog.—In many animals like the dog, the sense of smell is much more acute than in man. In them the nostrils are filled with layer upon layer of membrane containing nerves of smell.

Fig. 55.—Section of the Nasal Cavities, seen from behind, showing the Bones (6) which partly divide them into Upper and Lower Chambers, and the Central Partition or Septum (7).

Summary.—Smell is due to special nerves situated in the membrane lining the smell chamber. The smell chambers are placed at the top of the nostrils, and communicate with the breathing channel below, and the mouth behind.

Taste a compound of smell, touch, and taste.—Taste, as we speak of it, is really a compound sense. It includes smell and touch as well as taste.

When suffering from a cold in the nose we say that we lose our taste ; or, if we hold the nose whilst swallowing medicine, we don't taste it so much. The savoury part of our food is that which we like best ; but savouriness is observed by the sense of smell rather than by

FIG. 56.—Nerves of the Outer Wall of the Left Nasal Cavity.
The network of nerves at the upper part are the special nerves for the sense of smell.

FIG. 57.—The Upper Surface of the Human Tongue, showing the Taste Papillæ.

true taste. Thus, when we have a cold and cannot smell, we care less for our food. Scent enters the nostrils from the opening before referred to at the back of the mouth.

If we bite chalk or sand, it appears to have a gritty taste ; or if the meat is hard, we say that it tastes tough.

Chalk and sand have no real taste at all. They, like the toughness of the meat, are detected by touch. Thus touch also enters into what is called taste.

True taste.—True taste is situated in the tongue and some other parts of the mouth. It is particularly met with in some peculiar little papillæ arranged in a V-shape at the back of the tongue (fig. 57).

For a substance to be *tasted*, it must be dissolved, or capable of being dissolved in water, as the taste nerves —or taste buds as they are called—open into a little ditch of fluid surrounding the papilla.

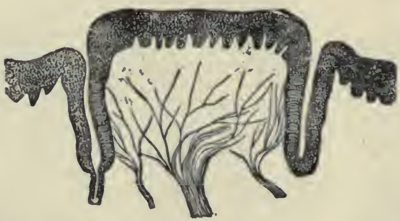


FIG. 58.—Section of a Papilla, showing its Nerve-fibres ending in Taste Buds on each side.

On the left side is the duct of a gland opening into the bottom of the ditch surrounding the papilla.

Taste papillæ.—A magnified view (fig. 58) shows the papilla in the middle, a ditch of fluid round it, and a wall round that. Opening into the bottom of the ditch are the ducts of one or two glands to keep it full of fluid whilst eating. Round the sides of the papilla, and communicating with the fluid in the ditch, are the mouths of the taste buds. Sugar, salt, and all soluble foods dissolve in the fluid, and are thus brought in direct contact with the taste buds. Taste is carried from the buds to the brain by the nerves. A cold in the head, or holding the nose, will not prevent us from tasting sugar or salt, as these are appreciated by the true sense of taste.

Summary.—Taste is a compound of smell, touch, and taste. True taste is only affected by soluble substances. Soluble substances are brought into direct contact with the taste buds of the papillæ, and the sensation is carried from them to the brain by nerves.

Touch due to nerves of skin.—Touch is the sense of feeling due to the nerves of the skin. It is much more acute in some parts than others. If the points of a compass are opened about one-eighth of an inch and touched on the tip of the tongue, lips, or tips of the fingers, they are felt as two distinct points. Here sensation is very acute. But on the limbs and back the points will have to be opened from two to three inches before they can be distinguished as two.

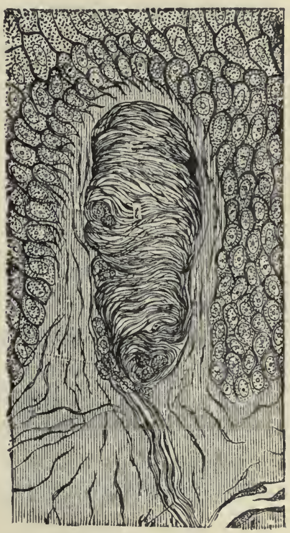


Fig. 59.—Section of a Papilla of the Skin, showing a Touch Corpuscle (highly magnified).

t, tactile or touch corpuscle; *d*, nerve-fibres passing up to it.

Touch corpuscles.—Wherever the sense of touch is acute, the microscope shows that the nerves of the skin end in small bodies called touch corpuscles (fig. 59). These are affected by the sense of touch, which is conveyed to the brain by the nerves.

The sense of touch, like the sense of taste, is a compound one, and includes sensations of heat and pain. As a cold in the head excludes smell from the ordinary sense of taste, so some nerve diseases may exclude one or other of the sensibilities of the skin; for example, the sense of heat may remain when the sense of pain is lost, and a patient who cannot feel the prick of a needle may readily distinguish between heat and cold.

Summary.—The seat of touch is in the nerves of the skin. It is most acute in the lips, tongue, and tips of the fingers, where touch corpuscles abound; least so in the back, thighs, and arms. Touch is a compound sense, including sensations of touch, pain, and temperature.

CHAPTER XIX

THE NERVOUS CENTRES—THE BRAIN AND SPINAL MARROW

Central nervous system.—The brain is the central, overruling organ of the nervous system, and of the whole body. It is connected with every part of the body by means of the nerves.

Parts of the brain.—It consists of the chief brain, the little brain, and the spinal marrow. The two former are contained in the skull, which protects them from injury. The latter is only a continuation of the brain, extending down a hollow in the backbone (fig. 35).

Spinal marrow presides over vital processes.—The spinal marrow (fig. 60) is a long cord of nervous matter, thick above where it forms the base or under part of the brain, and narrow below where it is contained in the backbone. It presides over all the organs which are concerned in carrying on life—the digestive, circulatory, and respiratory organs. Thus it is this part of the nervous system which regulates the beating of the heart, respiration, the movement of the food along the digestive canal, the digestion of food, and all such vital processes. These are not the work of the intellectual part of the brain, they are under the control of the spinal marrow.

Little brain presides over muscular movements.—The little brain (figs. 61 and 62) is placed at the back and lower part of the head. Its duties are not yet thoroughly understood, but when it is injured or diseased the power of main-

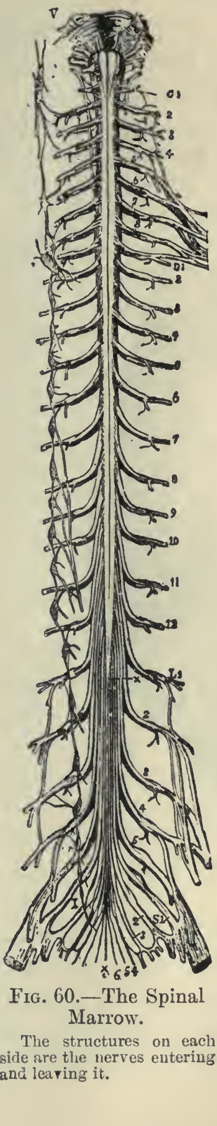


Fig. 60.—The Spinal Marrow.

The structures on each side are the nerves entering and leaving it.

taining the equilibrium of the body and of properly associating the muscles in their action is lost. Thus we know that the little brain is connected with the muscular system, and is especially concerned in maintaining the equilibrium of the body.

Chief brain the seat of intelligence.—The chief brain is the seat of intelligence. It is connected by nerves with the sense organs, the little brain, the spinal marrow, the muscles, and all parts of the body It is the general overruling organ

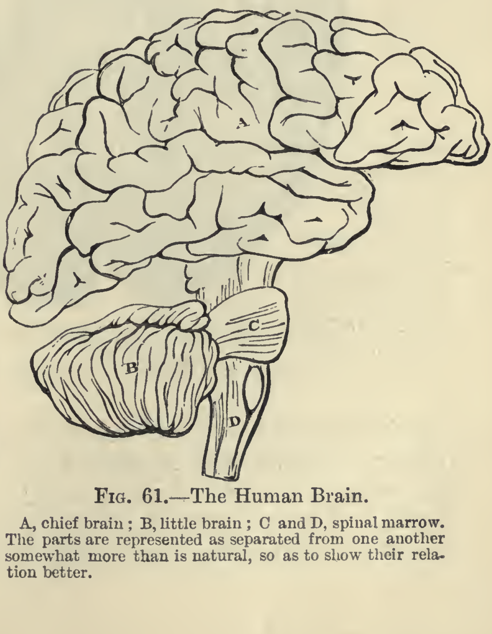


Fig. 61.—The Human Brain.

A, chief brain ; B, little brain ; C and D, spinal marrow. The parts are represented as separated from one another somewhat more than is natural, so as to show their relation better.

of the system. The spinal marrow and the little brain each have their duties to perform, but they, like the rest of the body, are under the control of the chief brain.

In very low animals the chief, or intellectual, part of the brain is so small as to be scarcely noticeable, while

Fig. 62.—The Under Surface of the Brain, showing the Nerves attached to it.

A, chief brain; B, little brain; C and D, spinal marrow.

the little brain and spinal marrow are as large in proportion as in us. As we ascend the scale of animal life, the chief brain gets larger and larger. In the human brain it is so much larger than in animals that it makes the whole brain weigh more than those of animals ten times our size. It is this intellectual part of our brains which places us at the head of the creation.

The chief brain, then, presides over the whole body, over the sense organs, over the vital functions, and over muscular movement. It is the organ of intelligence, and of the emotions, and will.

Summary.—The central nervous system consists of the chief brain, the little brain, and the spinal marrow. The central nervous system receives nerves coming from all the sense organs—the eyes, ears, nose, tongue, and skin—and distributes nerves to all the muscles. The chief brain is the seat of intelligence, and is the over-ruling organ of the body. The little brain presides over muscular movements, especially those concerned in maintaining the bodily equilibrium. The spinal marrow presides over the vital processes.

CHAPTER XX

THE NERVES

Sensory and motor nerves.—The nerves (fig. 63) are white cords or fibres which usually accompany the blood-vessels in their distribution over the body. They are divided into two sets—(1) the sensory nerves, which pass from the sense organs to the brain, and carry sensations from one to the other; and (2) the motor nerves, which pass from the brain to the muscles, and convey nerve-force derived from the brain to make the muscles act as required.

Structure of nerves.—A nerve when magnified is found to consist of a number of fibres bound together into a bundle (fig. 65). Each fibre is a single nerve. The nerve fibre is constructed like the wire of a battery. Running through the centre is an axis which conducts

FIG. 63.—The Brain, Spinal Marrow, and Nerves.

the nerve-force (fig. 64) ; outside this is a layer of fatty matter enclosed in a fibrous sheath, which prevents the nerve-force from escaping on its way to the muscle. In the battery wire we have a central axis of copper to conduct the electricity, and round this a gutta-percha sheath to prevent it from escaping. In either case the central axis is insulated, or cut off from surrounding structures, by a non-conducting sheath, so that the nerve-force or electricity travels along it without escaping, as water travels along a pipe. In this way any number of nerves or wires may be bound together into a bundle, and each will still carry its message quite independently of the others.

Fig. 64.—Two portions of Nerve-fibres (highly magnified), showing the axis-cylinder and the surrounding sheath.

The reason why telegraph wires are usually suspended separately is that this is cheaper and more convenient for repairs than ensheathing the wires with

Fig. 65.—Part of a Section of one of the Nerve-bundles of the Sciatic Nerve of Man, highly magnified.

The central dots are the axis cylinders of the nerves as seen when cut across.

gutta-percha and combining them into a rope, though the latter plan is sometimes adopted.

Summary.—Nerves are white cords connecting the brain with all parts of the body. They are usually distributed alongside the blood vessels. Nerves are of two kinds: (1) Sensory—coming to the brain and carrying sensations of light, sound, scent, taste, or touch; and (2) Motor—going from the brain to the muscles and carrying nerve-force for muscular action. Nerve-fibres are constructed like the conducting wires of a battery.

CHAPTER XXI

FOOD—THE FOUR ALIMENTARY PRINCIPLES

The two chief uses of food.—There are two great purposes for which food is necessary to us and to all kinds of animal life. It is best to state these at the very beginning of the subject, for they should be kept constantly in mind whilst we study it. Not only must we remember them, but we must clearly understand that they are of quite distinct and opposite uses, and are not derived from the same kind of food. They are: (1) to make the substance of our bodies; and (2) to give us heat and vital force.

One use is to give heat and vital force.—If we compare the food of an animal with the fuel or food of an engine, the comparison is fair so far as the production of heat and power is concerned. Thus the engine is fed with coal, a vegetable carbonaceous material, which produces heat and energy, or force, by combustion. The human body is likewise fed with carbonaceous food, which produces heat and vital force by combustion.

The other use is to supply material for growth and repair.—The body, however, requires food for quite another purpose. It grows, and its structure is maintained out of the food eaten; whilst the engine is constructed at once and for all out of metal. Thus we eat one kind of food for the growth and repair of our bodies, and another kind for the carrying on of vital actions. The two kinds are as different as are the metal and coal for the engine. We know how impossible it would be to make an engine out of coal. It would be just as absurd to think that a body could be made out of the carbonaceous or combustible foods. The engine of course must be made of metal, and the body, equally of course, must be made of flesh or flesh-like foods.

Division of food into two classes.—These facts explain the first division of food into two classes: (1) the flesh-like substances, and (2) the combustible substances. The body is constructed from the former, and life is sustained by the latter.

Flesh-like foods.—*The flesh-like substances*, when examined or analysed by chemical processes, are found to consist of four things, called nitrogen, carbon, hydrogen, and oxygen. No other food contains nitrogen. This is therefore the characteristic element of the flesh-like substances, and explains the name, *nitrogenous food*, by which they are known.

Lean meat is the chief source of nitrogenous food for human beings, but nitrogen is contained more or less in nearly all the food stuffs ordinarily eaten: in milk and eggs; in all kinds of corn; in peas and beans; and to a less extent in fresh vegetables. Thus nitrogenous or flesh-like food can be obtained from vegetable food as well as from meat, though its most pure and digestible form is the latter.

Combustible foods.—*The combustible substances* consist of carbon, hydrogen, and oxygen only. They are of two kinds, the starches and the fats.

Carbo-hydrates.—The former include all substances of the nature of starch and sugar. They are called carbo-hydrates.

Hydro-carbons.—The latter include all kinds of fat, such as meat fat, cream, butter, and the oil contained in seeds and kernels. These are called hydro-carbons.

The fats are distinguished from the starchy substances by the larger proportion of carbon they contain, and by yielding consequently a greater amount of heat and vital force.

These three classes of substances embrace all the true food materials; that is, all those which undergo digestion and chemical change in the body.

The mineral foods.—There is, however, a fourth class of substance included with them, the mineral foods. These are water and certain salines, such as common salt, phosphate of lime, and some other salts. All living tissues require water and salines for their construction and work. Water is necessary for the digestive juices, for the blood, and for keeping all parts moist and supple. The salines are used in the blood, muscles, and all soft parts to a slight extent; but especially in the bones and teeth, the hardness of which depends upon the presence of lime salts.

There are, then, in all the various food stuffs only four principles upon which their nutritive value depends. They are called the *alimentary principles.*

The alimentary principles.— These alimentary principles are: (1) *Nitrogenous substances.* The flesh-like foods used for the growth and repair of the body. (2) *Starchy substances,* combustible food, used for heat and vital force. (3) *Fats,* also combustible, and more valuable for heat and vital force. (4) *Mineral substances.* Water and salines, used mechanically in the construction and work of the body.

CHAPTER XXII

THE FOOD STUFFS—CLASSIFICATION OF FOODS

Food stuffs.—We do not eat food in the form of alimentary principles. That would, indeed, not be possible, for in nature they are always combined two, three, or all four together, in various proportions. We call the foods that we eat, and with which we are all familiar, *food stuffs*. These are the different kinds of animal and vegetable food, such as beef and mutton, flour and rice, potatoes and carrots.

Food stuffs are composed of alimentary principles.—The food stuffs are composed of the principles, much in the same way as dress materials are composed of the original fibres of cotton or wool. A dress material may be made by weaving two or three kinds of fibres together, and a food stuff may consist of two or three food principles combined together.

Food classified like clothing.—Food and clothing are each arranged under three heads, having very similar relations to each other. The three heads for clothing are: (1) The original fibres; such as cotton, linen, wool, and silk. (2) The dress materials, such as calico, cloth, merino, and velvet. (3) Garments, or made-up materials, such as jackets and dresses.

The three heads for food are: (1) The original constituents or principles; the nitrogenous substances, starches, fats, and minerals; (2) the food stuffs, such as meat, fish, and potatoes; (3) dishes or prepared foods, such as cottage pie and rice pudding.

The fibres are the original constituents of the dress material, and the principles are the original constituents of the food stuffs. We do not dress ourselves in the simple fibres of cotton or silk, and we do not eat the alimentary principles. We weave the fibres into cloth, and we make the cloth into a dress for wearing; as nature combines the principles into food stuffs, which we cook and prepare for eating.

Nutritive value of food stuffs depends upon the alimentary principles they contain.—The alimentary principles then must not be confounded with the food stuffs. The object of learning the alimentary principles is to know the nutritive value of food stuffs. Thus a carrot is a food stuff. We cannot subsist on carrots alone. Why? Because they are composed of water, woody fibre (which is indigestible), a little starch, and a little sugar.

That is to say, carrots yield only a small proportion of starchy substance, which is the poorest kind of digestible food. Meat, on the other hand, is a very sustaining food. Why? Because the lean is the strongest form of nitrogenous food, and the fat is the strongest kind of combustible food.

Division of food stuffs into animal and vegetable.—The food stuffs are subdivided into the animal and vegetable foods.

The animal foods are: (1) flesh meat, such as beef, mutton, pork, veal, and lamb; (2) poultry and game, such as chickens, ducks, turkeys, geese, and rabbits; (3) fish of all kinds; (4) shell-fish, such as oysters, shrimps, and crabs; (5) milk, including cheese, butter, and cream; and (6) eggs.

The vegetable foods are: (1) the cereals, or varieties of corn, including all foods prepared from wheat, oats, barley, rye, rice, and maize; (2) the legumes, including the foods made from peas, beans, and lentils; (3) fresh vegetables, such as potatoes, carrots, and cabbages; and (4) fruits.

CHAPTER XXIII

FLESH MEAT, ITS QUALITIES, COMPOSITION, AND DIGESTION—BONES, HEART, LIVER, KIDNEYS, AND SWEETBREAD

Class of animals used for food.—The animals used for human food, with the exception of birds and fish, belong to the order Mammalia, and are invariably vegetable feeders. The flesh of carnivorous animals has a strong and disagreeable flavour. In England the flesh of the ox, sheep, and pig is alone generally eaten, though 'horse beef' is undoubtedly often sold as ox flesh in the lower districts of our large cities. On the Continent goat's flesh is also eaten, and in some distant countries the horse, reindeer, seal, walrus, and many other animals are staple articles of food.

Qualities of meat as a food.—Meat has many qualities which render it especially suitable for food. The chief of these are: (1) It has the same composition as the body which it is to nourish; (2) fat and lean together supply all the requirements of the body; that is, repair, heat, and vital force; (3) it is one of the most easily digested foods; (4) it is the most sustaining of all foods.

The parts of animals used for food.—All parts of an animal are good for food, and all except the stomach, entrails, skin, bones, and blood are ordinarily eaten; even these under certain circumstances are also used, and are wholesome. Tripe is prepared from the stomach of the calf. Sausages are enclosed in the entrails of the pig. Black puddings are made by stirring oatmeal with pepper and salt into the fresh blood of the pig. Bones are used for making broth and soup; and skin, as the crackling of roast pork, or as in calf's head, is reckoned a delicacy

Composition of meat.—Flesh consists of nitrogenous matter, fat, salines, and water. The following is the composition of an average joint of cooked meat:—

	Parts
Nitrogenous matter	28
Fat	15
Salines	3
Water	54
	100

The nitrogenous matter.—The nitrogenous matter of flesh is of two varieties: (1) substances of the nature of albumen; (2) gelatine. The former are derived from the red flesh, the latter from the fibrous parts of the meat. Albumen is much more nourishing than gelatine. Both are digested by the gastric and sweetbread juices, and supply the blood with nourishment for the repair of our tissues.

The fat.—Fat is contained in fibrous meshes which are dissolved by the gastric juice. This liberates the oily part which is digested by the bile and sweetbread juice. Fat is stored in the fat parts of our bodies, and is used for heat and force.

The salines and water.—The salines and water are not digested, but are absorbed, and the former helps to keep the blood healthy.

Bones.—Bones consist of earthy matter, nitrogenous matter, and fat. The earthy matter is almost entirely composed of salts of lime, chiefly phosphate of lime. It is quite insoluble in boiling water, but dissolves in the gastric juice; so when a dog eats bones they are completely digested. The nitrogenous matter is gelatine; thus broths and soups made from bones set into a firm jelly when cold. Fat is contained in the marrow. It is very delicate and free from fibres.

Percentage of bone.—The carcase of an animal contains as much as 20 per cent. of bone, and most of the good joints have 8 or 10 per cent. Bone is, of course, much less valuable as a food than flesh, therefore the less a joint contains the more economical it is.

Flesh of young animals.—The flesh of young animals, though more tender, is less digestible and less nutritious than that of full-grown animals. The lean parts are more watery, and contain more gelatine and less albumen. The fat parts are usually richer.

Rigor mortis.—A few hours after the death of an animal flesh undergoes a change, in which the muscles set hard and rigid. This is called rigor mortis. It lasts in hot weather only two or three days, but in cold weather ten days or a fortnight. Meat cooked when this rigid condition is present is hard and tough. Thus it should be cooked before this change comes on, which is usually inconvenient; or after it has passed off, which means that it must be hung a few days in summer and several days in winter.

The Viscera.—The solid viscera, or internal parts, are all good for food, though not so wholesome as the flesh. The heart is almost the same as flesh, but somewhat harder, and a little less digestible. The liver is nourishing, but rich; it is strong-flavoured except in young animals. Kidneys, if not very carefully cooked, are tough and indigestible. Those of the sheep are most esteemed. Sweetbread, especially of the calf, is much esteemed, and when simply cooked is a suitable and delicate dish for an invalid.

CHAPTER XXIV

BEEF—VEAL—MUTTON—LAMB—PORK—BACON AND SAUSAGES

Beef.—*Beef* is considered the finest meat, both on account of its flavour and its stimualting and sustaining qualities. The flesh of a well-fed four-year-old ox is the best. Older meat becomes more tough and difficult of digestion; younger meat more watery and less stimulating. The fat of the ox is a strong heating but easily digested animal fat.

Joints of beef.—The joints of beef vary much in quality and in the amount of bone they contain. The best roasting joints are the sirloin, ribs, and part of the rump; but all are extravagant on account of the large amount of bone and the higher price. Part of the round is much more economical, and of good flavour; but not so tender. It is free from bone. The best parts for boiling, after having been salted, are the silver-side of the round and the brisket. The best steaks are cut from that part of the rump called the steak-piece, those of second quality from the round. Stewing beef is best from the round or shoulder; inferior from the sticking-piece, or flank. The shins are most suitable for soups.

Veal.—*Veal*, as has been said, is less stimulating, less strengthening, and less digestible than beef; though not to a marked degree. The more it has been bled, the whiter the meat, and the less nutritious. It is deficient in fat, and is consequently usually eaten with bacon. The meat is tender, and prized for its delicate flavour. Veal tea is more easily taken by many invalids than beef tea, and is an excellent substitute for chicken broth.

Mutton.—Mutton is closely allied in its stimulating and nourishing properties to beef. Its fibre is shorter and finer, which makes it somewhat more tender. The lean is probably more digestible than beef; but the fat is harder and less so. The lean of well-boiled mutton is certainly more easy of digestion than any form of beef, and is for this reason frequently ordered for invalids.

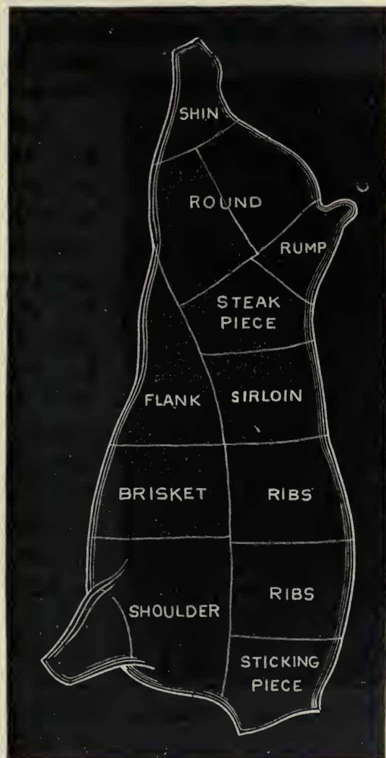


Fig. 66.—Joints of Beef.

Joints of mutton. The sheep does not cut into nearly so many joints as the ox. The leg is the best, as it has very little bone, and not too much fat. The loin has an excess both of bone and fat, and is thus extravagant. The shoulder has also a good deal of bone. The neck, though very bony, is usually an economical joint, since it is very suitable for cooking with vegetables in the form of Irish stew, Scotch broth, scouse, or hot-pot. All parts are suitable for boiling, but the leg, loin, and shoulder are the favourite joints for roasting. The best chops are cut from the loin.

Lamb.—Lamb is chiefly eaten as a delicacy. It is richer and less nutritious than mutton. It is a much fatter meat than veal.

Pork.—Pork is a meat which varies more than any other in price, estimation, and digestibility, in accordance with the way in which it is prepared.

FIG. 67.—Joints of Mutton.

Salt pork.—The plain rolled and salted pork is but little esteemed by the wealthy, nevertheless it is the staple meat food of the hardy outdoor labourer. When boiled, the fat of pork is well digested, especially if eaten, as it should be, with plenty of vegetable food or bread. Salt pork is cheap, and, from the large amount of fat, yields much heat and vital force. The proportion of nitrogenous matter is only about half that of beef or mutton for the whole pig; that is, about 14 per cent., and is much less than this in the sides. Thus the use of beans, which contain over 20 per cent. of nitrogenous matter, with pork, is a wise and wholesome custom.

Roast pork.—Roast pork is very rich, and one of the most difficult of all meats of digestion. It is especially savoury and rich when stuffed with sage and onions.

Hams and Bacon.—Bacon and hams are the highest prized and most expensive kinds of pork, and often cost as much as the best beef steaks; though inferior bacon is quite cheap. Good bacon is by common consent the most popular breakfast dish amongst all classes, and is certainly easily digestible, as it is eaten by the most delicate and fastidious.

Sausages.—Sausages are made by mincing and seasoning pork, and then forcing it into the pig's entrails after thorough washing. The meat is sometimes mixed with bread-crumbs or tomatoes, which makes it less rich.

CHAPTER XXV

POULTRY—GAME—FISH—SHELLFISH

White and dark fleshed poultry and fish.—Poultry and game considered as food may be divided into two classes, according as to whether the flesh is white or dark. The white-fleshed are delicate in flavour, tender, free from fat, and very easy of digestion. The dark-fleshed have a stronger flavour, are mostly much richer and more difficult of digestion. The chicken may be taken as an example of one kind, and the duck of the other.

The same observation is true of fish. Whiting and sole have a white, delicate flesh, free from fat, and are the most easily digested food of this class when boiled. Salmon and herring, on the other hand, are rich and oily. They are more sustaining, but require a stronger digestion.

Poultry a valuable food for invalids.—Poultry and game are always expensive. They are a luxury to the strong and hearty, but sometimes a necessity to the sick. An invalid when allowed meat food is usually placed first on whiting or sole, and then on chicken, before being ordered flesh meat. Thus chicken as a food is of so much importance that, notwithstanding the cost, many young fowls are used daily for the sick in all our large hospitals, including even workhouse and prison infirmaries.

Chicken.—Chicken has the most delicate and tender flesh of all poultry. Boiling is the simplest method of cooking it. Roasted, it is a little richer and more tasty, and if served with bacon or sausages to supply the deficiency in fat, it is a sustaining but expensive dish for the strong.

Turkey.—Turkey is much like chicken, but the fibre of the flesh is coarser and a little less delicate.

Game.—Pheasant and partridge have a compact and nutritious flesh of highly esteemed flavour. If not too much hung, they are very delicate and digestible; but they are more expensive and not quite so suitable as chicken for invalids.

Ducks and geese.—Ducks and geese have a strong dark flesh mixed with fat, and are of rich flavour. They resemble roast pork in their richness and difficulty of digestion.

Hares and rabbits.—Hares and rabbits when young are tender and delicate. If simply cooked they are easily digested, and a boiled young rabbit may sometimes be given as a substitute for chicken. They are deficient in fat, and should be served with bacon for those in health.

White-fleshed fish.—Fish is a less stimulating and sustaining food than meat. It requires to be eaten in larger quantities and at more frequent intervals if used in place of the latter.

Whiting and sole are the most delicate and digestible of all kinds.

Plaice are digestible, but inferior in quality.

Turbot and **brill** are firmer-fleshed, richer, and somewhat more sustaining.

Cod and haddock have a coarser flesh, but are quite free from richness.

Skate have a hard and coarse flesh, which is improved by keeping a day or two before cooking. They are decidedly nutritious.

Dark-fleshed fish.—Trout and salmon are richer, but very delicate in flavour, especially the former.

Mackerel and herring are strong-flavoured and rich. The latter are especially popular, on account of their plenty, low price, and characteristic flavour. Their oily flesh is very suitable for the various curing processes of drying, smoking, and salting.

Eels are very rich fish, but at the same time very nutritious.

All processes of curing render fish less digestible. Kippered herring, haddock, cod, and salmon, though much relished and quite suitable for healthy people, are certainly not easy of digestion.

Shellfish.—Shellfish are of two kinds. One is represented by lobsters, crabs, and shrimps; the other by oysters and mussels.

Crabs and lobsters.—Lobsters are much relished, but their flesh is hard and tough. Crabs are not only indigestible but rich, and most people find them unwholesome. Shrimps, on the other hand, usually agree very well, and as an adjunct to plenty of bread and butter are a wholesome food.

Oysters.—Oysters are far the most valuable of the shellfish as a food. The soft part eaten raw is easy of digestion and nutritious. They have a piquant flavour much relished by those who feel no objection to eating an animal food in the raw state, and are thus especially useful in some chronic illnesses in which loss of appetite is a marked feature, when cooked oysters are much less digestible.

Mussels are a food of the same class as oysters, but much inferior. Sometimes they disagree so violently as to cause fatal poisoning, which deters most people from eating them.

CHAPTER XXVI

MILK—ITS COMPOSITION

Milk a complete food.—Milk is the natural food upon which all the higher animals are reared. A healthy child fed upon milk alone will weigh three times as much at the end of the first year of its life as it did at birth. Milk supplies everything that is required of food—growth, repair, heat, and vital force. It is called a *complete* food, because it contains all the food principles in their proper proportions.

Composition of milk.—Milk contains: 1. Nitrogenous matter, casein; 2. Fat, cream; 3. Sugar of milk; 4. Salines and water.

Casein.—Casein is the name given to the nitrogenous matter. It is a flesh-like substance dissolved in milk; but it can easily be separated in the form of curd by adding rennet or lemon juice, or by allowing the milk to become sour. The curds consist of casein. In the stomach the gastric juice first curdles the milk, and then dissolves or digests the curds just as it would meat. The digested casein supplies the material for the growth and repair of the child's body.

Cream.—Cream is the fat of milk. The white colour of milk is entirely due to the presence of minute particles or globules of fat dispersed through it. These globules are seen when a drop of milk is magnified under the microscope (fig. 68). They are lighter in weight than the rest of the milk, and gradually rise to the surface as cream.

When milk or cream is beaten about in a churn the particles of fat run together, and then form butter. Cream requires no digestion, though it often disagrees owing to its richness.

Sugar of milk.—Sugar of milk is contained in the whey which remains when casein has been separated from milk in the form of curds. It is not so sweet as cane sugar. It belongs to the starchy class of food, and is in the condition of digested starch; therefore, like cream, it requires no further digestion. Cream and sugar are the carbonaceous or heat and force producing substances in milk.

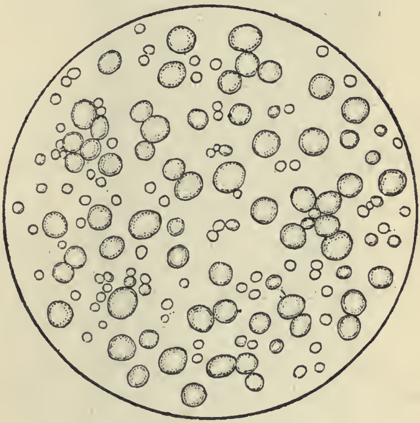


Fig. 68.—Milk under the Microscope, showing the Globules of Fat.

Salines. — The salines of milk are such as the tissues of a young growing body require. There is an especial abundance of phosphate of lime for the bones and teeth.

Water.—The water is sufficient for the purposes of the body, and is in larger proportion to the solids than would be required by adults. Young children need more water than grown-up people in comparison with their size.

Milk of animals.—The milk of all animals contains the same substances, but not in the same quantities. This is important to know, because, if a mother has no milk for her child, that which is substituted should be made as nearly like human milk as possible. The following table gives the analysis of human milk and cow's milk:

	Cow	Human
Water	86	$89\frac{2}{3}$
Casein	4	$3\frac{1}{3}$
Butter	4	$3\frac{1}{3}$
Sugar of Milk	5	3
Salts	1	$\frac{2}{3}$
	100	100

The table shows cow's milk to be too rich for infants, so the baby's bottle is filled with milk and water, or barley-water, to which a little sugar is generally added.

CHAPTER XXVII

MILK—ITS CHARACTERS—BUTTER MILK—SOUR MILK—CURDS AND WHEY—KOUMISS

Characters of fresh milk.—Fresh milk has an opaque white or slightly buff colour, a sweet agreeable taste, and has no flocculent particles in it. A little added to tea gives it a rich creamy look, and when it is set aside cream slowly rises to the surface.

The creamometer.—The purity of milk may be tested by accurately observing the amount of cream which rises to the top in a given time. For this purpose a tall cylindrical glass is used which is graduated from 0 to 100 as in fig. 69. The glass is filled with milk up to the top mark, and is left to stand for 24 hours, when for a good average specimen the glass ought to indicate 8 parts of cream. This is the simplest test which can be applied to milk, and may be relied on, as milk which shows a good percentage of cream cannot have been skimmed, and is not likely to have been adulterated with water.

Characters of skim milk.—Skim milk has a bluish-white colour, a less soft and rich taste, and has little flocculent particles of cream on the surface. It makes the tea look watery and poor, and when set aside scarcely any cream rises to the surface.

Buttermilk. — Buttermilk is a thick fluid quite unlike new milk. It has a rather harsh sour taste, but is nutritious and digestible. It contains all the ingredients of milk except fat. The water and salines are unaltered. The sugar of milk has undergone an acid change, and the casein is in small curds. The curdling of the casein is brought about by the acid change in the sugar of milk. The cream has been converted into butter, and removed by the process of churning.

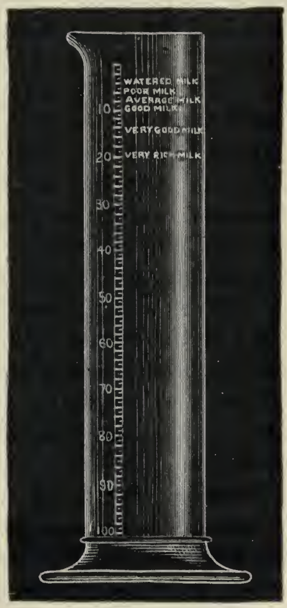


FIG. 69.—**Creamometer, or Graduated Glass for measuring the percentage of Cream.**

Buttermilk thus contains all the nitrogenous matter of milk, and is a very suitable addition to a farinaceous diet. The poor in Ireland, who would starve on potatoes, can thrive on potatoes and buttermilk; the reason being that potatoes do not contain enough nitrogenous matter for growth and repair. Owing to the small size of the particles of curd, smaller than those produced by the gastric juice in the stomach, some people digest buttermilk more easily than fresh milk.

Acid fermentation of milk.—Sour milk.—Milk changes perhaps more rapidly than any other article of diet; but it does not actually decompose sooner than meat would do. The change is a fermentation by which the sugar of milk is converted into lactic acid. Though sour milk is not bad in the sense of eggs or meat being bad, it is still so altered in taste and appearance as to be useless as a food. Hence we have to be more careful in the storage of milk than any other kind of food.

Curds and whey.—Curds and whey are made by the addition of rennet or lemon-juice to milk. The fresh curd is collected in a shape, and allowed to set. It is light and digestible, and consists of casein mixed with some of the fat globules of the milk. Eaten with cream it forms the well-known Devonshire junket. Whey consists chiefly of the water, salines, and sugar of milk, with a little uncurdled casein and fat globules. It is pleasant to drink, and requires hardly any digestion. For this reason it is a valuable food in diseases of the stomach and fevers.

Alcoholic fermentation of milk.—Koumiss is an effervescing fermented drink made by adding yeast to milk and bottling it. By this process of fermentation, alcohol is formed instead of lactic acid. Koumiss was introduced from Eastern countries, where the only milk obtainable is that of mares. Mares' milk contains much more sugar than cows' milk, hence it ferments more easily. When making koumiss in this country, it is usual to add sugar to the cows' milk employed. This drink has a reputation for curing consumption.

CHAPTER XXVIII

BUTTER—CHEESE—EGGS

Butter making.—Butter is the solidified fat of milk. It is made either by allowing the milk to become a little sour and churning it in bulk, or by collecting and churning the cream alone. The fat obtained is well kneaded and washed with cold water to free it from all traces of buttermilk, which would cause it to speedily go bad. The more perfectly this is done the longer the butter will keep. Salt butter will keep much longer still. It is made by adding salt at the time of kneading.

Butter as a food.—Butter is a very important food. It and meat are the only two considerable sources of fat in an ordinary diet, and fat, as has been explained, is the most valuable heat and force producing food, especially for cold climates. Butter, moreover, is the most pleasant flavoured and easily digested of fats. When, however, it has become rancid, or has been changed by cooking, it is not so easily tolerated by the stomach.

Margarine.—A few years ago butter was largely adulterated with cheaper fats. This substance was sold under the name of butterine, though it contained very little real butter. The Government now only allow it to be called margarine, in order that it may not be confounded with butter. The flavour of margarine is good, and it is perfectly wholesome. It is more heat and force producing, but less delicate and digestible, than fresh butter. It is much better than stale or rancid butter. The best margarine is made from purified beef fat flavoured with milk or mixed with butter.

Cheese: manufacture.—Cheese consists of casein mixed with more or less of the fat of milk. It is made by curdling the milk usually with rennet, a little salt being added. The curds, which entangle most of the fat globules, are pressed in moulds. In course of time all the whey drains away, and a solid mass or cheese is left in the mould. Cheeses may be eaten either fresh or ripe, and in each case may be made either of milk alone, or milk and cream.

Varieties.—Fresh milk cheese is drained without pressure, and consists chiefly of casein. It is light and friable, and digests easily.

Fresh cream cheese contains a large proportion of fat, and is in consequence much richer.

Ripe cheeses are subjected to prolonged pressure in the mould, and are then stored for some time before being sent to market. Ripe milk cheeses, such as Cheshire, American, Dutch, and all the drier and less rich kinds, consist chiefly of casein, and are nourishing and meat-like in their character. With a good strong digestion they may be freely partaken of, and supply the place of meat. Rich cheeses, like Double Glo'ster, Stilton, and the foreign Gorgonzola, are made of milk mixed with cream. They consequently contain much more fat, and should be eaten in smaller quantity.

Eggs a complete food: composition: compared with milk.—Eggs, like milk, are a complete food. The young chick derives from the egg all the food necessary for its development up to the time of hatching. Henceforth it is able to pick and digest the same foods as the adult fowl. An egg weighs about two ounces and consists of: White: albumen and water. Yolk: albumen, fat, and water. Shell: carbonate and phosphate of lime. Albumen is a nitrogenous meat-like substance. The fat forms thirty per cent. of the yolk. The water contains some salines, but the chick obtains the lime salts for its bones from the inside of the shell. There is no starchy matter in eggs: therefore, though complete in the sense of containing all the substances necessary to support life, they are a less perfect food than milk. Eggs are less easily digested than milk, and, though very nutritious, cannot be used as a substitute for it, especially in the case of young children.

Eggs as food.—The eggs of all birds are wholesome, though few others have the delicate flavour of those of the domestic fowl. Their digestibility varies greatly with the mode of cooking. A light-boiled egg is more easily digested than either a raw or a hard-boiled one; but in no form are they so indigestible as when fried in fat. They cook well in puddings, causing milk to set as in custard, and are an important ingredient in many favourite dishes and cakes. In milk, tea, or clear soup, or with wine or brandy, they are often a most suitable form of fluid nourishment for invalids.

CHAPTER XXIX

VEGETABLE FOODS—GENERAL CHARACTERS—VARIETIES

Vegetable compared with animal food.—Vegetable like animal foods contain all the essential constituents or principles required to support life and perform work. They differ from the latter chiefly in the following important particulars: (1) They are less digestible; (2) they contain much less nitrogenous matters; (3) the heat and force producing substances are starch and sugar in place of fat.

Vegetable-feeding animals eat much larger quantities of food than flesh-eaters. An ox or a sheep feeds all day, a tiger not more than once a day. The latter gets as much nourishment out of one moderate meal as the former out of a day's continuous feeding. Vegetable feeders have very powerful digestive organs, and a very long alimentary canal, especially constructed to digest raw vegetable food. Flesh-eating animals or human beings would die if fed entirely on raw vegetable food.

Food value of vegetables.—The indigestible nature of vegetable substances is overcome in two ways: (1) by carefully selecting those suitable for human food, and (2) by thorough cooking. Grass, however prepared, would always be indigestible to us; whilst starch, as in well-cooked rice, is one of the easiest things to digest.

The low proportion of nitrogenous matters is more difficult to overcome. Only one class of vegetables contain it in high degree, the pea and bean tribe, and they are always difficult of digestion. Either an entirely vegetable diet must be eaten in inordinate quantity, or there must be some admixture of animal food. The strictest vegetarians find it necessary to take milk, eggs, cheese, or some other supply of nitrogenous food, as an addition to their otherwise purely vegetable diet.

The substitution of starch for fat is certainly beneficial in hot climates, though an absence of fat from the diet is severely felt in cold countries.

Anatomical evidence in favour of a mixed diet.—As a matter of fact, the character of the teeth, the digestive juices, and the alimentary canal generally show that man is specially fitted to digest both animal and vegetable food. From this it seems only right to conclude that he ought to eat both, and that, if he limits himself to only one or the other, some functions of the body will be neglected and suffer in consequence.

Varieties of vegetable food.—Of vegetable foods one class stands pre-eminent all over the world, and that is the grain-producing plants or cereals, wheat, oats, barley, rye, Indian corn, rice, and millet. Of these wheat is the most valuable, but they are all highly nutritious, and can be cooked in various ways to render them palatable and digestible. Their chief constituent is starch, but they also contain a fair amount of nitrogenous matter. Next to the cereals come a less important class of roots and tubers, &c., yielding little else but starch, such as arrowroot, tapioca, and sago. Next a very important class, the legumes: peas, beans, and lentils, the special feature of which is their high percentage of nitrogenous matter.

After these are the fresh vegetables and fruits eaten cooked or raw. Their nutritive value is very low, but they possess wholesome qualities, which render them an important addition to our diet.

CHAPTER XXX

THE CEREALS — WHEAT — WHEATEN FLOUR — ITS CONSTITUENTS AND DIGESTIBILITY

Wheat: structure of a grain of wheat.—Each grain of wheat may be divided into three parts: (1) An outer skin; (2) an inner bark; (3) a central kernel.

The outer skin (fig. 71, *a*) consists of scales of woody fibre, which are quite indigestible, however cooked. When removed they are called bran.

The inner bark (*b*) consists of more delicate scales, which cannot be removed without tearing off the outermost layers of the kernel. These latter are the richest part of the grain in gluten, or nitrogenous matter (*c*). Hence, when the inner bark is removed, it consists of a brown flour of a highly nutritious character. It is called pollards or bran flour.

The kernel (*d*) grinds into a pure white flour, composed of starch with about 10 per cent. of gluten.

Flour.—Wheaten flour is prepared by grinding the grains. The product is passed through sieves of different degrees of fineness. The finest, or 'firsts,' is a pure white flour derived from the centre of the kernels, and is chiefly used for pastry. The 'seconds' is a coarser and less purely white flour. It is used for household bread, the whiteness of which is sometimes increased by the addition of rice flour or potato starch. The next

Fig. 70.—Varieties of Wheat.

a, summer wheat, or spring wheat; *b*, winter wheat; *c*, Egyptian wheat; *d*, turgid wheat; *e*, Polish wheat; *f*, spelt wheat; *g*, one-grained wheat.

quality is the pollards, a coarse brown flour, rich in gluten, and very nutritious. The refuse consists of bran.

Whole-meal.—Whole-meal may either be made by re-grinding the pollards and bran and mixing them with the flour, or by decorticating the grain—that is, removing the outermost layers of bran, and grinding all the rest. The latter is sold as 'decorticated whole-wheat meal.' Brown bread used to be made by mixing the finest parts of the bran with white flour. Now, whole-meal is generally preferred for this purpose.

Composition of wheat.—Wheat consists of bran, starch, gluten, mineral salts, and a very little fat.

Bran.—Bran is composed of woody fibre, which is quite indigestible to us, but not to horses or cows.

Starch.—Starch forms the bulk of the kernel, about 70 per cent. It consists of little grains of different shape or size, according to the plant from which it is derived (fig. 72). Each starch grain has a delicate shell or envelope of indigestible woody fibre, within which is the nutritious starch flour. Cooking breaks up the shell, but raw starch passes through us undigested.

Fig. 71.—A thin Section of Part of a Grain of wheat, highly magnified.

a, the outer skin, or bran; *b*, the inner skin; *c*, gluten cells; *d*, starch cells; B, starch grains, more highly magnified.

Gluten.—Gluten is the nitrogenous or flesh like element in wheat; white flour contains about 10 per cent., and pollards as much as 15 per cent. It may easily be separated from flour by making the latter into dough, and then washing and kneading it under the tap till the water ceases to be milky. The substance remaining is gluten, a tough, elastic material, so adhesive that when pulled apart with the fingers it will stretch several inches before snapping. Owing to this peculiar nature of the gluten, dough made from wheaten flour can be leavened; whilst that made from the flour of other cereals refuses to rise. Barm in each case produces bubbles of gas, which, in wheaten dough, become entangled in the elastic adhesive gluten, and swell it up like a sponge; whilst in the flour of other grains the bubbles escape, and the dough settles flat and heavy. This is why light bread can only be made from wheaten flour, and why wheat is more valuable than any of the other grains.

Fig. 72.—Varieties of Starch Grains, highly magnified.
1, wheat; 2, maize; 3, potato; 4, rice.

Salts. — The mineral salts exist only in small quantity, but they are very useful for the body.

Uses and digestibility of wheaten flour. — Wheaten flour is made into bread, biscuits, pastry, puddings, cakes, and other common articles of diet. The digestibility of these, apart from the other ingredients they contain, depends upon the ease with which they can be broken up by the teeth and penetrated by the digestive juices. Thus, stale bread, toast, and biscuit digest well; new bread, boiled bread (dumplings), muffins &c. not so well; pie-crust, heavy bread, hot buttered toast, or muffins, badly.

Macaroni and vermicelli.—Macaroni and vermicelli are made from hard Italian wheats, rich in gluten. They are very nutritious when well cooked.

CHAPTER XXXI

OATS—BARLEY—RYE—MAIZE—RICE—ARROWROOT—TAPIOCA—SAGO

Oat and barley meal nutritious, but cannot be made into bread.—Oats and barley are not unlike wheat in composition. They are quite as nutritious, and the flavour of each is pleasant. If oatmeal and barley meal could be made into a light and porous bread, they would probably be just as popular as wheaten flour. However, owing to the soft nature of their gluten, they cannot be leavened in the same way, and the uses to which they are put are therefore more limited.

Fig. 73.—The Common Oat.

Fig. 74.—Section of Oat, highly magnified.
a, outer skin; *b*, inner skin; *c*, gluten cells; *d*, starch cells; B, starch grains adhering in oval masses, more highly magnified.

Oatmeal foods.—Oatmeal supplies oatcake, porridge, and gruel. The two former to a large extent take the place of bread in Scotland and the north of England amongst the working classes, especially in country dis-

Fig. 75.—Varieties of Barley.
a, spring barley ; *b*, winter barley ; *c*, common or long-eared barley ; *d*, sprat or battledore.

tricts. They are very nourishing, more so even than bread, and very wholesome, particularly when the appetite is good and digestion strong. Porridge is very digestible, and cannot be spoken of too highly. Gruel is a kind of fine porridge, very useful for invalids. The structure of a grain of oat is very similar to that of wheat (see fig. 74).

Fig. 76.
Rye.

Barley as food : Malt.—Barley freed from the husk is used as pearl barley for broths and barley water, but not to any great extent. The meal is sometimes mixed with flour and made into an inferior bread. The great use, however, to which barley is put in this country, is to make *malt* for beer and whisky. *Maltine* is an extract of malted barley. It is nutritious, and helps to digest all starchy foods.

Barley meal is a favourite food for pigs and fowls. They fatten quickly on it, and the meat is well flavoured.

Rye bread.—Rye meal, with or without flour, makes a dark, heavy kind of bread. It is not very popular in England. It is dark in colour

Fig. 77.—Maize.

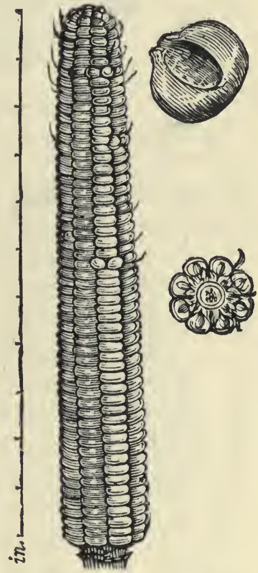


Fig. 78.—An Ear of Maize, a cross-section of the ear, and a kernel of the full size.

and poor in flavour, but in the character of its gluten it approaches more nearly to wheat than any other cereal.

Maize an inferior food.—Maize, or Indian corn, is a rich nutritious cereal, containing more fat than any of the others except oats. In this country it is chiefly used for feeding horses and fowls. Like oatmeal, it cannot

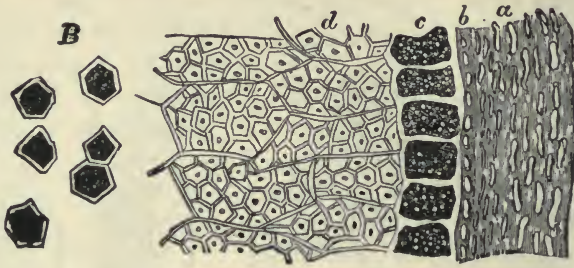


FIG. 79.—Section of Maize, highly magnified.
a, outer skin; *b*, inner skin; *c*, gluten cells; *d*, starch cells; B, starch grains, more highly magnified.

be made into bread without being mixed with wheaten flour; but dry cakes like oat-cakes are made of it, and are popular in America. Cornflour and hominy are preparations of maize flour, and the young green corn is eaten abroad as we eat green peas. Maize is one of the most nourishing and cheapest of the cereals, yet owing to the absence of a tenacious gluten like that found in wheat, and also perhaps to its somewhat peculiar flavour, it only ranks as an inferior food. The structure of its grain is shown in fig. 79.

FIG. 80.—Rice.

Rice as a food.—Rice, though the poorest of all in nutrition, is a great favourite on account of its simple flavour and easy digestibility. It consists almost entirely of starch, and is therefore less suitable than any of the others for the sole support of life; yet it is the staple food of one-third of the human race. They, however, live in hot Eastern countries, where starch digests much better than fat, and where the people are generally less powerful and energetic. Moreover, they obtain an additional supply of the nitrogenous matter which is so deficient in rice from lentils, flesh, or milk. The nutritive value of boiled rice is about equal to that of potatoes. Rice flour is the least suited of any for bread-making, but owing to its whiteness it is sometimes mixed with wheaten flour to improve the appearance of the latter.

Cooked rice.—Rice is best boiled or steamed, when it answers equally well with meat as a vegetable, or with fruit, syrup, jam &c. as a pudding. Cooked with milk it is nutritious and very wholesome, probably the most wholesome pudding made. The common fault in making a rice pudding is that people cook it too little and too quickly. It should be cooked slowly for about three hours.

Ground rice.—Ground rice, or rice flour, is used for making certain cakes and puddings, but it has no advantage in digestibility over the whole rice.

COMPOSITION OF THE DIFFERENT KINDS OF FLOUR OR MEAL (AFTER BAUER).

—	Wheat	Oats	Barley	Rye	Maize	Rice
Nitrogenous matter .	11	14	11	11	14	7
Starch	73	66	72	68	70	77
Fat	1	5	1	2	4	1
Salines, water, &c. .	15	15	16	19	12	15
	100	100	100	100	100	100

Arrowroot.—Arrowroot is the starchy product of a tuberous root grown in the West Indies. When cooked with water it makes a clear gelatinous paste very easy of digestion. It is used for invalids, made either with milk or water. It consists of starch only.

Tapioca.—Tapioca is another simple starchy product, obtained from the manioc, a tuberous root grown largely in Africa. The root contains poisonous properties, but the starch extracted from it and sold as tapioca is very wholesome and easily digested. It is used in puddings and soups.

Sago.—Sago is a starch obtained from the pith of certain palm trees. It also is simple and easy of digestion, and is used in puddings and soups.

CHAPTER XXXII

THE LEGUMES—PEAS—BEANS—LENTILS

Composition of the legumes.—The ripe seeds of the legumes, or pulses, stand alone among vegetable foods in possessing a large percentage of nitrogenous matter. Dried peas, beans, and lentils, in point of nutrition, partake more of the nature of meat than bread. If they were as wholesome and as easy to digest as meat, they would indeed be a valuable and economical food; but unfortunately they are not. The following table shows their composition compared with beef and wheat :—

—	Raw Beef	Wheat	Peas	Beans	Lentils
Nitrogenous matter . . .	21	12	22	23	24
Fat	5	1	1	2	1
Starch	0	68	53	53	54
Water, salines, &c. . . .	74	19	24	22	21
	100	100	100	100	100

High nutritive qualities.—Here we see that, whilst containing more than half their total weight of starch, they yet have more nitrogenous matter than an ordinary joint of meat. Moreover, whilst meat will only keep a few days, these seeds will keep, if dry, for years. So that in a small bulk we have a stronger nourishment in as useful and permanent a form as the cereals. The only drawback is that they are difficult of digestion. The young green peas and beans are quite different. They digest easily, but the nutritious properties of the older seeds are not yet developed in them. Green peas are a very wholesome vegetable, but they are not very nourishing; whilst the old peas are very nourishing but not very wholesome, except with a good appetite, a strong digestion, and a hard-working, outdoor life.

An economic form of nitrogenous food.—However, there are plenty of people in the world who, whilst limited in means, have no lack of appetite and digestion: robust, hard-working men and women, who only want enough to eat. Such people when very poor often live on tea and bread. This satisfies the appetite without renewing the strength. Tea and bread yield water, starch, and an insufficient quantity of nitrogenous matter. With plenty of it there is enough carbonaceous food, especially if butter can be afforded, but not enough material for tissue repair. So the muscles waste and the strength fails, when a handful of peas, beans, or lentils each day, properly cooked, would make all the difference. They would build up the daily wear and tear, and enable the renewed muscle to make full and proper use of the carbonaceous starch and fat.

Critical estimate of the food value.—Let us estimate these foods at their proper value. Chemistry shows them to be practically as nourishing as meat and bread. Physiology and daily experience, however, show that it is much more difficult for our bodies to get this nourishment from them than it is from meat and bread. Therefore the well-to-do are wise to reject this class of food, except as an occasional soup or vegetable for a cold day. But the working-man should find in it an especial friend. In him hearty digestion and great wear and tear of tissue are usually combined, and there is no other class of food which in the same bulk and at the same price is capable of satisfying these demands.

Peas : dried peas : dried green peas : fresh green peas.—Peas may be put into three classes: (1) ripe peas; (2) dried green peas; (3) fresh green peas. Peas when fully ripe are hard and dry like corn, and are sold in the shops as split peas. In this condition they contain the greatest amount of nourishment, but require prolonged and careful cooking to render them digestible. They are best used with a meat or bone stock to make a thick, nourishing, and sustaining soup. Pea flour is sometimes eaten in pease-pudding. The dried green peas are usually selected from fine varieties of garden pea, gathered and dried when nearly ripe. They occupy an intermediate position between the split peas and fresh green peas, both in point of digestibility and of nutritious qualities. After thorough soaking and boiling, they may be eaten whole as a vegetable or in soup. Fresh green peas are a very pleasant and wholesome vegetable. They are easily digested, and more nutritious than other green vegetables, but have not the sustaining qualities of the more mature article.

Beans : haricot beans : broad beans : kidney beans.—Beans may be put into three similar classes: (1) ripe beans; (2) broad beans; and (3) fresh kidney beans. The only ripe beans ordinarily eaten are the haricot or French beans. Well boiled they are relished as a vegetable which has high nutritive properties, and is less indigestible than split peas. Bean flour made from the horse bean has been used to adulterate wheat flour. It is nutritious but indigestible. Broad beans are a popular dish, especially with boiled bacon. They are nutritious, though less so than the haricot beans. Either is a very suitable adjunct to a fat meat like bacon, their nitrogenous matter supplying the deficiency in lean. Fresh kidney beans and scarlet runners are very delicate fresh vegetables, having the same value and wholesome qualities as green peas.

Lentils.—Lentils are imported from the East, where they have long been used by people whose chief diet consisted of rice. The nitrogenous matter of the lentil fulfilling the part of meat, renders the rice diet complete, when by itself it is much less perfect than bread. In this country lentils are yearly growing in favour as a substitute for dried peas in soup. They have about the same food value and are less expensive.

Lentil flour is used in the composition of the 'Revalenta Arabica,' a well-known and valuable food for invalids.

CHAPTER XXXIII

FRESH VEGETABLES—THEIR COMPOSITION—POTATO—TURNIP—CARROT—CABBAGE—CAULIFLOWER—CELERY—ONION—AND OTHERS

Value of fresh vegetables.—Fresh vegetables are eaten for two purposes: (1) like other foods, to supply nourishment; and (2) to supply certain fresh juices and saline substances which keep the blood vigorous and healthy. When these juices are withheld for some time, as has so often been the case in sea voyages, a disease called scurvy breaks out. As the fresh juices of vegetables and fruits prevent scurvy, they are said to possess anti-scorbutic properties.

Food value of various fresh vegetables.—All fresh vegetables are anti-scorbutic; but as a rule they are only nutritious in a low degree. Of all, the potato ranks decidedly first, because it is by far the most nutritious. Turnips and carrots come next, but with much less nourishment. The real value of the rest is anti-scorbutic. At the same time they are useful, if not actually necessary, in other ways. The pleasant and appetising flavour of a dish may depend upon the presence in it of celery, onions, turnips, tomatoes, or mushrooms. The plate of meat and bread would be dry and unsatisfactory without potatoes, cabbage, cauliflower, or some other vegetable. And, also, what is decidedly of importance with many people, we should often eat too much nourishing food if we did not, so to speak, dilute it with less nourishing vegetables. Chemical analysis shows that with the exception of potatoes there is not much nourishment in our English fresh vegetables; but practical experience tells us that they are very wholesome for us. The following table gives the analysis of some of the more important:—

	Potato	Turnip	Carrot	Cabbage	Lettuce	Mushroom
Water . . .	75	91	88	90	94	91
Nitrogenous matter .	2	1	1	2	1	4
Starch . . .	20	5	7	0	0	0
Sugar . . .	0	2	2	2	0	0
Woody fibre and salines, &c. . .	3	1	2	6	5	5
	100	100	100	100	100	100

The potato.—The potato is a tuber; that is, a variety of root. It grows well in this country, and is always an inexpensive article of diet. The mealy kinds are the most wholesome and nutritious. When well cooked they digest easily. Waxy, fried, or half-cooked potatoes are much less easily digested. The nitrogenous matter, as in wheat, is chiefly disposed just under the skin; hence a good deal of it is lost in peeling the potatoes before cooking them. The salines dissolve in water, and are much more lost in boiling than steaming.

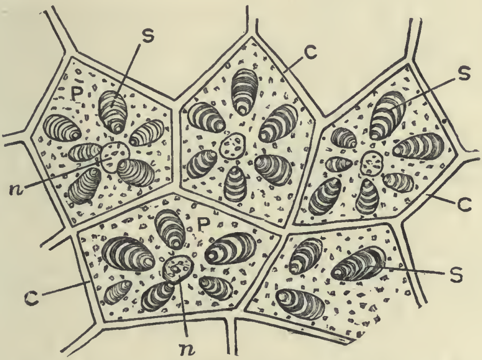


FIG. 81.—Slice of Potato under the Microscope.
C, cell walls of cellulose, containing S, starch granules ; *n*, nucleus of cell ; P, cell sap.

Potatoes steamed with their jackets on are better and more nutritious than when cooked in any other way. The starch of commerce is largely derived from potatoes, and potato starch being cheaper is sometimes substituted for other varieties, such as arrowroot.

Food value of potato.—As a food the potato is almost purely carbonaceous, and should always be combined with other nitrogenous substances, such as meat, fish, buttermilk, or one of the pulses. It was found that when the poor in Ireland lived almost entirely upon potatoes, they had to eat upwards of 10 lbs. a day to sustain life: thus encumbering the system with a vast amount of food to get the smallest equivalent of nourishment sufficient for life.

Sweet potato: Artichoke.—The sweet potato and yam replace our potato in many hot countries. They are similar tubers, containing a quantity of starch, and the former also a quantity of sugar. The artichoke is another sweet tuber, but it is of much less value, as it does not contain starch.

Carrots and turnips.—Carrots, parsnips, turnips, beetroot, and radishes are all fleshy roots of a similar class. They contain but little starch, but all have in addition a little sugar. When well cooked and young they are easily digested. But when old, they contain tough woody fibre which is quite indigestible. Summer carrots and turnips well boiled are the most wholesome; radishes which are eaten raw, the least so.

Greens.—Cabbage, cauliflower, Brussels sprouts and other greens are eaten for their pleasant, wholesome, and antiscorbutic properties. They could not be eaten by human beings in sufficient quantities to support life alone. When young, tender, and pale in colour, they digest well. When old and dark green, they are liable to disagree.

Spinach.—Spinach has less nutritious properties than any vegetable, but is considered wholesome and beneficial when eaten occasionally.

Celery.—Celery is very popular both raw and cooked. In the latter form it is most digestible. It is accounted good for rheumatism.

Asparagus.—Asparagus and seakale are very delicate vegetables. They are easily digested in small quantities, and much relished by invalids; but they are always expensive.

Onions.—The onion is an edible bulb of a peculiar pungent flavour. Eaten raw, it is decidedly indigestible; but as a flavouring agent in cooking it has an especial value.

CHAPTER XXXIV

FRESH VEGETABLES—LETTUCE—CRESS—MUSHROOM—VEGETABLE FRUITS—TOMATO—VEGETABLE MARROW—CUCUMBER—RHUBARB—FRUITS

Salads.—Lettuce is of all salads the most popular. When well grown and young, it is perhaps the best vegetable eaten raw. It is delicate and tender, and does not produce indigestion.

Mustard, cress, and water-cress are more pungent salads. They are quite wholesome, and no doubt, like condiments, have a stimulating action on the digestive apparatus.

Mushrooms.—Mushrooms are quite a different kind of vegetable food. They belong to the fungus class of plant, and have a somewhat high percentage of nitrogenous matter, with an absence of starch. They possess a delicate appetising flavour, and are much relished in stewed meats. An excellent sauce called catchup is made from them; but as a food they are difficult of digestion, and otherwise far from wholesome.

Vegetable fruits.—Tomatoes of late years have rapidly and deservedly gained in popularity. They are a refreshing fruit-like vegetable, equally good cooked or raw.

Vegetable marrow is a bland, easily digested vegetable; wholesome, but watery, and almost devoid of nutritive qualities.

Cucumber is eaten raw, alone or with other greens, as a salad. It has a pleasant, cool, refreshing taste, but is decidedly indigestible. Young cucumbers make a favourite pickle. They are known as pickled gherkins. Boiled cucumber resembles vegetable marrow. Like other vegetables, it is more digestible cooked.

Rhubarb.—Rhubarb is eaten as a fruit, though it is actually the stalk of a vegetable. The early spring kind which has been forced is the best, as it is more tender and contains less oxalic acid. This acid is less wholesome than the other fruit acids. It is contained in sorrel, and to a less extent in tomatoes. People who suffer from acidity should consequently eat these substances sparingly. Rhubarb makes good tarts and puddings, but is perhaps most serviceable stewed and eaten with rice or bread. In the latter form it is a good food for children, especially as it comes on in the early spring, when they have probably had rather too dry a diet through the winter. Rhubarb also makes a good preserve, and a wine.

Fruit: Anti-scorbutic properties: Unripe and over-ripe fruit: Composition of fruit: Food value.—In botany the part of a plant containing the seed is called the fruit; but when the term is used in reference to food, it is limited to certain acidulous juicy fruits used ordinarily for dessert and in tarts, puddings, preserves, &c. Fruits of this class contain but little nourishment, and would not be capable of sustaining life; but they have a very agreeable refreshing taste and marked anti-scorbutic properties. The juice of lemons or limes is always carried on long sea voyages, and is served out regularly to the sailors as a preventative of scurvy. Fruit which has been cooked is generally more wholesome than raw fruit; but some kinds, like the strawberry, ripen so perfectly that their softness and delicacy cannot be increased by cooking. It is important that all fruit eaten raw should be properly ripe, for active changes take place during and after the ripening process. Both under-ripe and over-ripe fruits are unwholesome; though each condition, especially the former, is modified by cooking. Before ripening, the fruit is hard, indigestible, and acid; after ripening, fermentative and decomposing changes set in. Fruits consist of sugar, gummy substances, vegetable acids and water. Though their nutritive value is low, they serve many useful purposes as food. Some, such as bananas and dates, are distinctly nutritious, and are an important and sustaining article of diet in their native countries. Some yield the most valuable wines and spirits. All fresh fruits are remarkably anti-scorbutic, and all fruits give a pleasant relish to the drier farinaceous foods.

Fruits, fresh, cooked, or preserved, are certainly more relished by children and young people than those who are older, and there is no doubt that they are better suited to the young, active, hearty time of life than to the more quiet and sedentary period of advancing age. This is especially true of the very acid or the very sweet fruits.

CHAPTER XXXV

FRUIT—RAW—COOKED—DRIED—PRESERVES—BEVERAGES MADE FROM FRUIT

Ripe fruits: The grape.—The grape takes precedence amongst fruits: as a fresh fruit in health or sickness; as a dried fruit for puddings and cakes; and as the source of all the finest wines. It is one of the few fresh fruits that it does not answer to cook, as cooking quite destroys its delicate flavour. The best and most expensive grapes are grown in English hothouses; but quantities are now imported from abroad of fine quality and in excellent condition, and which may often be bought in our markets for a few pence per pound. The grape contains a good deal of sugar, and is more nourishing than many other fruits.

Apples and pears: strawberry: raspberry: currants: orange: banana.—The most useful English fruit is undoubtedly the apple, but it is more wholesome cooked than raw. The pear ripens better, and is more esteemed, but does not keep so well and is not quite so wholesome. The strawberry is one of the most delicate, delicious, and wholesome of ripe fruits. Enormous crops are now grown in Kent every year, many tons being sent off by rail daily during the season. The raspberry, blackberry, and gooseberry, though not quite so delicate, are very wholesome and useful fruits. Currants, red, white, and black, all have more acidity and are not quite so wholesome. Oranges are very pleasant and refreshing, and are the most popular of winter fruits. The pulp is wholesome, but every part of the rind is indigestible. Bananas are nutritious, but not so easily digested as some other fruits. In the unripe state the plantain and banana contain starch in place of sugar. In this condition they are eaten cooked, and serve as a farinaceous food in the countries where they are grown.

Stone fruits: melons: pineapples.—Stone fruit is, as a general rule, less wholesome than other kinds, unless carefully selected and quite ripe. Unripe and over-ripe plums are the cause of a good deal of summer diarrhœa, but when properly ripe they may be eaten in moderation without fear. Peaches, nectarines, and apricots, when grown in England, are very delicious, but expensive fruits. When imported, they are gathered unripe, and are best cooked. Cherries are great favourites, and quite wholesome when no stones are swallowed. Melons from abroad are very cheap. They have a most pleasant and refreshing flavour, but like cucumbers are apt to disagree. Pineapples of good quality are always expensive. They are highly esteemed, but decidedly unwholesome.

Cooked fruits.—It has been stated that most fruits are more wholesome cooked than raw. This is especially true of the apple. Raw, though not easily digested, it is not by any means unwholesome for people in health; but the pulp of a well-cooked apple is one of the most easily digested vegetable substances which can be given to an invalid or young child: a very important matter when coarser vegetables cannot be borne, and fresh blood-purifying substances are needed. The apple is the most valuable fruit for cooking. It may be cooked in very many ways, and goes well with other substances such as blackberries, rhubarb, quince, &c., and as a sauce with some kinds of meat. The pear, though a dainty dish when well stewed, is not so wholesome, cheap, or useful as the apple. All plums cook well, and are better cooked than raw. Raspberries, currants, bilberries, blackberries, and indeed all English fruits, are suitable for cooking.

Dried fruits.—The most important are dried grapes in the form of raisins and currants. They are imported in large quantities, and are used for puddings and cakes, and as a winter dessert fruit. Raisins contain an amount of sugar and some other substances which are nourishing; but their chief value is as a relish for farinaceous foods. Currants are especially indigestible, though they usually do not cause any discomfort. Figs and dates are sweet and moderately nutritious. The latter are used as a food by the Arabs, and when compressed into cakes have been called the 'bread of the desert.' Prunes and other dried plums are usually eaten cooked, except the finest varieties.

They are certainly more wholesome cooked. Dried apples of various kinds cook well and are quite wholesome. Crystallised fruits can hardly be regarded as a food, though as a dessert bonbon they are very popular.

Preserves.—Preserves may be made from almost any kind of fruit by properly cooking it with plenty of cane sugar. They are necessarily very sweet, as it takes a large amount of sugar to preserve the fruit. The most popular preserving fruits are the strawberry, raspberry, damson, apricot, plum, ripe gooseberry, and blackberry; the orange for marmalade, and the apple, currant, and blackberry for jelly. Preserves in moderation are quite wholesome, especially for children, with bread, rice, or other simple farinaceous food.

Fruit beverages: fruit juice: cider and perry: British wines: grape wines: Brandy.—The beverages made from fruits range from the most simple summer drinks to the most costly wines. Lemon and lime-juice are very valuable as preventatives of scurvy at sea. In the form of syrup, these and other fruit juices mixed with water make popular summer drinks, which are refreshing and harmless. From the apple cider is made on a large scale in Hertfordshire and Devonshire; from the pear perry, a less wholesome beverage; from the orange, currant, gooseberry, rhubarb &c. various so-called British wines are made. They are not very strong, and in small quantities are harmless. The grape is the only fruit yielding high-class wines, such as port, sherry, champagne, burgundy, claret, hock, and other continental wines. They will be mentioned again later on, as well as brandy, which is distilled from fermented grape-juice.

CHAPTER XXXVI

COOKING—GENERAL PRINCIPLES OF ROASTING, BOILING, STEWING, FRYING, AND GRILLING—SOUPS AND BEEF-TEA

Cooking.—Only the general principles of cooking will be explained in this chapter, and these only so far as they affect the wholesome and digestive characters of food. The practical details for compounding and cooking various dishes of food should be taught in a practical class. Here we shall only consider the action of heat such as is used in cooking upon meat, fish, milk, eggs, and vegetable substances.

Action of heat upon meat.—Meat consists of fibres which are saturated with a moisture or juice. If meat is subjected to great pressure, the juice can be squeezed out of it, the fibres remaining behind white and dry. On boiling the juice it separates into a thin liquid A 1 and solid particles A 2, which fall to the bottom. The liquid does not set into a jelly when cold. The solid particles consist of the albumen of the meat, the most nourishing part of it. This is liquid like white of egg in the fresh

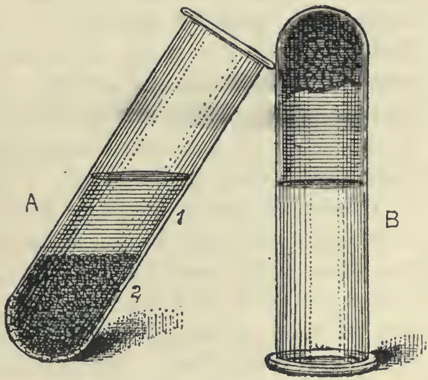


FIG. 82.

A, meat juice which has been boiled. It does not set into a jelly, but separates into—1, a clear liquid, and, 2, a sediment of solid particles.

B, fibrous part of meat which has been well boiled in water. It sets into a jelly when cold.

meat, but sets hard on being strongly heated. On boiling the fibres from which the juice was squeezed in water, very little effect is produced until the boiling has been continued for some time. Then the fibres begin to separate and soften, and the liquid on cooking sets into a jelly. This is due to the fact that all the fibres of meat, as well as sinews, gristle, and bone, contain gelatin, which is extracted by prolonged boiling. Here, then, are two important facts: (1) a strong heat causes the albumen of the meat to set hard like hard-boiled egg; (2) a prolonged heat extracts gelatin from the fibrous parts. Further effects of heat are: (3) heat develops a pleasant flavour in meat, which is quite absent in the raw state; (4) heat kills the eggs of parasites which are sometimes present in meat; (5) heat stops decomposition, and to a large extent removes the harmful effect of any decomposition which may have taken place before cooking.

Principles of cooking meat: Roasting.—The principles of cooking meat are based upon a knowledge of these facts, especially the first two. To roast a joint well, it is first put down to a hot fire in order that the outside may be strongly heated and hardened by the setting of the albuminous juices. It is then drawn further from the fire in order that the interior may cook at a lower temperature, and without hardening the albumen. In this way the nourishing juices of the bulk of the joint are kept in the meat. The outside cut is hard and rather indigestible; but the inside is juicy, tender, and nourishing.

Boiling.—Exactly the same principles are adopted in boiling a joint, and it is even more important to observe them, as boiling extracts the nourishing juices much more effectually than roasting. In boiling meat the nourishment must be either in the meat or the broth.

It is better to keep it in the meat, and let the broth depend chiefly upon vegetables. To boil a joint it is plunged into briskly boiling water to harden the outside, and then allowed to cook very slowly indeed. In this way boiled meat may be kept almost as juicy and tender as roast meat.

Stewing.—Stewing is an economical way of cooking meat, for nothing is lost, and with plenty of vegetables meat goes further this way than in any other. If the meat is cut up small, put into the water cold, and cooked slowly, nearly all the goodness will go into the gravy, the meat becoming poor and dry. If cut in large slices, put in when the water has come to the boil, and afterwards cooked slowly, the gravy will be poor, but the meat tender and rich. The latter is the better plan, as the gravy should depend for its goodness more upon the vegetables added than upon the meat.

Frying.—Frying is often regarded as a test of the skill of a plain cook. Badly fried meat and fish are very apt to disagree, because the meat is hard, dry, and saturated with fat. Fat boils at a temperature hot enough to scorch meat. When a chop is plunged into plenty of very hot fat, it is browned and hardened on the outside as in roasting, the juices being kept in. If put in half-hot fat the juices ooze out and the fat soaks in, quite spoiling the meat. The secret of good frying is to use plenty of fat, and heat it nearly to its boiling-point before putting in the meat.

Grilling.—Broiling or grilling are modifications of roasting suited to slices of meat like chops and steaks. When well done they are excellent modes of cooking.

Soup.—Soups depend largely upon gelatin for their character. They may be thick or clear, and made with or without vegetables; but the original stock should always contain gelatin. Soups, therefore, require prolonged gentle boiling in order that this gelatin with other nourishing matters may be extracted from the meat or bones used. Bones are generally used, as they are cheaper and contain more gelatin.

Beef-tea.—Beef-tea is an important food for invalids. In all acute diseases milk and beef-tea are the two chief foods. It may be made by two entirely different processes. One yields a simple nourishing meat juice, the other a rich, tasty, stimulating broth.

The first process is to cut fresh, pure beef into small pieces, sprinkle over it a little salt and cover with cold water. Then set it near the fire and gradually warm, but do not let it get hot enough to separate into a thin fluid and solid particles. Lastly, squeeze through muslin. This beef-tea is very nourishing and digestible. It is not unpalatable. Children take it well, but older people often recognise the want of sufficient cooking, and turn against it.

The other process is to put the meat cut up and free from fat into a well-covered brown jar, with water, salt, and pepper. The jar is then placed in a slow oven or a pan of gently boiling water for some hours. The beef-tea obtained in this way is much pleasanter to take; but it is richer and more stimulating, and could not always be given where the simpler and more nourishing juice is required.

CHAPTER XXXVII

COOKING—FISH—MILK—EGGS—VEGETABLES—BREAD-MAKING—FRUIT

Cooking fish.—Fish is not, like meat, liable to be rendered tough by cooking. On the other hand, it is more likely to be too soft. Moreover, what is sufficient cooking for meat is not enough for fish. We like it set firm and cooked throughout, so that the flesh easily comes off the bone. With this object fish is boiled more quickly than meat. It is not suitable for roasting, but some kinds, such as cod and haddock, bake well. Frying should be conducted as for meat, and is the best way of cooking flat fish, though boiling is the simplest and best method for invalids. Fish, like herrings, containing a good deal of fat, grill well.

Milk does not require cooking.—Milk undergoes no special change in cooking. Casein, unlike albumen, is not affected by heat; nor are the other constituents. Consequently we only cook milk when it is used in the preparation of a dish which requires cooking, such as a baked rice pudding, It is, however, sometimes boiled with the object of keeping it good in the summer.

Cooking eggs.—Eggs consist chiefly of albumen. When heated the albumen sets hard, but not so hard as meat, as there are no fibres present. The more rapidly and thoroughly an egg is heated, the harder it sets. When we want to boil an egg hard throughout, we keep the pan boiling on the fire for ten minutes. When we want it light, soft, and delicate, we put it in the pan when the water boils and then set it aside for five minutes. In this way no part of it is heated up to boiling-point, and the albumen consequently sets more lightly, just as the juices of the meat do when cooked slowly. This is the best and most digestible way of cooking eggs. Frying in fat is the least digestible way.

Action of heat on vegetables.—The action of heat on vegetables is even more important than on meat. Many vegetable substances which are very nourishing when cooked are practically useless as a food when raw. Raw meat, on the other hand, though tough, stringy, and unpalatable, is perfectly digestible. Indeed, raw scraped beef is so nourishing and digestible that the lives of many invalid children have been saved by it. Human digestive juices have no action on woody fibre. Now, most vegetable substances are bound together with woody fibre, and all nourishing substances such as nitrogeneous matter, sugar, and starch grains, are, so to speak, locked up by it. Consequently, until this fibre has been softened and broken up by heat, we cannot extract the goodness from vegetable foods. The fresh wholesome juices, of course, we can get from raw vegetables, but not the nourishing matters. A raw potato, for instance, is just as full of nutrition as a cooked one; but we should starve outright on the former, whilst the latter is a very wholesome food.

All fresh vegetables are usually cooked by boiling or steaming in the ordinary way; but the most important vegetable food, bread, is cooked in the oven.

Bread-making.—When describing the cereals, it was pointed out that wheaten flour had an especial value owing to the elastic adhesive nature of its gluten. This feature enables us to make wheaten dough into a porous, spongy mass, by generating little bubbles of air or gas in it. In other kinds of dough the bubbles escape, and the dough settles flat again. In wheaten dough the bubbles are retained, and cause the dough to rise and make light bread.

Three methods: Action of baking powder.—There are three methods adopted for making the dough rise. The easiest to understand is the use of baking powder. This is a simple effervescing powder like citrate of magnesia, pyretic saline, or ginger-beer powder, and like them only effervesces when wetted. It is composed of carbonate of soda and tartaric acid. The dry powder is mixed with the wheaten flour, and as soon as the latter is moistened and made into dough the powder effervesces. The bubbles of gas given off, instead of escaping, as they would from water, become entangled in the adhesive dough, and swell it up like a sponge. When put into the oven the heat causes the bubbles to swell still more, and the loaf rises higher in the tin, and then sets firm by the continued action of the heat.

Barm bread: Aërated bread.—The usual method of making bread, however, is not this plan, but by mixing yeast or barm with the dough. Yeast is a fungus plant, and in feeding on the starch it gives off little bubbles of gas. Thus the same effect is produced in a different way. The heat of the oven kills the plant, but during its growth it produces a slight change in the dough which gives barm bread a different taste to any other, a taste which is generally preferred. The other process is that which makes the aërated or machine-made bread. This is nothing more than making bread with effervescing water like soda-water. The flour is mixed with the water by machinery in a closed iron trough. In this it is under pressure, as the soda-water is in the corked bottle. As soon as a trap door is opened out springs the dough, as the soda-water would if opened with the bottle lying on its side. As the dough comes out it swells up with the gas in it, is divided by machinery, and received into tins. Thus this method has the advantage claimed for it, that the dough is not touched by the hand.

Cooking fruit.—Fruit is generally rendered more tender and wholesome by cooking. Many kinds of unripe fruit are wholesome when cooked, and in over-ripe or stale fruit the fermentative processes are stopped, and it is at any rate rendered less harmful. Boiling is not a good method of cooking fruit, as it breaks it up too much. It cooks much better in a closed jar in the oven or a steamer; but perhaps the most popular method is to bake it in a tart, or boil it in a suet crust. The object in cooking fruit is somewhat different to that in cooking vegetables. The latter require cooking to make them nourishing as well as wholesome, whilst fruit is scarcely nourishing under any circumstances, and is only cooked to make it somewhat more wholesome or more palatable.

CHAPTER XXXVIII

THE PRESERVATION OF FOODS—MEAT—FROZEN MEAT

Value of the art of preserving food.—When we bear in mind the rapidity with which many of our most important foods undergo decomposition, and the uneven distribution of population in different countries, it is very evident that the art of preserving food is a most important one. Meat, which in one part of the globe is so plentiful that it may be sacrificed for the mere value of a hide, is in a crowded country like England so valuable that many have to do almost without it.

Effect of preserved meat in lowering the price.—Only a few years ago the art of preserving meat was limited to two or three imperfect and unsatisfactory methods, such as salting, drying, and smoking. It is true that these methods sufficed to supply sailors with meat on long sea voyages, and to enable us to preserve hams and bacon; but constant 'salt junk' was one of the greatest hardships of the sailor's life, and a fruitful cause of the scurvy which used to prevail in those days. It was not a form of meat that it could ever be worth while for us to import; nor were the processes suitable for any meats but pork and beef. In those days American beef and Australian mutton were unknown in our crowded cities, and the home beef and mutton were proportionally dearer.

If meat was dear then, think how much dearer it would be now had we none but English cattle to draw from. Probably, what now costs us from 6*d.* to 1*s.* a pound would have cost from 1*s.* to 2*s.* if it were not for the better knowledge of how to preserve meat in such a way as to enable us to import it from distant countries.

The means by which decomposition can be prevented: four methods of preserving food.—This better knowledge has come to us through studying the causes of decomposition. When it was known that all putrefactive changes were brought about by minute fungus germs, the seeds of which are always in the air, the first step was gained. The next step was to discover what conditions would destroy and exclude these germs without harming the meat. This was learnt by observing the conditions under which these germs flourished. As we require food, air, warmth, and so forth, so these germs require certain conditions to enable them to grow. They are: (1) moisture; (2) mild temperature; (3) air; (4) food; and, like other living things, they can be killed by certain chemical poisons. The means, then, through which we can affect them are: (1) by the exclusion of moisture—drying; (2) by extremes of temperature—freezing or boiling; (3) by exclusion of air; (4) by certain chemical substances. Of course, we cannot affect them through their food, because that is our food, and our object is to preserve, not to destroy it.

Meat can be preserved by all four methods.—All four methods are used for this most important, but perishable food. That, however, which stands first, both in simplicity and utility, is freezing. By this method alone can the flesh of animals be kept for long, unlimited, periods without marked change or deterioration. Frozen beef and mutton, which have come to us from thousands of miles over the sea, eat with all the freshness of recently killed meat. They are not quite the same as our home produce, or the meat of cattle imported living, but the difference is not very material. Frozen beef and mutton are good in quality and flavour, and almost, if not quite, as nourishing as fresh meat.

Preservation of meat by cold.—The process of freezing is conducted in specially constructed cold chambers, in which the temperature of the air can be lowered, by the action of machinery, many degrees below freezing point. Steamers bringing frozen meat to this country are fitted with such cold chambers, in which several thousand carcases can be stored. On their arrival the meat is at once removed to similar chambers in the dock warehouses, where it can be kept until required by the butchers. Passenger steamers, especially those going long and hot voyages, are also fitted with small cold chambers in which fresh meat, milk, vegetables, and fruit, can each be kept at the temperature which preserves them best. These luxurious ships supply their passengers in mid-ocean with the same fresh food that they could obtain at a first-class hotel.

CHAPTER XXXIX

PRESERVATION OF FOODS—MEAT (*continued*)—FISH—MILK—EGGS—VEGETABLES—FRUIT

Preservation of meat by heat and exclusion of air.—Another method of preserving meat which is also of great importance is that of first heating it and then hermetically sealing it from contact with the air. This is what is done with tinned meat. Heat, though more fatal to germs than cold, is a far inferior food preservative, owing to its destructive action on the food. In a few hours meat is boiled to rags; but experience in Arctic regions seems to show that frost will preserve flesh unaltered for any length of time. Exclusion of air, if it could be used alone, would be a perfect method; but, unfortunately, the meat contains germs when put into the tin. These germs must consequently be killed before the tin is sealed up. Now, the only method at present known by which this can be suitably done is boiling. Freezing will not do, as the germs are only rendered inactive by frost. They would revive again when the meat in the tin thawed, and spoil it. Thus, all food which is preserved by hermetically sealing, must first be boiled or steamed in its tin or bottle.

The process of tinning or bottling foods.—There is no secret about this process. Any housewife can employ it, if she so desires, to preserve any article of food that is not injured by cooking. She must remember that the food, the bottle, and the cork, are all contaminated by germs, and must be heated to boiling point for about an hour. Meat, vegetables, or fruit, should be placed in a steamer in bottles, with their corks beside them, steamed for an hour, then rapidly removed, and filled to the top with *boiling* stock, salt and water, or thin syrup respectively, corked immediately with well-steamed corks, and finally sealed with bottle-wax. Foods preserved in this way will keep just as well, and probably taste much better than the tinned and bottled foods sold in the shops. Patent self-sealing bottles can now be bought, which save entirely the trouble of corking.

Tinned less wholesome than frozen meat.—Various kinds of meat are preserved in air-tight tins by this method, but they are not like fresh meat, and are not nearly so popular as frozen meat. It is fortunate this is the case, for experience shows that, though tinned meat is perfectly wholesome and nourishing, it does not answer to use it continuously. People who eat it every day sooner or later suffer, either owing to some contamination from the tin, or to the absence of fresh meat juices.

Salt meat.—Salting meat will keep it for some time, especially in cold weather; but it loses some of its nourishing qualities, which escape into the brine, and the salt renders it less wholesome and digestible. The meats ordinarily salted are pork and the rounds and brisket of beef.

Smoked meat.—Smoking and drying, with a less amount of salt, is the favourite method of curing hams and bacon. They keep well, and the fat part especially, when sufficiently fried, is a wholesome and digestible food. Tongues, German sausages, and other meat 'relishes,' are preserved in the same way, though sometimes with the addition of spice. Potted meats are usually covered with fat to keep the air from them, or are preserved in tins.

Preservation of fish.—Ice is used largely in the summer months for keeping fish. It is not spoilt, as meat would be, by the moisture from melting ice. At the same time, this method only anwers for a few days, as no cold short of actual freezing will permanently arrest decomposition. The process of smoking and drying is very suitable for some kinds of fish, such as herring and haddock. Drying in the sun and salting is also used for cod. Much salt injures fish for food in the same way that it does meat.

Borax and boracic acid are also used. They are the least harmful of chemical preservatives, but it would be much better to do without them. If fisheries were better organised, the fish on being landed would be placed in cold chambers as the imported meat is. It could then be stored until required, without the necessity of using salt or any chemical substances.

Preservation of milk.—Milk may be kept for some days if boiled, and well corked in a bottle, or if a little carbonate of soda be added to counteract the acid change in the sugar of milk. Sometimes chemicals are used; but this is wrong, as milk supplies the entire food for infants, and should be perfectly pure. The only satisfactory method of permanently preserving milk is that of condensing it, and sealing it up in air-tight tins. Condensed milk is concentrated by evaporation to about one-fifth its bulk, either with or without the addition of cane sugar. Another method is to dry and powder the milk, but this has not proved very satisfactory. Milk has also been preserved in tins without concentration; but the cream is liable to separate in the form of butter, and its greater bulk renders it more costly than condensed milk.

Preservation of eggs.—Eggs are spoilt for future use by any kind of cooking. They are, therefore, difficult to preserve permanently. Boiling is out of the question. Freezing is unsuitable, and too costly for so small a purpose. Drying is unsatisfactory, and has met with very little favour. The best methods in use are intended to help the shell more thoroughly to exclude the air from contact with the interior of the egg. They are: (1) to coat the shell with butter, oil, wax, or gum, to render it less porous; (2) to pack the eggs in salt, sawdust, bran, or some other suitable material. In either way they will keep for some months, but lose their fresh flavour.

Better keeping qualities of vegetable foods: dried and tinned vegetables.—The most important of these are sufficiently dry to keep well without adopting any of the special methods of preservation. The cereals and legumes will keep quite good for years if stored, with moderate care, in a dry place. Potatoes, turnips, carrots, and similar roots, will keep well through the cold months of winter in a dark place, where they will be cool but not get frozen. These and other vegetables may also be dried, which preserves them permanently; or boiled, and sealed in tins like meat.

Dried and bottled fruits.—Fruit dries well; the sugar naturally contained in it helping to preserve it. When boiled and sealed in bottles or tins, some *cane* sugar should be added to prevent the tendency which fruit always has to undergo fermentation. Salicylic acid is sometimes recommended as a preservative, but should not be used, as it is decidedly harmful, and also spoils the flavour. Bottles are much better than tins, as the fruit-acids always dissolve some of the solder, which is of a poisonous nature.

CHAPTER XL

UNWHOLESOME FOODS—FROM DECOMPOSITION—THE PRESENCE OF INFECTIOUS DISEASES

Conditions which render food unwholesome: decomposition: due to germs: action of germs: meat rendered poisonous by decomposition: decomposition in various food-stuffs: effects of eating decomposed food.—Food of the best kinds, if not wisely used, may be, and often is, harmful to us. Eating to excess, for instance, though not producing the immediately distressing consequences of drinking to excess, is yet as fruitful a source of disease. By bad cooking, by an unwise choice of food, by eating at wrong times, or by neglecting the proper proportions of the food principles, we may make good food unwholesome. Besides these, there are other conditions rendering food unwholesome which lie concealed in it. They are of all the most important to understand, as, when they pass unrecognised, serious consequences sometimes ensue. These conditions which may be present in food are: (1) decomposition; (2) infectious disease; (3) parasites. Decomposition has already been explained to be due to the presence of germs of a fungus nature. Of these the mould, which grows on cheese, bread, jam, or any stale food, is the most common and visible variety. Yeast is another well-known germ plant, and its action upon sugar is a good illustration of the power these germs have to change substances. The yeast plant changes simple sugar into powerful alcohol. The former is harmless; but when we see strong men helpless under the influence of the latter, we recognise how powerful it is. In a similar way, when the germs of decomposition attack meat they develop poisonous substances in it. Fresh meat, which is wholesome and nourishing, by decomposition is made more or less poisonous. If decomposed meat were injected straight into the blood it would kill us, but cooking and the action of the gastric juice render it less harmful. Apparently, the worst kinds of decomposition take place in meat, poultry, or game, closely packed whilst still warm, and in foods which have decomposed in tins. Fortunately, our senses generally make any kind of decomposition repugnant to us; but the evidence of it is sometimes less apparent than usual, or it may have been concealed by the vendor of the article, as in well-seasoned sausages, when we are liable to suffer severely from eating it. Decomposition renders every class of food harmful, and is proportionally worse when the food is eaten raw, or has decomposed since cooking. Meat is, perhaps, the worst of all. Sour milk is not to be regarded as decomposed milk; the sourness is due to fermentation. Putridity does not take place for several days, and is then as unpleasant as in meat. Eggs, owing to the amount of sulphur they contain, are too nauseous when decomposed ever to be used as food. Vegetables, like milk, may also become sour by fermentation before actually decomposing. Both conditions are, of course, unwholesome, but the latter is by far the most so. In fruit the tendency to fermentation is so marked as to somewhat replace that of ordinary decomposition. The effects of eating decomposed food are: (1) local irritation of the alimentary canal, causing diarrhœa and vomiting; and (2) (rarely) the absorption of some unaltered poison into the blood, which is always serious, and may be rapidly fatal.

Infectious diseases carried by food.—Infectious diseases may be carried by food in two ways: (1) by fever-germs from human beings getting into the food; and (2) by eating the flesh of animals which have suffered from some infectious disease.

Fever-germs in milk.—In the first instance, the only cases in which it has been clearly shown that fevers have been spread by food, the substance has always been milk. Now, milk is usually not cooked; consequently, if any germs of typhoid, scarlet, or other fever, get into milk, they are liable to be taken into the body in the living state, and to infect the person so taking them. For this reason milk-houses are licensed, and are under special inspection. The germs do not alter the appearance of the milk in any way, so we have no means of deciding if they are present; but if in doubt, the milk should be boiled, when the germs will be killed.

Meat rendered unwholesome by disease.—The flesh of animals suffering from infectious diseases may generally be recognised: it is soft and watery, and has a faint unpleasant odour. It is usually of dark colour, and the fat is sometimes reddened. The liver and spleen are worse than the meat; they are much enlarged and very soft. Frozen meat, when thawed a day or two, is also watery, and the fat stains red; but it has none of the unpleasant, suspicious characters of diseased meat. The meat inspectors are instructed to condemn all meat of this kind. Thorough cooking would always prevent infection, but disease germs, in addition to the danger of conveying infection, produce changes which, like those of decomposition, might set up diarrhœa and vomiting.

Diseased meat condemned.—When studying subjects of this kind, we must not be guided by sentiment. It is for our own and the public good that such matters should be generally understood, and the reasons known why certain carcases are destroyed. Our feelings incline us to say, if an animal has any kind of a disease, Condemn it. But do we condemn an apple because it has a spot of decay? There are many diseases in animals which are as purely local, and, unless the meat shows the effect of the disease, as it does in those of an infectious nature, it is very wasteful and wrong to condemn it. Also, we may always remember that *thorough* cooking will effectually destroy the disease germs, though it does not remove those less serious changes which make the meat irritating to the alimentary canal.

Internal parasites conveyed by food: how to avoid them.—Man fortunately suffers less from internal parasites than animals, because, by cooking his food, any parasitic eggs which it might contain are destroyed. The source of such parasites has only been definitely traced to a few articles of diet, such as pork, beef, veal, and some of the vegetable substances eaten raw, of which, perhaps, cress and watercress are the most suspicious. Thorough cooking kills the eggs of parasites in meat;

but partial cooking, combined with smoking and drying, does not. Hence it is unwise to eat food like German sausages without additional cooking. When the eggs are deposited on green food, they will be removed if it is well washed; we have, therefore, an easy means of protecting ourselves from these unpleasant causes of disease.

CHAPTER XLI

BEVERAGES—ALCOHOLIC AND NON-ALCOHOLIC—WATER—TEA

Uses of beverages.—The primary object of a beverage is to supply the system with water. Other uses served by this form of food are refreshment and nourishment. When a drink is, like milk, purely nourishing, and quite devoid of refreshing and exhilarating qualities, it is regarded as a food and not as a beverage. And when such a drink is freely partaken of, the amount of solid food should be proportionally lessened, or the system will become overloaded.

Uses of water in the system.—Water is necessary to us for several important purposes: (1) It enters into the composition of every part of the body—the muscles, brain, and all other organs, and even the bones and teeth. (2) It is the vehicle for the removal of some waste products from the blood, such as urea and salines. (3) The digestive juices and other secretions consist chiefly of water. (4) Water is used to help in regulating the temperature of the body, by means of the perspiration.

Daily income and output of water: varieties of beverage. Every day some four or five pints of water are required by the body when performing active work in health. This water is derived partly from beverages and partly from food. It is removed by the skin, lungs, and kidneys. Beverages are divided into the alcoholic and the non-alcoholic. The former include spirits, wine, and beer; the latter, water, tea, coffee, cocoa, and aërated waters. We will take the non-alcoholic beverages first.

Water: characters of drinking water.—Water consists of two gases, hydrogen and oxygen, in chemical combination. It is quite pure as distilled, or fresh rain water; but is then insipid to the taste. Ordinary drinking water contains more or less air dissolved in it, and some saline substances derived from the earth. These render it more pleasant and refreshing; but the latter are the cause of hardness, and make it less useful for washing. Wholesome water should contain no organic matter, that is, vegetable or animal substances, such as are present in pond or ditch water, and not too much saline or mineral matter. A fuller consideration of the characters of water will be given when we study the water supply.

Tea, coffee, and cocoa, all contain the same active principle: tea: green and black tea: composition of tea: the aroma.—Tea, coffee, and cocoa are the most popular of all beverages. Though widely different in taste and appearance, and in the plants from which they are derived, they have one common feature. Strange to say, this feature is common to beverages of this class throughout the world. It is that they all possess a delicate crystalline substance, almost identical in each, which has a stimulating and exhilarating effect upon the nervous system. It is no doubt owing to the presence of this substance that the leaves or berries of these plants have come to be used for making beverages. We do not drink tea simply because we like the flavour of it, though that is pleasant to most of us, but because of its refreshing influence. Tea consists of the leaves of a small shrub growing in China and India. Green tea is derived from the young leaves, which are carefully picked and dried, or roasted, as it is called, at once, thus preserving their green colour as well-dried summer hay retains its grass-like appearance. Black tea consists of the older leaves, which are collected in heaps, and wither somewhat before being roasted, and thus lose their fresh colour and become black. Scented tea is made by mixing orange and other blossoms with the tea, and, after a time, sifting them out again. Tea contains: (1) an aromatic essence; (2) a nerve stimulant—thein; (3) extractives—of which tannin is the most important. The aromatic essence gives the delicate, aromatic flavour to tea. It only exists in a very minute quantity, and is dissipated by heat. This is the reason why tea spoils if it is boiled, or if it is kept hot for a long time. In each case the volatile oil is lost, and the best part of the flavour gone.

Thein.—The nerve stimulant is called thein, and is only found in a proportion of less than 2 per cent., but it is very strong. It stimulates the nervous system—refreshing us when we are fatigued, and rousing both body and mind to increased exertion.

Tannin.—The extractives are neither useful nor harmful except tannin, and that, unfortunately, is the latter. Tannin is a powerful astringent, and has a tendency to cause indigestion, especially as regards meat. The extractives give the strength, body, and colour to the tea; consequently, we like tea that has plenty of extractives. This is the reason for the growing popularity of Indian tea: it contains twice as much tannin as China tea, and tastes proportionately stronger, but is not nearly so wholesome.

Tea as a beverage.—Tea is equally suitable for both hot and cold weather. Taken in moderation, and not too strong, it is refreshing and wholesome; but when too freely indulged in, it causes indigestion and exhaustion of the nervous system.

Maté.—Maté is the tea of South America. It is derived from the leaves of a species of holly, native to Paraguay. It contains an exactly similar nerve-stimulating principle.

CHAPTER XLII

OTHER NON-ALCOHOLIC BEVERAGES—COFFEE—CHICORY—COCOA—AËRATED WATERS

Characters of coffee.—Coffee is prepared by roasting and grinding the seeds of the coffee tree—a small tree growing in Arabia, the East and West Indies, Ceylon, and some other places. The tree bears fruit like berries, in each of which are two seeds. As imported in the raw state these seeds are hard, tough, and of a pale yellow or green colour; they have very little scent or flavour, and their general appearance is something like small dry beans. During the roasting, which is conducted in iron cylinders revolving over a fire, a fragrant volatile oil is developed, and the seeds swell and become of a rich brown colour. They also become light and friable, so that they can easily be ground to a powder.

French coffee.—Coffee is cheaper than tea by weight, but does not go so far. Its strength is apparently increased, and its price much lowered, by mixing it with chicory, the mixture being known as French coffee.

Composition of coffee: the aroma.—Coffee contains: (1) an aromatic essence; (2) a nerve stimulant—caffein; (3) extractives; (4) fat. The fragrant odour and delicate flavour of coffee depend upon the aromatic essence developed during the process of roasting. This essence is volatile, and escapes if the coffee is kept long after roasting and grinding, unless inclosed in well-fitting tins. It also escapes, though not so readily as in tea, if the coffee is boiled in making it; the proper plan being to pour the boiling water on the grounds.

Caffein.—Caffein corresponds exactly to thein in its action on the nervous system. It is sold by chemists, as the effervescent citrate of caffein, for headache and other complaints.

Extractives: fat: tea and coffee compared as beverages. The extractives produce the thickening and brown colour of the beverage. They are more plentiful and more nourishing than in tea, and, fortunately, contain very little of the injurious tannin. Coffee, in addition, contains a small proportion of fat, which, together with the extractives, renders it a more heating beverage than tea. Comparing the two, we should say that tea is purely a beverage; it is devoid of nourishing and heating qualities (except the heat of the water), and possesses an invigorating and refreshing action on body and mind. It is especially suited to the after part of the day, when work is well advanced, and the time for sleep not too near to be affected. Coffee is richer, more heating and sustaining, and free from astringency. It is a suitable beverage for early morning, for cold weather, and especially for cold journeys.

Chicory: no active principle.—Chicory, the roasted and ground root of the wild endive, is of very much less value than either of the preceding. It contains an aromatic essence and extractives, but no nerve stimulant. It therefore does not possess the refreshing character essential for a popular beverage. On account of its cheapness, it is sometimes used alone by the poor on the Continent, and is frequently used mixed with coffee in all countries. Many think that it improves the flavour, as well as lessens the cost, of coffee, and prefer the so-called French coffee to the pure article.

Cocoa: characters.—Cocoa is prepared from the seeds of the cacao or chocolate tree, growing in the West Indies, Mexico, and parts of South America. They occur in numerous rows, growing in a very large pod. The imported article consists of the seeds removed from the pod, but inclosed in a thin, brittle husk. They are about three times the size of a coffee bean, and of a redder brown in colour. Cocoa is prepared, like coffee, by roasting the kernels, which develops a pleasant aroma.

Composition.—Cocoa contains: (1) an aromatic essence; (2) a nerve stimulant—theobromine; (3) extractives; (4) fat—50 per cent.; (5) starch—13 per cent.; (6) nitrogenous matter—15 per cent. The first three substances are those common to all beverages of this class. The last three form about the most concentrated nourishment of any article of food.

Cocoa as a beverage: cocoa nibs: prepared cocoa.—Cocoa is made into a beverage in several different ways. (1) The roughly crushed seeds called cocoa nibs are boiled in water for about two hours. The thin liquor which is poured off contains the theobromine, with very little of the nourishing substances. It thus resembles in character tea and coffee, but is not nearly so pleasant and popular. (2) The cocoa nibs are ground to a powder and mixed with starch and sugar. This is called prepared cocoa. When boiling milk or water is poured upon the powder, the starch thickens, and an aromatic, pleasant-flavoured drink is produced. This is the popular cocoa. It contains all the nourishing substances as well as the theobromine, and is more of a food than a beverage. It is unfortunately too rich to be easily digested.

Peptonised cocoa.—(3) Peptonised or partially digested cocoa is prepared by chemical processes for invalids.

Chocolate.—(4) Chocolate is made by grinding the nibs with sugar on hot steel plates. The heat melts the cocoa butter, and the paste resulting is poured into moulds to set. It is often flavoured with some essence, such as vanilla.

Value of cocoa to the working classes.—Cocoa, like milk, is of doubtful value as a beverage to those who can afford and can eat plenty of food. For invalids, however prepared, better foods can be obtained. But for the hard-working man or woman, who can make good use of all the food he or she can get, cocoa is a boon, as it combines all the elements of a strong nourishing food with those of a pleasant, refreshing drink.

Aërated water: soda water.—Aërated waters consist of water impregnated with carbonic acid gas. This is how plain soda-water is made. For ordinary drinking this simple aërated water is the best; but for medicinal purposes it is charged with soda, potash, or lithia.

Lemonade.—Lemonade, ginger beer &c. are usually merely aërated waters flavoured with lemon, ginger, &c., though the latter is sometimes made with barm.

Temperance drinks.—Artificial temperance wines, such as zoedone, moselline, and a host of others, are all flavoured aërated waters. When first introduced they contained so-called 'nerve tonics,' which were much more pernicious than alcohol. The nerve tonics have now been generally omitted. The best temperance drinks after pure water are those which can be concocted at home, and of which the ingredients are known. Plain water, or simple aërated water with lime juice cordial, raspberry vinegar, or some other fruit syrup, is nice, pleasant, refreshing, and wholesome. Effervescing drinks are perfectly harmless in moderation, but they are liable to interfere with digestion if constantly used, and consequently are better not taken at meals.

CHAPTER XLIII

ALCOHOLIC BEVERAGES—ACTION OF ALCOHOL—VARIETIES OF ALCOHOLIC DRINKS

Alcohol composition: a food.—Alcohol consists of carbon, hydrogen, and oxygen (C_2H_6O). It is therefore a carbonaceous substance, which, if decomposed in the body, must yield heat and energy. When taken, some of it is excreted, unaltered and unused, by the lungs, skin, and kidneys, but the bulk cannot be recovered again. This proves that it is used in the body, though a little escapes owing to its very volatile nature. Alcohol, therefore, strictly speaking, is a form of carbonaceous food. It is not stored in the body as fat and starch are, but is used at once. The reason that some people fatten on alcoholic drinks is because they save the use of fat, and thus the latter accumulates.

Alcohol a powerful stimulant: its action on the stomach: on the liver: on the heart, blood vessels, and skin: on the brain and nervous system.—Though it cannot be denied that alcohol has this power of nourishment, it is for a very different reason that people like and take it. Alcohol is before anything else a stimulant, its nourishing qualities being inferior to those of the poorest foods. As a stimulant it is very powerful. Indeed, from a medical point of view, it is the strongest and best stimulant we possess; but its very strength makes it a source of danger, for it is as powerful to do harm as to do good. When alcohol is swallowed in a small dose it stimulates the stomach and increases its power of digestion. In larger doses it congests the stomach and causes indigestion. Small or large doses are rapidly absorbed and pass to the liver. A little produces no effect, but much causes congestion of the liver; and if often repeated, permanent disease of that organ. Beyond the liver the alcohol is carried by the blood throughout the body. It increases the beats of the heart, and causes a flow of blood to the skin, producing a sensation of warmth. By its action in the circulatory system the abuse of alcohol causes diseases of the blood vessels, heart disease, and apoplexy, and frequently eruptions on the skin. It also acts upon the brain, exciting it pleasantly and harmlessly in small doses, but dangerously in large ones. Very large ones paralyse the nervous system, and are fatal outright in children and animals. Frequently repeated excesses weaken the brain, and eventually cause incurable mental disease.

Effects of judicious and injudicious use of alcohol.—In effect, the judicious use of alcohol in small quantities is to produce a stimulating action upon the digestive, circulatory, and nervous systems, which is probably even less harmful than that produced by tea. But it has the misfortune to prove so attractive to many people that the harmless limit is being constantly passed. When this is the case, alcohol, instead of being useful and helpful, becomes so mischievous that it is known to be the chief cause of diseases, accidental injuries, and crimes. There is no other known condition which is so powerful for harm, as is shown every day by the experience in hospitals and police courts.

Total abstinence.—Under these circumstances many courageous people absolutely abstain from the advantages and pleasures of a temperate use of alcohol. They feel that, although no temptation to them, so great a temptation to sin and harm in others ought to be abjured by everyone. The object of this lesson, however, is to point out the true uses and dangers of alcohol, and not to advocate one or the other side of the temperance controversy. The moral question of total abstinence, like all important matters, should not be hastily decided upon, and one is naturally better fitted to make a wise decision when the good and the bad sides of the use of alcohol have been first studied without prejudice.

Source of alcoholic beverages: malt liquors: cider and perry: British wines: Continental wines: spirits.—Alcoholic beverages are all the result of the fermentation of sugar as it occurs naturally in various seeds and fruits. In this country, ale, stout, and whisky are the liquors which are produced on a large scale, and these are all made from the sugar which is contained in malted barley. Next to these come cider and perry, made by fermenting the juice of apples and pears. Other fruits, such as currants, gooseberries, oranges, &c., yield the various British wines named after them, but they are not much esteemed. The valuable wines are all produced abroad in warmer countries from the fermentation of grape juice; and pure brandy is only to be obtained by the distillation of grape wine. Some other spirits, such as gin and rum, are also imported.

Strength of alcoholic beverages.—Alcoholic beverages are divided into groups according to their alcoholic strength. The weakest are cider, perry, ale, and stout. The last two average about 5 per cent. of alcohol; draught cider is not so strong. Next the light wines, such as claret and hock, containing 12 to 15 per cent. Then the fortified wines, like port and sherry, with 15 to 20 or even 30 per cent. And lastly, the spirits containing as much as 50 to 60 per cent. of alcohol.

CHAPTER XLIV

ALCOHOLIC BEVERAGES (*continued*)—ALE—STOUT—LIGHT WINES—FORTIFIED WINES—SPIRITS—BEVERAGES SUITABLE TO VARIOUS CONDITIONS OF LIFE

Ale and stout: brewing.—Ale and stout are now manufactured on a large scale in immense breweries. In years gone by they were generally brewed at home. The process of brewing consists in (1) converting barley into malt; (2) mashing the malt with hot water; (3) boiling the liquid with hops; (4) fermenting it with yeast; (5) storing the beer in barrels. Malt is made by causing the barley to start growing, during which its starch is changed into sugar. At the right moment the growth is checked by roasting the grain, and it is then known as malt. In the second process the crushed malt is mixed with hot water, which dissolves out all the sugar and other soluble matters. The fluid strained off is called the sweet wort. This is at once boiled with hops, and then rapidly cooled. When sufficiently cold it is run into large open vessels, where it is fermented with yeast. The yeast changes the sugar into alcohol, and when this process is complete the beer is put into barrels. Stout is made in the same way, except that the malt is more highly roasted.

Cider and perry.—Cider is the popular beverage in the apple-growing counties, Herefordshire and Devonshire. It is made by fermenting the juice of apples. Perry is a similar drink made from pears.

Light wines.—Light wines are amongst the most wholesome of the alcoholic beverages. They are made in countries like France, where the autumn heat is not excessive. A high temperature is not so suitable for fermentation. For this reason, the wines produced in hot countries like Spain and Portugal require to be fortified by the addition of spirit before the fermentation has completed its natural course. Wines like French claret are produced by the simple fermentation of pure grape juice to which nothing is added, consequently they are light and wholesome.

Fortified wines.—Strong wines like port and sherry are made in hot countries, and are fortified with spirit. They are richer and stronger than the light wines.

Sparkling wines.—Sparkling wines such as champagne require great care in their manufacture. They are first fermented like claret, and then caused to undergo a second fermentation in the bottle by the addition of sugar. This produces the gas which causes them to effervesce.

Brandy.—Brandy is the spirit produced in the wine-growing countries. It is made by distillation from wine. It is when pure the most delicate form of spirit, and that which is adopted for medicinal purposes.

Whisky.—Whisky is a malt spirit; that is, it is distilled from fermented malt liquor. It is the spirit produced in grain-growing countries, notably in the British Isles. When pure and old it is the most wholesome spirit for ordinary use.

Gin.—Gin is another form of grain spirit, its peculiar flavour being due to juniper berries. The best is made in Holland.

Rum.—Rum is a strong spirit derived from the fermentation and distillation of molasses. Its peculiar flavour is due to an essential oil contained in the molasses. It is imported from the West Indies.

Beverages suitable to various conditions of life.—It is a common experience that the beverage which suits one person does not suit another; and although it is impossible to lay down rules which will do for everyone, it is possible to give advice which will prove generally true.

Beverages for an active outdoor life.—For perfectly healthy people who lead an active open-air life, the only necessary beverage is water. There is, of course, no reason why they should be denied tea and coffee, for however healthy one may be a warm drink is always appreciated at the morning and evening meal. Such people also take no harm from a moderate use of beer or wine, but they do not require it. Spirits should not be regularly taken by anyone except under medical advice.

Beverages for a sedentary life.—People who lead a sedentary town life often lack the vigorous appetite and digestion of those living in the country or working out of doors in the town. Their ordinary beverages should be water, tea, and coffee, with care not to exceed in tea, which is a rather common fault, especially amongst women. Such people, however, are often benefited by a strictly moderate use of ale, stout, or wine, as it increases their appetite and their power of digestion.

Beverages for muscular work.—For those engaged in labouring work, water, cocoa, and tea are the best beverages. Cocoa has the great advantage of combining food with drink, and is especially suitable for the working man, upon whose muscular exertions the support of the family depends.

Beverages for continued violent exertion.—For violent exertion causing free perspiration and unusual thirst, tepid water slightly thickened with oatmeal is the best. This is the drink which has been found most suitable by firemen and others engaged in a similar class of work.

Summer drinks.—For summer drinks water, and water flavoured with acidulous fruit syrups are the best. Aërated waters should be used in moderation. Alcoholic drinks are very pernicious when used to relieve thirst. They are very fatal in hot countries.

Beverages for children.—Young children require a fair amount of fluid. They should be given water, milk and water, or very weak tea containing a good deal of milk. Under no circumstances should any form of alcohol be given to children, except by medical advice.

Beverages for invalids.—Invalids can often take with advantage nourishing and stimulating beverages which are not suitable for those in health with good appetites. Thus milk, cocoa, stout, port wine &c. are valuable for weakly, consumptive, and convalescent people. Milk is the best food for those who are too ill to eat, and brandy and champagne are the best stimulants when necessary in serious cases.

CHAPTER XLV

DIETS: ANIMAL, VEGETABLE, AND MIXED DIETS

Points to be regarded in selecting a diet.—Chapters XXI to XLV have been devoted to teaching the nature, composition, and uses of the various foods and beverages. The practical object of studying these matters is to enable us to select a suitable diet for each of the many conditions of life under which mankind exists. Bearing in mind the definite use to which each food principle is put in the human body, it follows that they should be eaten in their proper proportions, or some will be in excess and others insufficient for the required purpose. It also follows that the diets for young and old, for work and rest, for heat and cold, for health and sickness, must each depend upon the condition of life, work, temperature, or health for which the food principles are required.

Food containing the nitrogenous and carbonaceous principles in their proper proportions may be selected from: 1. Animal food alone; 2. Vegetable food alone; 3. Mixed food.

Pure flesh diet.—The carnivora naturally live entirely on animal food. They are active, strong, fierce, and courageous, and do not feed more often than once in the twenty-four hours. In very cold climates vegetable food is rarely to be obtained; consequently, the Esquimaux, Greenlanders, Icelanders, and other northern races are, or originally were, pure flesh-eaters. The North American Indians lived on buffalo meat; the Pampas Indians on mares' flesh. In the immense cattle-rearing districts of both South and North America the inhabitants live chiefly or entirely on flesh. Thus we find both in hot and cold climates men can, and do, live in perfect health and vigour on a purely flesh diet.

Pure vegetable diet: its unsuitability.—The majority of large animals live on a purely vegetable diet. In the natural state they feed more or less continuously through the day, and have a long and capacious alimentary canal. They are strong and active, but docile and usually timid. Men rarely attempt to live on a purely vegetable diet, because, owing to the construction and capacity of our digestive organs, the legumes alone of natural vegetable foods have sufficient nitrogenous matter to supply our wants. So-called vegetarians do not pretend to live on vegetable food only. They take eggs, milk, cream, butter, and cheese, which are animal foods, and supply the place of meat. Their objection to animal food is limited to the sacrifice of animal life, and applies only to eating flesh. Thus a purely vegetable diet would necessarily depend upon a daily supply of peas, beans, or lentils for nitrogenous matter, because in all other vegetable foods the nitrogen is in too low a proportion to the carbon. Such food would be insipid, and a great tax on the digestive organs. Hence, if we were to limit ourselves to one class of food, the animal diet would be much the better of the two

Advantages of mixed diet: excess of flesh food harmful: conclusions.—Nature has fitted us with digestive organs suitable for both kinds of food, with a taste for both kinds, and, what is very much more to the purpose, has made it more economical for man to combine the two. General observation has shown that it is with man as with animals as regards the effect of these two classes of food. Where races of men eat freely of animal food, they are more active, brave, spirited, and warlike than those subsisting chiefly on vegetable food. At the same time, a purely flesh diet is not consistent with civilised life. It needs a hard outdoor existence to carry off the effect of such a diet, which would be most unwholesome for indoor work. Excess of flesh food is much worse than excess of vegetable food, and is much more likely to cause disease. We may therefore conclude: 1. That animal diet gives courage, strength, and great working energy, but is harmful if taken in excess. 2. That vegetable diet gives strength with less stimulation, and is not sufficient by itself. 3. That a reasonable mixture of animal and vegetable foods gives the best results in health and work.

CHAPTER XLVI

DIETS—AVERAGE DAILY AMOUNT OF FOOD—EXCESS OF FOOD —TOO LITTLE FOOD—TIMES FOR EATING

The daily amount of food: methods of calculation: food calculated by waste products: calculated by experiments. How much food ought we to eat? is a very important question. Too much is harmful and produces disease; too little makes us weak and unfit for work. Not only must the total amount be right, but the alimentary principles must be in proper proportions. It is no use giving the muscles enough carbon for work, if they have not also enough nitrogen for repair. These are really the two substances which we have to consider. Water and salines may be left to take care of themselves, because the salines occur naturally in the other foods, and water is not likely to be taken in too large or too small a quantity. It is then a question of how much nitrogenous and how much carbonaceous food a man should eat daily to make good the wear and tear of his body, and the expenditure of carbon in heat and bodily energy. Each day the output of nitrogen and carbon in repair and energy must be made good by the income in nitrogenous and carbonaceous food. The answer to this question has been calculated in two or three different ways, each giving the same result, and thus proving its correctness. If you wanted to know how much water was required by a water-mill to do a certain amount of work, you could estimate it by either measuring the water as it goes to or falls from the wheel; that is, either the supply or waste water. If you wanted to know how much coal was consumed by a steam-engine, again you could also estimate it in two ways: first, by weighing the amount of coal required to do the work, and second, by calculating the amount from the quantity of waste products, in the shape of carbonic acid and other gases, going up the chimney. So in man, the amount of food necessary for his work can be calculated either by the waste products or by ascertaining the smallest amount which would satisfy his bodily requirements. The waste products given off by the lungs, kidneys, and skin represent the amount of wear and tear and the expenditure of force. They average about 300 grains of nitrogen and 4,800 grains of carbon a day. The experience of many years in prisons and workhouses, where it is desired to give no more food than is necessary for health, shows that food yielding this amount of nitrogen and carbon is the smallest quantity upon which men can work and maintain their weight and health. It is a complicated sum to estimate the nitrogen and carbon in a very mixed diet, but if we take raw meat and bread-and-butter only, it is seen that ¾ lb. meat, fat and lean, with 2 lb. bread, and 1 oz. butter, yields what is wanted, with a small margin for loss.

	Nitrogen grains	Carbon grains
¾ lb. raw beef, fat and lean . . .	170	720
2 lbs. bread	175	3,770
1 ounce butter	—	350
	345	4,840

This, then, is the standard upon which we have to work when estimating the necessary amount of food. It must be remembered that an excess of carbon will not make up for a deficiency in nitrogen, so that if we lived on bread alone it would require about 4 lbs. to make up the nitrogen, and if on *lean* meat about 6 lbs. to make up the necessary carbon. Hence the value of a mixed diet.

Excess of food: more harmful after middle age and sedentary habits: effect of too much food.—However well the necessary income of food given above may fulfil our natural requirements, there is a constant tendency to exceed. Whilst excess in drink is strongly condemned, not only by law but by society, excess in eating is too often encouraged. The occasional feast is harmless, but the daily indulgence, especially in too much animal food, is a fruitful source of disease, more in those who are upwards of forty years of age than in younger people, and more in those of sedentary habits than in those leading an active life. Too much food causes: (1) a too great accumulation of fat; (2) a constant over-stimulation of the digestive and circulatory systems; (3) an accumulation of excessive waste products. The first is the least harmful. The second wears out the stomach, liver, heart, and blood vessels too soon. The third produces sick headache, gout, and other joint affections, kidney disease, and numerous other painful troubles.

Effect of too little food.—Causes wasting, muscular weakness, increased liability to disease, inability to resist cold, and, if continued, chronic starvation.

Times for eating.—The almost universal practice of taking three meals a day is a good one: breakfast about eight; dinner about one; tea about six. Workmen who go out early in the morning should not do two or three hours' work on an empty stomach. A crust of bread is sufficient to prevent the exhaustion which would follow if the stomach were empty, and the work had to be supplied entirely by the reserve stored in the body. Those who work late should take a light meal of porridge or gruel before going to bed.

CHAPTER XLVII

DIETS FOR INFANTS, CHILDREN, ADULTS, AND THE OLD—FOR CLIMATE AND SICKNESS

Milk the natural food for infants: bottle food: stronger foods.—The natural food for the young of all the higher animals is the milk of their mothers. When this cannot be obtained, it must be replaced by the food most resembling it. That, of course, is the milk of some other animal.

Milk (see page 92) contains only one substance requiring digestion, casein, the substance of which cheese is made. The curds of casein formed in the stomach require a good deal of digestion. It is therefore important that milk which is substituted for mother's milk should at least resemble it in casein. Now, cow's milk (see table, page 94) contains more casein than mother's milk, therefore the baby's bottle should be filled with equal parts of fresh and pure cow's milk and barley water, with a little cane sugar. During the first month it should take 1 pint a day of this mixture. The quantity should be gradually increased until it takes about 3 pints a day at the age of 6 months; that is, $1\frac{1}{2}$ pint of milk and $1\frac{1}{2}$ pint barley water. When the child is born its salivary and sweetbread digestive juices are inactive, so it cannot digest farinaceous food. At 6 months these juices are active, and consequently rusks or some form of infant's food powder may be added to the milk. At one year the food may be thickened more and given with a spoon, and in larger quantity. Next, bread-crumbs and gravy, eggs, and milk puddings may be added, and as the teeth are cut, harder foods should be given. The chief points to learn are, that no food can fully replace *fresh* milk, and that the health of the child depends more upon careful and regular feeding with suitable food than upon any other circumstance.

Children's diet should be generous but not stimulating. Children are growing rapidly, and are usually very active. There is both growth, and wear and tear to be supplied. Consequently, they want a fair amount of nitrogenous food. Their meals should be regular and wholesome. There should be no feeding between times, no stimulants, and no heavy meals before going to bed. They should be allowed milk to drink, and more sweet things than older people.

Hospital diet: diet for adults.—*Breakfast*: bread, 10 oz.; butter, $\frac{3}{4}$ oz.; tea, with milk and sugar, 15 oz. *Dinner*: cooked meat, 4 to 6 oz.; potatoes, 8 oz.; milk pudding, 8 oz. *Tea*: bread, 10 oz.; butter, $\frac{3}{4}$ oz.; tea, with milk and sugar, 15 oz. *Supper*: milk, or bread and milk, 10 oz.

Subsistence diet.—During periods of idleness half the above diet will keep a man alive, but will not supply him with the necessary vigour for work.

Diet for hard work.—Hard work needs extra food, or, at any rate, stronger food. When the means are small, care must be taken to buy the most nourishing food which can be obtained for the money available. Dripping and margarine are each more heating than butter, as well as cheaper. Oatmeal is more nourishing than flour. Lentil or pea soup is very nourishing. Beans and bacon are one of the most sustaining of foods, and cocoa is many times more valuable than tea for hard work.

In summer less strong foods are required, and more use should be made of the cheaper kinds of fish, fresh vegetables, rice and cooked fruit. If the husband had to hand lemonade, made by pouring boiling water on lemons with a little sugar, or, what is still more refreshing, weak tea containing a slice of lemon, he would less often go to the public-house to satisfy a natural thirst.

Simple diet for old age.—As age advances activity diminishes, and the tissue change becomes less and less; thus do old people require much less food, both nitrogenous and carbonaceous, than they did when younger. Their digestive powers also are weaker. Their diet should be light and simple, and the fact should be remembered that they are not growing like young children, but rather decreasing. They should be fed on equally digestible foods, but should take no more than sufficient. The child can always use up any excess with its rapid growth and activity; the old have very imperfect means of disposing of superfluous food.

Diet for hot and cold climates.—The great food for intensely cold districts is fat. In the arctic regions the natives live chiefly on the flesh of the seal, walrus, and bear, of which they eat enormous quantities. These meats are extremely fat. They have less of the stimulating and more of the heating qualities of flesh meat such as we eat.

In hot countries fat is not relished, except in small quantities, as an adjunct to drier foods. The great carbonaceous food is rice, which is said to form the chief food for one-third of the human race.

In cold countries strong and heating foods are required, such as fat meat, pea soup, oatmeal, cocoa and coffee. In hot countries light and less heating foods, such as the lighter meats, mutton, veal, poultry and fish; rice and other farinaceous foods; fresh vegetables and fruits.

Diet for acute illnesses.—In acute illnesses, such as inflammations and fevers, the diet should be fluid, and should consist chiefly of milk, as that is the only complete fluid food. It is generally best given with soda, barley, or lime water. If the illness lasts more than a week, an adult ought generally to take about four or five pints of milk a day. Clear soup or beef-tea may also be given, and if the illness is long, fresh vegetables ought to be cooked in the soup or beef-tea, and strained out before using, that their fresh juices may keep the blood healthy. Jelly may generally be given, and often there is no objection to a few grapes or the pulp of a well-cooked apple.

Diet in vomiting and diarrhœa.—In stomach and bowel affections, with vomiting or diarrhœa, milk and lime-water is the best food. It should be given in very small quantities at a time. Fresh beef juice (see page 126) or one of the prepared meat extracts may be used, but the former is the best. Arrowroot is also well taken in such cases, and is often a good substance in which to administer a little brandy.

Diet in poorness of blood.—In towns, women especially sometimes get a distaste to meat food, and live on tea and bread-and-butter. Sooner or later this ends in their becoming pale and weak from poorness of blood. Tea ought to be almost given up, and a light, nourishing diet taken, including one or two pints of milk and fresh vegetables or a little cooked fruit.

Convalescent diet.—Those who have been pulled down by a serious illness, or who have a consumptive tendency, can use more food than when in ordinary health. They, in addition to ordinary requirements, have something to make up. If the meals are wholesome and digestible, there need be no stint of food, and they may also take a little beer or wine if it agrees well. As a patient recovers from the febrile stage the usual change of food is, first to arrowroot, gruel, or custard pudding; then bread-and-butter, and boiled whiting or sole, and milk puddings; then chicken or boiled rabbit; and after this to ordinary diet.

The stimulants used for invalids are: brandy for failure of the heart, and in all very serious illnesses; champagne in illnesses with great prostration; port wine during convalescence, and with water as a stimulant for children; stout during convalescence, and in chronic wasting diseases and poorness of blood.

CHAPTER XLVIII

CLOTHING—BODILY HEAT: THE MEANS BY WHICH IT IS REGULATED—THE USES OF CLOTHING FOR PROTECTION AND ORNAMENT

Temperature of body 98½°: constant during health.—If a suitable thermometer be held in the armpit, or in the closed mouth for a few minutes, it will be found that at all seasons and under all conditions consistent with health, the temperature of the body is about 98½°. This is between 30° and 40° above the temperature that we ordinarily live in, either indoors in winter, or out of doors in summer. It is a characteristic of all warm-blooded animals thus to maintain an even temperature in their bodies, irrespective of that of the surrounding air.

Considerable rise or fall is fatal.—When in the course of a fever the bodily heat increases to 103° or 104°, it is a sign that we are very ill, and should it continue to rise to 108° or 110° it would kill us. The same happens if the temperature of the body falls more than a few degrees. Thus our lives are just as dependent upon the means which are used to maintain this even temperature as upon pure air or wholesome food.

Cause of bodily heat.—The body is always losing heat, and when we die our bodies become cold like the surrounding air in a few hours. Therefore it follows that to maintain a constant temperature of 98° heat is always being produced within us. It is generated in the muscles, and in the liver and other internal organs by the combustion of carbonaceous food; and it is given off by the skin and to a less extent by the lungs. The amount of heat which can be generated is limited, therefore our temperature is regulated more by increasing or checking the *loss* than by affecting the supply.

How heat is lost.—The chief means by which heat is ordinarily lost from the surface of the body are: (1) by evaporation of perspiration; (2) by conduction and radiation of heat to surrounding objects. When there is no visible perspiration, and we are comfortably clothed, the loss of heat is only slight. In proportion as the perspiration increases and the clothes are removed, the loss becomes more rapid; and conversely as the pores of the skin are closed and the body is wrapped in warm clothing, it is less rapid. When we are too hot nature sends the blood to the skin, causes us to perspire freely, and gives us the desire to remove some of our clothing. When we are cold, on the other hand, the blood leaves the skin, the perspiration stops, and we have the inclination to wrap ourselves in warm clothing.

Effect of perspiration in reducing heat.—The evaporation of perspiration has such a marked effect in cooling the body that we can remain for a time in air which is even hotter than boiling water. The temperature of the hot room of a Turkish bath is generally from 212° to 220°, and even reaches 240°. Notwithstanding this great heat, the bodily temperature of those taking the bath remains practically unaffected by it. In fevers the temperature never rises high when the perspiration is free.

Effect of clothing.—Nature watches over this most important means of regulating temperature for us, increasing or lessening the supply of blood to the skin, and causing or checking perspiration according to our requirements; but it is left to us to supplement nature by the use of suitable clothing. The way in which clothing keeps us warm is by preventing cold air from coming into too close contact with the skin. In fact, clothing does for us what the tea-cosy does for the teapot. With a cosy on the tea will remain hot for hours, without one it soon gets cold. Cold air is a rapid remover of heat. Nature clothes animals with fur, wool, or feathers, which increase in winter and fall off in summer. But no animals can bear the changes in temperature to which man can submit, partly because he is able to make such rapid and complete alterations in his clothing.

Clothing must not check the action of the skin.—Whilst the object of clothing is to prevent too much cold air from coming into contact with the body, air must not be entirely prevented from reaching the skin. Of the many duties which the skin has to perform in addition to the sense of feeling, the most important are to protect the body, to regulate the temperature, and to purify the blood. In the latter it helps the lungs and the kidneys. Now if air were kept from the skin entirely, it could not help the lungs. Thus one of the most important characters of a material for clothing is that whilst capable of keeping us warm, it is at the same time sufficiently porous to prevent the air about the body from becoming impure. This is why a mackintosh is so oppressive and uncomfortable to wear. Owing to its impermeable nature the vapour and gases given off by the surface of the body are unable to escape. Mackintosh should only be worn for the purpose of keeping out wet, and should always be ventilated.

Other uses of clothing.—Not only do we require clothing for keeping out cold and wet, but in very hot climates it is just as necessary to protect us from the scorching heat of the direct rays of the sun. We also need it to protect the skin from injury, especially in the case of the feet. These are all not only useful, but necessary purposes; we could not get on without them. Another use, which if less essential still receives much attention in practice, is that clothing always has served, and always will serve, the purpose of ornamenting the human body. This is quite a right and proper use to put it to, so long as the dictates of fashion are not permitted to set up any absurd and fanciful notions of ornament, which would be an actual source of bodily harm.

Finally, the uses of clothing may shortly be stated as follows: Primarily for protection from cold, wet, heat, and injury; secondarily for ornament.

CHAPTER XLIX

DRESS MATERIALS—LEATHER—FURS—HAIR

Dress materials.—The materials used for clothing are of many kinds, and are derived from many sources. From the animal kingdom we obtain leather, furs, hair, feathers, wool, and silk; from the vegetable kingdom, cotton, flax, hemp, jute, coir, straw, and grass.

Leather: process of tanning.—Leather is prepared from the skins of animals by tanning. In this process the skin is rendered so hard, tough, and imperishable as to convert it into the most durable of all substances used for clothing. Tanning is conducted in three stages. In the first the skins are soaked in lime-water to loosen the hair and scarf skin. They are then stretched on frames and thoroughly cleaned on each side with a suitable knife. In the second stage the cleaned skins are immersed in the tan pits, which contain a decoction of oak-bark. When they are completely tanned they are hung up to dry. Lastly, the leather is finished by damping, oiling, and working until it is quite smooth and supple. For some purposes, such as covering furniture and books or making gloves, leather is subsequently dyed of various colours. For others it is enamelled, and frequently it is split into two or more layers of thinner leather.

Ox-hides.—Ox-hides are the most important source of leather. In addition to the home supply enormous numbers are imported annually from the great cattle-growing districts of South America, Australia, and the Cape of Good Hope. From ox-hides the thick, strong leather is made which is used for the soles of boots, for portmanteaus, and harness.

Calf skin.—Calf skin yields a leather of the same excellent quality, but much thinner and more supple. When split, the outer layer forms the best substance for the uppers of boots, and for the manufacture of numerous small articles in general use. The under layer is much inferior.

Small skins.—Of smaller skins those of the sheep are the most important on account of their number. They make a soft, pliable leather, of fair wearing quality, but not equal to goat skins (morocco), which are much less numerous. Sheep skins are the ordinary source of leather, like that used for covering chairs. The under split yields the soft shammy leather, employed for cleaning and polishing.

Pig skin.—Pig skin forms one of the most durable kinds of leather, and has a special reputation for the manufacture of saddles.

Russia leather.—Russia leather is prepared by tanning skins (properly calf skins) with tan made from birch bark, which is the cause of its pleasant odour and insect-resisting qualities.

Morocco.—Morocco leather is made from goat skins, and is much superior to its common imitation in sheep skin.

Buck skin.—Buck skin is made from deer skins by a process which causes it to be soft, like shammy leather.

Fancy leathers.—Fancy leathers are obtained from peculiarly marked skins, such as those of the alligator and lizard, which are now so popular. Inferior leathers are often stamped with a similar pattern in imitation of them.

Strength and durability of leather.—Leather is the strongest material used for clothing. It presents a combination of toughness and pliability possessed by no other article, and consequently cannot be replaced for certain purposes, notably for that of making boots. All over the world, both civilised and wild people have used the skins of animals as a foot covering. For numerous other purposes, also requiring hard wear, nothing can compete with leather, such as leggings, gloves, portmanteaus, bags, harness, and straps of all kinds. Also for covering furniture and books.

Furs.—Furs are an expensive luxury, many of them possessing great beauty as well as utility. In very cold climates they are worn by almost everyone on account of their great power of retaining the bodily heat. All the best furs come from northern districts like Siberia and North America, as animals living in such places have the thickest and softest coats.

Characters: preparation.—Furs consist of the skins of animals prepared with the natural coat of hair or fur attached. In cold countries the coat usually consists of two layers; a surface of long hairs, and an under felt of soft fur. In the preparation of the skin it is usual to pluck out the hairs, leaving the fur only. This is done with seal skin, which, previous to the plucking, has a harsh hairy coat. The skins are not tanned, but toughened by a modified process called 'tawing,' in which alum is used instead of oak-bark.

Fur-bearing animals.—Amongst the more important skins are the following: the Alaska or fur seal, chiefly obtained from a group of islands in the Behring Sea, where the annual capture is limited by law to 100,000; the sea otter, a beautiful, rich and expensive fur, now becoming scarce; the common otter, which is more plentiful; the beaver; the fox of various kinds, such as the blue, grey, red, silver, and black, varying much in value; the Astrakhan and Persian lamb, of which the latter is the more prized; the bear, which yields a fine long hairy fur; squirrel in enormous numbers for cloak linings; the marten and ermine, small animals of the weasel tribe; and the Russian sable, a similar animal with a very valuable fur, used not only for wear, but also for artists' best brushes. Several million rabbit skins are also imported annually for the manufacture of felt hats.

Hair: hair-cloth: uses: hair for stuffing.—All kinds of wool and fur consist of hair; but in the manufacture of textile fabrics only one kind of hair-cloth is recognised, and that is made of horse-hair. The long hairs from the tail are those used for this material. It is harsh and strong, and is used for covering furniture. Some is especially woven with an open web to be used for sieves. The most important use of horse-hair is for stuffing mattresses, and the seats and backs of chairs and sofas. For this purpose the shorter hair from the mane is used. It is cleaned and curled, and sometimes mixed with cheaper kinds of hair.

Other varieties of hair.—Pig's hair is one of the chief sources of bristles for brushes.

Cow hair, which is an extensive waste product in tanneries, is used for making roofing felt. It is also mixed with other fibres in the manufacture of common blankets, carpets, and rugs.

Alpaca, cashmere, mohair, and camel hair are all soft hair closely allied to wool. They are used for the manufacture of the finest fabrics of a woollen or cloth-like nature.

CHAPTER L

DRESS MATERIALS — FEATHERS — WOOL — MOHAIR — ALPACA — CASHMERE — CAMEL HAIR — SILK — COTTON — FLAX — JUTE — HEMP — COIR — STRAW AND GRASS

Feathers: down.—Feathers are unrivalled as a warm, light, and elastic stuffing for pillows, quilts, and beds.

For this purpose the down feathers only should be used, those from the eider duck being the softest and best. Down quilts should be ventilated; that is, perforated with holes along the lines of the quilting. Even with this precaution they are less porous than a blanket, and though so much lighter in weight are liable to prove more oppressive.

Feather beds.—There is certainly no material which can compare with feathers for stuffing a pillow. However much a feather pillow may be used, a shake always makes it soft and elastic again. Feather beds are not quite so popular as they were; but if not made too soft and luxurious they are quite healthy, and probably more restful than any other kind of bed.

Bird skins and feather trimmings.—The skins of beautiful birds and ornamental feathers, like those of the ostrich, form a large and valuable import. They are chiefly used for ladies' bonnets. It is much to be regretted that the passion for such head-dresses should lead to the annual slaughter of so many beautiful creatures. In a single year the value of this import was estimated at 2,000,000*l*. During recent years the more beautiful feathers of domestic and game birds have been extensively used for the manufacture of ornamental trimmings, 'boas' &c. for ladies' dress.

Wool: characters and uses.—Sheep's wool is the most valuable source of dress materials, both on account of its intrinsic worth and its plenty. The fibres of wool are of the same general nature as hair, of which it is only a variety. Substances ordinarily called hair are smooth, straight, and inclined to be hard, whilst wool is wavy and soft. At the same time it is strong and elastic, and possesses all the highest qualities of a dress material as regards warmth, power of absorbing moisture, and perfection in dyeing.

Wool is used for the manufacture of all kinds of cloth, serge, and flannel, for blankets, for woollen underwear, and all knitted or worsted goods.

Mohair, uses.—Mohair is obtained from the Angora goat. It is milk-white in colour, and possesses a silky lustre. It is a valuable material, and is used in the manufacture of astrakhans, plushes, velvets, and other showy fabrics.

Alpaca, uses.—Alpaca is obtained from the Peruvian sheep, a kind of llama. The wool is fine, strong, and silky. It is used for the manufacture of thin coatings for hot climates; for shawls, umbrellas, and ladies' dress materials.

Both alpaca and mohair, owing to their lustre, are used as substitutes for silk.

Cashmere, uses.—Cashmere is the soft silky hair of the Cashmere or Tibet goat. Very little can be obtained from a single fleece, as much as ten being sometimes required to complete a shawl; consequently cashmere clothing is always dear. It is peculiarly fine, soft, and silky, and is entirely appropriated to the manufacture of cashmere shawls.

Camel hair.—Camel hair has the characters of a fine, hair-like wool. In Eastern countries cloth has been manufactured from it for centuries, and during recent years it has been imported here for use in woollen goods. Camel hair is very highly spoken of by Dr. Jaeger, and is used in the manufacture of some of the Jaeger materials. The so-called camel hair brushes are not made of camels' hair. The best are made of sable, and the common ones usually of squirrels' hair.

Silk, characters and uses.—Silk is the strongest, richest, and most lustrous fibre used in the manufacture of textile fabrics. It possesses three times the strength of linen. The original silken thread is spun by the silk-worm as a protecting sheath or covering, called a cocoon. The silk from the cocoon is wound on reels, and then two or three fibres are twisted together to produce the class of thread from which silk goods are manufactured.

Silk is used in the manufacture of silks, satins, ribbons, plushes, velvet, and crape. It is also introduced into some woollen goods to give them brilliancy and lustre.

Cotton: cultivation: importation: uses.—Cotton is a vegetable fibre derived from the down attached to the seeds of the cotton plant. This plant belongs to the mallow order, of which the common marsh mallow is a species, but it only grows in hot countries. It is especially cultivated in the Southern States of America, the East Indies, Egypt, and Brazil. The seed is planted annually in the spring, and the cotton gathered in the summer. The fibres are freed from the seeds by machinery, and the cotton is packed in bales for exportation. Between three and four million bales, each weighing 400 pounds, are used annually in Great Britain. Cotton is used in the manufacture of calico of all kinds, including sheeting, towelling, and various coloured goods. Also for fustian, jean, velveteen, flannelette, and paper. It is freely mixed with wool in the manufacture of materials of medium warmth for underwear, such as the merino used for vests and socks, and in many dress materials for ladies. It is also mixed with silk in all the cheaper class of silk goods.

Flax: cultivation: linseed: preparation: characters and uses.—Flax is derived from a pretty little plant with a fine stalk, delicate leaves, and a bright blue flower. It grows well in many countries, but very little is cultivated in England and Scotland. More is grown in Ireland; but Russia is the great source of supply. The plant is an annual, sown in the spring, and gathered by hand in the summer. After harvesting, the seeds are removed by machinery. They are the well-known linseed from which the meal for poultices is made, as well as linseed oil and linseed cake, a valuable food for cattle. The fibre is contained in the straw of the plant, which has to be subjected to various processes for the purpose of separating it. First, the straw is steeped in water until the woody part is rotten and breaks easily. It is then dried and beaten on revolving wheels until the fibres are quite clean and free from woody particles, when it is packed in bales for the manufacturer. Flax yields a fine, strong fibre, which when bleached is very delicate and white. It is used for the manufacture of linen, cambric, and lawn, and is much more costly than cotton.

Jute, characters and uses.—Jute is obtained from the bark of the jute plant, a large annual of the lime tree order, growing in India. The processes adopted for separating the fibre from the bark are similar to those described for flax. The fibre is somewhat coarse and harsh, but varies much in different samples. It has a silky lustre. Jute does not wash nor wear nearly so well as linen; it is used chiefly for cheap carpets, curtains, and table-covers, and as a backing for floorcloths and similar materials. Ropes, sacking, and paper are also made of it. The principal British jute factories are at Dundee.

Hemp.—Hemp is a coarse fibre derived from the stem of the hemp plant, a native of Asia, but growing also in parts of Europe and America. It is prepared like flax, and is chiefly used for sail cloth, packing canvas, yarn, and rope. Manilla hemp has a special value for the manufacture of rope. Hemp seed is a popular bird food, and a substance is extracted from the Indian hemp which has properties allied to opium.

Coir.—Coir is the fibre of the husk of the cocoa-nut. It is obtained by beating the husk after prolonged soaking in water. It is light in weight, but coarse, tough, and harsh in character. Coir is well suited for hard wear, and is chiefly used for matting, door-mats, brushes, and ropes.

Straw and grass.—Straw and the stems of some other grasses are used for the manufacture of light hats for both men and women. They are very suitable for summer wear. Grass-cloths are made from various plants; but the better kinds, like the so-called China grass, are really not grass at all.

CHAPTER LI

DRESS MATERIALS—MICROSCOPIC CHARACTERS—PROPERTIES —WARMTH

Microscopic characters of dress fibres.—It is a fortunate thing that the original fibres of the various dress materials are easily and certainly recognised when magnified under the microscope. All woollen goods should be composed of hair-like fibres, about $\frac{1}{1000}$th inch thick, or rather thicker, and marked on the surface with the characteristic imbricated scales of hair (fig. 83). Silk threads are more delicate, measuring uniformly about $\frac{1}{2000}$th inch thick, and having no surface markings. Silk is the brightest, clearest, and most glass-like fibre under the microscope (fig. 84). . Cotton filaments vary from the size of silk to that of wool; but average less than $\frac{1}{1000}$th inch thick. They are flat or ribbon-like, and are always twisted (fig. 85). Linen fibres are not flat like cotton. They somewhat resemble silk, but are irregular in size, being mostly larger, and they always show a fibrous and jointed structure which is absent in silk (fig. 86).

Thus anyone who is able to use the microscope can at once recognise wool by its scales; silk by its bright clear thread; cotton by its flat twisted appearance; and linen by its fibrous structure and transverse lines. However ingeniously the fibres may be blended and woven together, or altered in appearance by dyeing or skilful manufacture, it is impossible to evade detection by this test. Under the microscope each fibre stands out clearly identified.

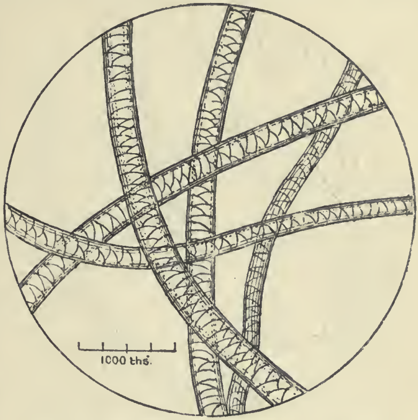


Fig. 83.—Wool under the Microscope, taken from white flannel.
The fibres show the imbricated scales characteristic of hair.

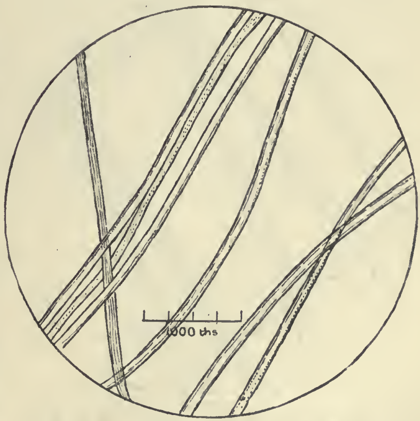


Fig. 84.—Silk, from a Silk Thread.
The fibres show the clear glass-like structure and uniform size typical of silk.

Warmth an important property of a dress material.—Warmth is undoubtedly a feature of primary importance in a dress material. From what has been said about bodily heat in Chapter XLVIII it will be understood that the warmth is not in the clothing, but in the body.

The clothing which feels the warmest is merely that which has the best power of retaining the heat.

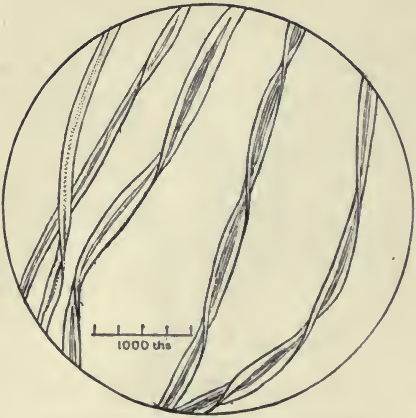


FIG. 85.—Cotton, from Flannelette

The flat and twisted nature of the fibres is well seen.

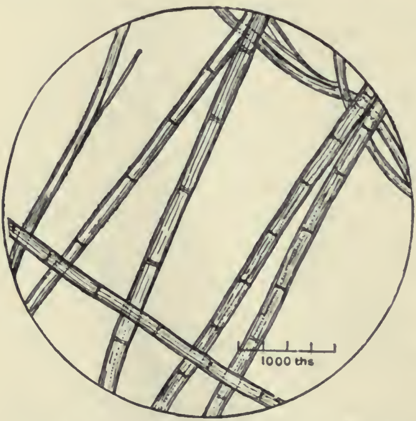


FIG. 86.—Linen, from Table-cloth of Irish Linen.

The fibres are irregular in size, round, and have fibrous structure with cross markings.

Sensations of heat and cold: conducting power of different materials.—The sensation of heat or cold in an article touched depends entirely upon its power of conducting heat to or from the hand touching it. If in the same room we walk with bare feet upon stone, boards, and carpet, they feel as though they were all at different temperatures. The stone feels very cold; the boards less cold, and the carpet comparatively warm. Yet all are actually at exactly the same temperature; namely, that of the air of the room. The reason that the stone feels so cold is, that it is a good conductor of heat, and rapidly abstracts warmth from the feet. Wood is a less good conductor, and absorbs less warmth; whilst the woollen carpet is so slight a conductor that it robs scarcely any heat from the feet, and consequently causes no sensation of cold.

Another example.—Another illustration of the sensation of cold or warmth being produced by contact with substances at the same temperature may be observed in the case of bed-clothes. If on a winter's night we get in between the blankets, they feel warm. If between rough twill cotton sheets, it causes but a slight sensation of cold. But if between fine linen sheets, it produces a distinct chill. The meaning of this is, that the woollen blanket is a very slight conductor of heat; the rough cotton is also a poor conductor, whilst the fine linen is a good conductor. They are themselves all at exactly the same temperature; but the linen rapidly removes some of the bodily heat, whilst the blanket abstracts scarcely any.

Conducting power affected by texture.—Yet another illustration shows how the same material differently woven varies in its quality of warmth. On a cold night a calico night-dress feels chilly, whilst a flannelette night-dress feels comfortably warm. Both are made of cotton, but the smooth surface of the calico abstracts the bodily heat more rapidly than the loosely woven, woolly textured flannelette.

Finally the warmth of a dress material also varies in proportion to the number of layers in which it is disposed on the body. This is the chief reason why we wear so many garments.

Effect of colour.—A different means of varying the heat properties of a dress material is by colour; but we take advantage of this more for keeping the body cool than warm. It is a well-known fact that white absorbs only half as much heat as black. Consequently, if you were out in the sun with a white dress on you would only absorb one-half the amount of heat from its rays that another person would wearing a black dress. As the effect of colour upon the warmth of clothing is only appreciable in open sunshine, it is not worth considering except with the object of protecting the body from excessive sun-heat. In winter there is so little sunshine that the effect of dark colours in increasing the warmth of winter clothing is too slight to be observed; but in summer, and especially in the tropics where heat is quite as distressing as cold is with us, the difference between white and black is so great that comfort and even health may depend upon colour alone.

Thus the warmth of a given amount of clothing depends upon the four following conditions: (1) material; (2) texture; (3) number of layers; (4) colour.

Material.—The heat-conducting power of wool, fur, and feathers is the lowest; silk stands next, then cotton, and lastly linen is the best conductor. Consequently wool, fur, and feathers are the warmest materials; then silk and cotton, whilst linen is the coolest.

Texture.—The bodily heat robbed from us by a cool dress material is passed on to the air, and the more quickly it conducts heat the colder the dress feels. When a material is woven of smooth threads it comes into closer contact with the body, and rapidly abstracts the heat and carries it away to the air outside; but if the same material is loosely woven to resemble wool or down, it only touches the body by little hairy points, which greatly lessens its conducting power. Moreover, a material of loose texture holds a considerable amount of air between its fibres, thus constantly retaining a layer of warm air next the body. These are the reasons why all soft, furry materials always feel warm, whether made of cotton or wool.

Number of layers.—Between each two garments is a layer of air which acts as a non-conductor and becomes warmed by the heat of the body. The greater the number of garments, the more layers of air there will be retained between them; consequently the warmth of a given amount of clothing of a certain material, texture, and colour, will depend upon the number of layers in which it is disposed upon the body. This explains the great additional warmth derived from a light under-vest. The same amount of material added to the dress or coat would have an inappreciable effect.

Colour.—White has the least power of absorbing heat, and is consequently the coolest colour; then the others come in the following order: yellow, red, green, blue, and black. Colour in underclothing, so far as warmth is concerned, has no effect whatever, the popular belief in the extra warmth of red over white flannel being an entire fallacy. The colour must be outside to be affected by the sun's heat. It is unwise to wear brightly coloured clothing next the skin, as it has sometimes been a cause of skin disease, owing to the presence of poisonous dyes.

CHAPTER LII

PROPERTIES OF CLOTHING—POWER OF ABSORBING MOISTURE—POROSITY—WATERPROOF PROPERTIES – INFLAMMABILITY

Cause of a chill: power of absorbing moisture possessed by dress materials.—Serious chills, such as give rise to inflammation of the lungs, are most likely to occur when over-heated. The reason for this is that under such circumstances the skin is actively engaged in its duty of cooling the body. It is full of blood and perspiring freely. The underclothing becomes damp, and if at such a time we are exposed to cold, what is called a chill results. The skin which was warm and full of blood suddenly becomes cold and pale, the blood being driven from the surface into the internal organs, where it is liable to set up inflammation. A change of underclothing as the body cools removes this risk, for the chief danger is owing to its damp state. The wetter the underclothing, the more the danger. As it is usually impossible to make such a change, it follows that the more water a material can absorb without feeling damp, the better that material must be for underclothing. The various fibres already described have been tested with a view to ascertaining their power of so absorbing water. The result is that wool is found to take up twice as much water as linen or cotton, and that silk occupies a position between the two. Thus a woollen singlet will absorb an amount of perspiration without showing it, which would make a cotton singlet feel quite wet. The former would under such circumstances remain warm and a protection against cold, whilst the latter would feel cold and damp, and encourage a chill. It is evident then that woollen underclothing, which, bear in mind, is the natural clothing of animals, is as much better for this purpose as it is for keeping out the cold.

Porosity: effect of impermeable clothing.—Porosity means having pores or spaces which allow air to pass through clothing. Mackintosh is the least porous, and knitted wool the most porous material used for garments.

Animals with moist skins like frogs breathe as much through the skin as through the lungs. Those with dry skins like ours use them much less for this purpose; but still the blood does become purified in its passage through the skin, and anything which interferes with the action of the skin invariably affects the health. Everyone knows that it is more fatiguing to walk in mackintosh than in any other kind of clothing, and most people have found out that if they try to increase the warmth of bed-clothes by such devices as spreading a newspaper between the blankets, by throwing on a piece of mackintosh, or by using a too close-fitting down quilt, they obtain temporary comfort at the expense of health. That is, they may sleep warmly and soundly, but will probably wake up with a headache. So important is the action of the skin, that if an animal like a rabbit is coated over with varnish, which effectually prevents its skin from acting, the animal dies. This tells us that porosity is really an essential feature of clothing, and though nobody would be likely to dress in absolutely impermeable material like mackintosh, very few know or consider the value of an open texture. With porous clothing the vapour of the perspiration escapes, and the air surrounding the body is slowly changed and keeps pure. With impermeable clothing the action of the skin is interfered with, and the body feels hot and oppressed.

Of the various dress materials woollen fabrics are the most porous; so for this reason also wool comes before any of the other fibres. Cotton, if suitably woven, comes next, and silk as ordinarily woven comes last, if we except fabrics which have been waterproofed.

Varieties of waterproof material.—However bad it may be to unnecessarily dress ourselves in impermeable clothing, there can be no doubt that it is a great gain to be able to throw over an ordinary dress something which will for the time protect us from rain. For this purpose mackintosh, waterproof cloth, and oilskin are the substances used. Mackintosh is made by coating thin cloth with a varnish of caoutchouc dissolved in naphtha, or by applying it between two layers of cloth. Mackintosh cloaks should always be ventilated; that is, they should have some open places in them where the hot air and vapours of the body can escape. Ordinary cloth is made waterproof by acting upon it with either soap and alum, or size and an infusion of galls. Both of these processes fill up the pores of the cloth and render it impermeable to water. Oilskin is used by sailors. It consists of canvas clothing dressed with boiled linseed oil, which dries and makes the canvas perfectly waterproof. It is the most durable of all waterproof materials.

Inflammability of dress materials.—A common test between cotton and wool is to draw out a thread from the material under examination and set light to it. Wool, being an animal fibre, only smoulders, giving out a smell of burnt feathers, whilst cotton burns at once with a flash. The one is very inflammable, the other scarcely so at all. Of all the terrible burning accidents which happen every year, hardly any would be possible if woollen or silk clothing were worn. It is the vegetable fibres that burn so readily, and the more loosely they are woven the more rapidly they burn.

Cause of burns.—Not long ago a number of children were dressed in cotton wool at a bazaar. One accidentally took fire, and although they were surrounded with people trying to put them out, nearly all were so severely burnt that they died. Muslin is almost as dangerous as cotton wool. If a muslin dress or curtain catches fire it burns almost as quickly as gunpowder. Children often take fire owing to the draught up the chimney drawing their thin cotton pinafores or night-dresses against the bars.

To put out fire.—When clothing is on fire, the burning part should be bravely grasped in the hands, rolled up and squeezed tightly, and the person should be laid flat on the ground. Many a life might so be saved with promptness and courage. When this fails, or the flames are already too extensive, the person on fire should be wrapped and rolled about in a woollen rug, cloak, carpet, or blanket, which, not being itself inflammable, will smother the fire and put it out.

Anti-inflammable solution.—Certain chemicals have the power of making inflammable things incapable of taking fire. Anti-inflammable solutions and paints are sometimes applied to woodwork with this object, and the hand-grenades used for putting out fires are filled with a similar solution. An anti-inflammable starch has also been prepared, and is sometimes used for muslin dresses. The difficulty experienced in introducing this safeguard is owing to the fact that the chemicals employed are removed at each washing, and need to be re-applied. People would no doubt prefer to buy non-inflammable cotton stuffs if they could be rendered so by a permanent process.

CHAPTER LIII

DRESS—PRINCIPLES OF CONSTRUCTION—NATURAL CLOTHING—FAULTS—CONSTRICTION OF THE HEAD, NECK, ARMS, HANDS, AND WAIST

Principles of dress construction.—The previous chapters on the subject of clothing have dealt with the nature and value of the materials used. The object of the present lesson is to give some instruction in the principles upon which the various articles of dress should be constructed, to enable them to fulfil their proper purposes in accordance with the laws of health.

What is required of dress has already been stated, namely, warmth, and protection from wet, excessive heat, and injury, combined with a due regard for appearance. In affording this comfort and protection to the body, clothing should be so made that (1) it does not unduly constrict any part of the body; (2) it does not impede any natural movement; (3) it does not afford any unnatural support; (4) it is not unnecessarily heavy; (5) it is made of the proper material; (6) it is in reasonably good taste.

Natural clothing.—In the birds and beasts the most beautiful colours and the most brilliant natural ornaments are combined with perfect conditions as regards health. No tight bands, no impediments to free and graceful movement, no fashionable deformities; yet warmth, lightness, porosity, and perfect beauty. We rob them of their coats to make our clothing. We copy their brilliant colours, their soft velvety fur, and their feathery ornaments; but we have yet to learn how to wear the material we make as they wear their dress with all its use, comfort, and beauty, and none of its drawbacks. If we compare a suit of clothing with the sheep's fleece from which it was originally made, what a difference! One light, soft, porous, and warm, offering no impediment to movement or circulation; indeed, perfectly adapted both in use and appearance to its owner. The other often heavy, stiff, and close; impeding both movement and circulation; adapted to the prevailing laws of fashion, rather than to use or natural beauty.

The evils of unhealthy clothing.—If we all knew when we were young the harm that we may do ourselves by wearing unhealthy clothing, many of us would have tried to do better. The misfortune is that waists and feet are often deformed, constitutions weakened, and serious illnesses originated before we arrive at years of discretion. Perhaps we change then; but it is often too late. Those who study these chapters will have had the best recognised evils pointed out to them, and if they continue to transgress the laws of health for the sake of fashion, they will do so with a knowledge of their own folly, and of the harmful results which must be expected to ensue.

Faults.—We return now to a consideration of the faults in clothing as commonly worn. They are, as has been indicated, constriction, impediment, unnatural support, unnecessary weight, and improper material.

Constriction.—By this is meant the fastening of any article of clothing so tightly round a part of the body as to interfere with the circulation, or with its natural shape. It is the most serious and at the same time one of the most common faults of ordinary dress. Constriction is produced in two ways. One is by tight bands like belts, the other by the entire article fitting too closely, as gloves and boots often do. The former kind is the worst. The following are the common positions for constriction by clothing.

The head: by hats.—Hard hats, especially those worn by men, fit too tightly round the head for comfort, and interfere with the circulation of the scalp. This often causes a sensation of discomfort and oppression, and sometimes headache; it perhaps also helps in the early baldness so frequent in men.

The neck: by bands round the neck.—Tight bands are so uncomfortable in this position that they are not often worn. Even in the army, where comfort is so much sacrificed for appearance, the fault has been recognised and modified. Constriction of the neck interferes with the return of blood from the head. This is why it is so harmful here, and why in fits and all conditions of insensibility the clothing round the neck should always be unfastened.

The arms and hands: by tight sleeves: by gloves: chilblains.—Tight sleeves, especially when tight in the armpit, where the main blood vessels are, make the arms cold instead of warm, and incline the fingers to be bluish and enlarged at the ends. Tight-fitting gloves compress the fingers, and it is a very common experience to notice the coldness they cause. Anything which constricts the arms, wrists, or hands, encourages chilblains, which are merely due to bad circulation, in most instances the result of improper clothing.

The body: by waist belts: by petticoat and other bands: by tight lacing: organs affected by tight lacing.—Tight lacing, as it is called, is the most pernicious fault of fashionable dress. Any kind of constriction of the waist is especially bad, whether it is intended to affect the shape of the body or merely to support the clothes. The waist-belts sometimes used by men to fasten the trousers, or by working-men to support them during great exertion, are altogether wrong. In supporting one part they throw a greater strain on others, and in this way encourage the formation of rupture. In women the practice of tying numerous articles of dress round the waist frequently produces weakness and weariness of the limbs, and pains in the back. When the constriction is of the nature of tight lacing, the expansion of the chest is interfered with, and the abdominal organs are compressed and displaced. The shape of the chest and the respiratory movements are quite altered (figs. 87 and 88). The upper part of the chest does more work, and the lower part less work, than it ought to do. The lower parts of the lungs cannot expand properly, and consequently are less serviceable and more liable to disease. Even the action of the heart is impeded, making any tendency to fainting and weak circulation more marked. The movements of the stomach and intestines are still more obstructed, giving rise to indigestion and other troubles.

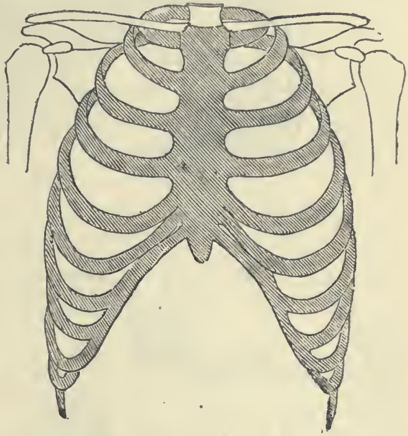


Fig. 87.—The Natural Form of the Chest.

Natural and artificial waist.—The natural waist is placed just above the hips (fig. 89), but the waist of fashion is artificially produced by the compression of the corset over the lower ribs. A line drawn through the body at this part would touch the following important organs: the bottom of the lungs, the apex of the heart, and the top of the liver (fig. 91); a little lower down are the stomach, spleen, and kidneys. So that a tight corset interferes with the action of nearly all the most important organs of the body. The size of the natural waist

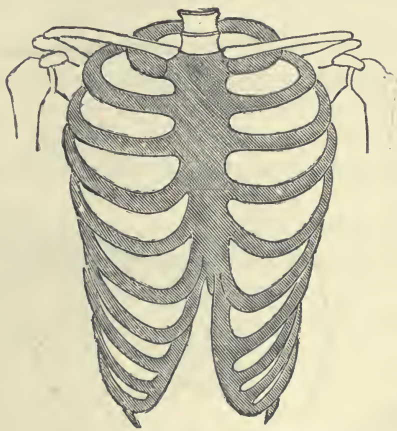


Fig. 88.—The Chest deformed by tight lacing.

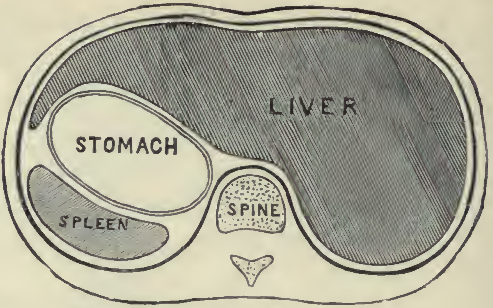


Fig. 89.—Section of a Natural Waist.

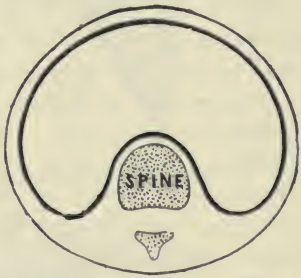


Fig. 90.—Section of a tight-laced Waist, showing diminished space.

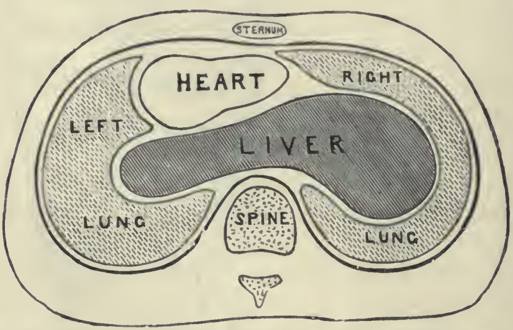


Fig. 91.—Section of a Waist, showing displacement of organs.
This figure is drawn to a larger scale than fig. 90.

of a well-formed woman is twenty-six to twenty-seven inches; yet very many girls are positively ashamed of nature's dimensions, and would sooner suffer torture than possess a natural waist.

Morality of tight lacing.—It is not claimed for constriction of the waist that it is adopted for any other purpose than appearance. Therefore the production of such a deformity—for it is an anatomical deformity—is suggested by the same instincts, and it is on the same level of morality, as the practice of deforming the feet of Chinese ladies by compressing them during childhood until they are actually too small to walk with (fig. 92); or of flattening the heads of infant negroes with boards to conform to a local standard of beauty; or, indeed, of cutting and tattooing the skin, wearing rings and bones in the nose, lips, or ears, and other similar enormities. If these latter are disgusting to our sense of fitness, they are at least not so pernicious to health as compression and displacement of the most important internal organs.

Fig. 92.—Chinese Lady's Foot, that has been pressed into this strange shape by bandages during early childhood.

Figs. 87 to 91 show the position of the organs, and the alteration in the shape of the lower part of the chest caused by tight lacing. It is a mere matter of common sense to understand that, though during the vigour of youth no harm may be felt from this practice, sooner or later its effects must become evident. Girls who have never been taught better may be forgiven for following a custom which has been so common; but no good woman to whom the harm has been pointed out will continue it;

much less, if ever she have the care of children, will she permit them to grow up in the same fault.

CHAPTER LIV

DRESS—CONSTRICTION OF THE LEGS AND FEET—IMPEDIMENTS—UNNATURAL SUPPORT—EXCESSIVE WEIGHT—IMPROPER MATERIAL—GOOD TASTE

The legs and feet: constriction by garters: by boots: chilblains.—The lower limbs are only subjected to constriction by two things, garters and boots. Garters are a cause of what is called varicose veins; that is, big swollen veins in which the blood circulates very slowly. Varicose veins give rise to aching pains, and often to ulcers of the legs. Women are specially liable to them, and should certainly wear nothing which tends to produce them. Boots have other and worse faults than being too tight, which will be alluded to further on. Tight boots interfere with the circulation, and cause cold feet and chilblains. Blisters, corns, and bunions are due to ill-fitting rather than to tight boots. The feet are the favourite spot for chilblains because they are the furthest part from the heart, and the circulation is naturally more feeble in them than elsewhere. Any undue tightness in boots is bad, but when the foot part is tight and the ankle is constricted by elastic sides, they are as bad as they well can be.

In ordinary clothing the fault of constriction is more or less common in the following parts of the body: the head, neck, arms, hands, waist, legs, and feet.

The causes of constriction are hats, collars and bands round the throat, sleeves, gloves, corsets and waist-bands, garters, and boots.

The worst form of constriction is due to tight lacing;

the next worst to improper boots and to garters. The others are of less practical importance.

Impediment: restriction of movement by clothing: long and tight skirts.—It is, perhaps, impossible to make our clothes in such a way as to offer as little impediment to movements as do the feathery and furry coats of animals. Knitted woollen textures are the nearest approach, and a child entirely clad, as it sometimes is, in this material, has the greatest possible freedom of movement. In women, however, this difficulty is frequently carried to an absurd extent. Long and close-fitting skirts are always objectionable, but especially so for young women, who ought to be bright and active. Long skirts are dirty, and a serious impediment to walking. Tight skirts are still worse; no sensible woman ought to submit to such an infliction. The divided skirt is often recommended by dress reformers; but it is not really necessary for either comfort or complete freedom of movement.

Tight sleeves.—In ordinary dress it is difficult to give the arms their full amount of play, though they are often unnecessarily hampered by tight sleeves.

Stays.—Stays, of course, interfere with the proper movements of the spine, which Nature has made lithe and graceful, but which Fashion delights to render as stiff as a board. These stays have scarcely a good point, and so many thoroughly bad ones, that every physiologist is forced to condemn them absolutely.

Hard boots.—Hard and inflexible boots have a similar effect in destroying the gracefulness of movement by taking the natural spring out of the arch of the foot. The arch of the foot was given us to render the tread light and springy. An Indian in moccasined feet walks with the softness and elasticity of a cat, whilst the civilised labourer in his hob-nailed boots or clogs treads more like an elephant.

Unnatural support: supported muscles waste: weak ankles: weak backs.—The human body has been formed by Nature to require no support other than that furnished by the muscles, bones, and ligaments. If for any reason a limb has to be supported by a splint, its muscles always waste and grow weak. In time they are not sufficient support for the limb by themselves, and it is quite a slow process after the splint is removed to restore them to their natural strength. The same thing happens when we fix unnatural supports to any other part of the body. Weak ankles supported by high leather boots become weaker still when the support is removed, and weak backs supported by stays in after life are too weak to do without them. Girls are not born with weak backs, but some of them are fortunately born with sufficient moral courage to resist the attractions of this most unhealthy feature of women's dress. Every girl who sets her face firmly against it, and encourages others by precept and example to do the same, is doing more for her sex than she can readily conceive.

Heavy clothing unnecessary.—Excessive weight is avoided by making clothes of the right material, in the right way, and wearing the proper number.

From what has been said regarding the qualities of the different dress materials, there can be no doubt that wool is the right one, as being the warmest and in every way the best.

One combination garment is warmer than the two which would be necessary to replace it, and is of course lighter. Thus combination garments made of wool yield the greatest amount of warmth for the least weight.

Improper material: woollen underwear: woollen stockings.—Although wool is the best dress material, it does not follow that it is equally necessary for every purpose. The nearer the garment is to the skin the more important it is that it should be made of wool. Some people object to woollen underwear; but the reason for this is that such garments are frequently made too close-fitting, coarse, and heavy. In winter flannel combinations are very suitable underwear for those whose skin is not of too delicate or irritable a nature. The slight irritation of its hairy surface is generally considered to be stimulating to the circulation, and useful to the health of the skin. For those who cannot comfortably wear flannel next the skin there are now manufactured very soft woollen goods of knitted texture, which will not cause any irritation. Women, owing to a little vanity about the size of the foot, object to woollen stockings. Yet no part of the body requires wool more than the feet. The circulation in them is the most distant and the weakest, and they are generally clad in impermeable leather, so that the perspiration cannot escape. Thus wool is especially necessary for stockings. Vests or combinations should be made with sleeves, so that the arms also may be covered with wool.

The rest of the underwear is better made of wool; but it is of less importance than the first layer, and in the case of the outer dress it is not at all necessary. In winter, of course, a cloth dress is the best for warmth, but any of the numerous mixtures, or plain cotton, may be worn if the underwear is made of wool.

Good taste.—We cannot pretend in a book like this to teach the principles of good taste. Yet it should be earnestly sought after by every girl, for good taste in dress gives an air of refinement and respectability which cannot be attained without it. Some people think that good taste lies in the use of plain but costly garments. Certainly common materials soon become shabby, but costliness has as little to do with refinement as showiness. Good taste is rather a subtle expression of good character. It never admits of anything too showy, or which has a suspicion of loudness; yet it does not fail to make the best use of the means at command. It is generally simple, quiet, and plain, but considers the circumstances of the individual, and the nature of her occupation and surroundings. It goes hand in hand with neatness and cleanliness, and is above all things honest. Indeed, good taste in dress is the external evidence of a simple, honest, and sincere character.

It is very important that any alterations which may be suggested for the hygienic improvement of women's dress should be designed as much with a view to their appropriateness and appearance as for the more solid value of health and comfort.

CHAPTER LV

GARMENTS—FEATURES OF HEALTHY GARMENTS—SANITARY CLOTHING—SANITARY BOOTS

Healthy garments.—We now come to the important question: What are the best garments for health? It is always much easier to criticise than to correct faults, and in nothing is this more true than in regard to women's clothing. Probably everyone who has taken the trouble to think at all about the matter will agree to the four following general rules:—

Four rules.—(1) Garments requiring suspension should be suspended directly or indirectly from the shoulders. (2) No article of clothing should be so tight as to interfere with the circulation, or so shaped as to alter the natural appearance of any part of the body. (3) No garment should impede or restrict any natural movement. (4) No great excess of material over and above what is actually necessary should be used for any garment.

Special reasons for sanitary dress.—These rules appeal directly to common-sense. Their truth cannot be called in question, and yet they condemn the clothing of the great majority of women to-day. Hitherto, dressmakers have worked almost independently of sanitary considerations. Our forefathers could perhaps afford to neglect precautions which we must be careful to observe. Overcrowding and over-pressure increase year by year, bringing with them various influences prejudicial to health. What was good enough for our forefathers will not suffice now. We must pay more attention than they did to such matters, if we are to work hard and maintain health when youth is gone; not because the race has degenerated, but because we work under different circumstances.

Healthy garments may be made attractive.—In full accordance with the above rules an infinite variety of garments might be constructed. It only needs the exercise of womanly wit and ingenuity to render them in every way as becoming as those at present in favour. Why should not a well and decently clad woman have the same free play for her limbs that a man has? Why should her clothes be a standing objection to her participation in healthy outdoor exercises and active games? Fortunately, the number of women wearing healthy clothing is daily increasing, and is probably much in excess of what would be supposed. This is, as it should be, the direct outcome of the higher education of women.

The following is the style of clothing adopted by some of these sensible women. It has proved not only healthy and comfortable, but quite as attractive as the old style.

Sanitary under-garments.—The first series of garments should consist of woollen combinations and stockings. The former should be made of fine wool, and are best constructed on the Jaeger pattern with long sleeves, double over the chest, and to fasten on the shoulder. In summer similar materials of lighter texture should be worn, though the popular mixtures of wool and cotton sold as merino answer very well for most people.

Second layer.—The second series may consist of a corset bodice with shoulder-straps, but without steels, to which an extra petticoat and the suspenders for the stockings can be fastened.

Third layer.—The third layer should consist of a neatly made and prettily coloured flannel petticoat, bodice and skirt in one. Either this or the previous layer may be dispensed with in summer ; or cotton may be substituted for flannel.

Dress.—Lastly, comes the dress. It may be made of any suitable material, but must be designed on the combination principle. It is in the dress that an excess of material is so frequently employed. This should be avoided.

In addition to the garments already referred to, there are a few special articles calling for separate notice. These are boots, gloves, outdoor garments, and night-clothes.

Boots.—The foot needs better protection from injury than any other part of the body. The conditions of our lives require that we should be shod with a strong substance like leather. Stout leather is the least yielding material used for clothing, consequently it has the greatest power of moulding the part to which it is applied into any desired shape. It seems a strange thing to say, but in this civilised land of ours it is quite an uncommon event to meet with a perfectly well-formed foot, except in children. Women are the greatest martyrs. Nearly all of them wear narrow boots with small high heels and pointed toes, and in middle life their feet are usually deformed, and often afflicted with corns and bunions.

A cause of deformed feet.—The shape of the natural foot is shown in fig. 93. It alone should be the guide to the outline of the sole of the boot. If boots shaped to

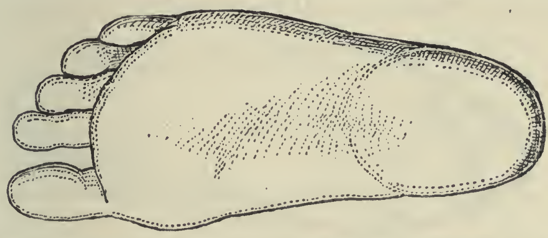


Fig. 93. -Showing the natural shape of the Sole of the Foot.

the natural outline of the foot were worn from childhood upwards, the ball of the foot would remain broad and the toes evenly spread out. This would mean much more power in walking, and complete freedom from corns.

Character of a sanitary boot.—The chief points in a sanitary boot are: (1) It should be made of leather as flexible as circumstances permit. (2) The great toe should be in a straight line with the inside of the foot, as it is in childhood. (3) The full length and breadth of the foot should be allowed for in the sole. Its outline for measurement should be taken when the weight of the body is resting on the foot, as in walking. (4) The heel should be broad and low. (5) The uppers should be soft, flexible, and easy, but not elastic.

The boot to fit the foot.—Such a boot requires no breaking in. It fits the foot comfortably from the first. The breaking in, it must be remembered, affects the foot as much as it does the hard, unyielding leather. The fashionable shoemaker is engaged less in fitting his customers, than in moulding their feet to a pattern of his own; absolutely no regard being paid to the anatomical structures and uses of the foot (fig. 94). Surely in this working world the next generation will prove to be more reasonable.

Corns and bunions.—Soft corns are due to crowding the toes together, and the irritation of perspiration

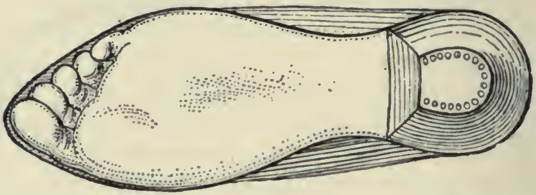


Fig. 94.—Showing the Foot compressed into an unnatural shape by an ordinary fashionable boot.

collecting between them. They are often very painful. Sufficiently wide boots, and stockings of the Jaeger pattern, with separate toes, are the best cure; though toes that have been crowded for years will never fully expand again. Hard corns and bunions, which are entirely due to ill-fitting boots, will sometimes, but not always, disappear on wearing healthy boots; at any rate, they will become less painful.

Chilblains.—Chilblains are brought about in people with a naturally poor circulation by wearing tight boots and thin cotton stockings. They may be prevented or cured by wearing easy-fitting boots and warm woollen stockings; care at the same time being taken to avoid standing or sitting about with cold, damp feet, and healthy outdoor exercise being increased.

Snow-shoes.—For going out in the damp and wet, snow-shoes are much better than goloshes, as they keep the feet not only dry but warm.

CHAPTER LVI

GLOVES—HATS—OUTDOOR WRAPS—NIGHT-CLOTHES—CLOTHES FOR INFANTS AND CHILDREN

Gloves.—When gloves are only used for appearance, taste and fancy may be given free choice. When for warmth, kid gloves must be avoided, as they check rather than encourage the blood supply to the hands. Easy-fitting leather gloves, knitted woollen gloves, or lined gloves are the best for real use. In warm weather no gloves at all are the best for busy fingers.

Hats.—Hats should be light, soft, warm, and well ventilated, with sufficient brim to shelter the face from rain, and the eyes from too brilliant sunshine. In the summer the hat needs to be cool rather than warm, and for this purpose a light-coloured, well-ventilated material is to be preferred. Women, on account of their abundant hair and the practice of carrying sunshades, are more independent in the matter of head-covering than men. They certainly make a very free use of this independence, and often substitute a mere ornament for the ugly but weatherproof article worn by the opposite sex. Excellent soft felt hats are made for women, which are very suitable for winter wear.

Outdoor wraps.—The character and amount of the additional clothing which should be worn out of doors depends upon the nature of the exercise to be taken, and the state of the weather.

Walking is the safest kind of outdoor exercise. The exertion is neither too great nor too little, and we have not to guard against being over-heated or chilled. Active games like football and tennis should be undertaken in light woollen clothing, extra wraps being used directly the game is over. For driving and railway journeys in cold weather we should, if possible, start warm and well wrapped up.

East winds are the most dangerous kind of cold, and extra wraps should always be worn during their prevalence. Those who are liable to sore throat will do well to use a scarf or muffler at such times. For wet, a long light mackintosh, which can be easily carried on the arm, is the best protection. It should be removed as soon as the rain ceases. Wet feet are no great source of danger if woollen stockings are worn, and changed at once on returning home.

Night-clothes: the skin should rest at night.—The circumstances affecting the variations of bodily temperature are quite different at night. In bed, the skin should not be called upon for special efforts to maintain an equal temperature. There should be no occasion for being either over-heated or chilled, so that the skin, like other parts of the body, may have a period of comparative rest.

Cotton for night-clothes.—Cotton clothing is more restful to the skin than woollen, and is the best for both night-dress and sheets. In summer linen may be substituted, and in the cold months of winter flannelette makes a very comfortable night-dress.

Bed-clothes.—Good blankets are the best bed covering for warmth. They are certainly much heavier than down quilts, but they allow better ventilation, and their very weight helps to guard against excess. Perfect rest can only be enjoyed when the clothing is such as to maintain a natural temperature, without effort on the part of the body to considerably increase or reduce the bodily heat.

Clothes for infants and children: rapid loss of heat in children.—The smaller the child the more rapidly in proportion is heat lost, and therefore the more important is its clothing. In the young, an unnecessary waste of heat means a loss of food which would have been used for growth and other forms of vital force. Babies and young children, owing to the activity of their vital processes, are able to use up all the food they can digest; therefore, if too much is spent upon one purpose, there will be so much the less for the rest.

Infants' clothing.—The underclothing of babies should be made of fine wool, and should be so fashioned as to be put off and on with the greatest ease, and the least amount of turning about. The first article is the binder. This should be made of knitted material. Unyielding flannel interferes with the proper expansion of the chest and abdomen. The binder is generally used with the wrong notion of giving support. Its proper object is warmth over the vital organs. Next to the binder comes a soft, knitted, armless vest, covering the chest and body; the diapers round the hips and legs, and knitted socks for the feet. Over these is a long gown of fine flannel with sleeves, often called a barrow; it is folded up and pinned back over the legs, leaving them plenty of room to kick about. Outside all is the long dress usually made of linen, with its little bib attached. When out of its cot the baby is usually wrapped in a soft shawl. Babies are very easily chilled, and need constant watching and care.

Children's clothing.—At the age of three months the long clothes are changed for short ones. These should be modelled on the same general principles as those that have been recommended for older people. There is much less to object to in children's clothing as at present worn than in that of adults. Indeed, it is some of the simplicity of the child's clothes which needs to be introduced into the fashions of grown women. The chief faults are that wool is not sufficiently used in the underclothing, and that the body should be more equally covered. None but robust children stand without harm bare arms and legs in cold weather. If they have more power to resist cold than we have, it is at the expense of material which ought to be applied to the increase of their bodies.

CHAPTER LVII

PERSONAL CLEANLINESS—DIRT—DIFFERENT KINDS OF DIRT —THE SKIN

Personal cleanliness: the virtue of cleanliness.—It is a duty that we owe equally to ourselves and others that we should be clean. The instinct of cleanliness is a virtue nearly allied to goodness. Those who are dirty in person are rarely clean in mind. At the same time, we must not be too fastidious in our judgment of others. A dusty trade may make a clean person look dirty; whilst a clean and smart exterior not rarely conceals a hidden filth.

What is dirt?—It is not easy to give a definition for dirt, although it is such a common article. What is dirt in one place may not be such in another. Thus food is clean on the plate, but dirty when spilt on the tablecloth. It has been said that dirt is matter in the wrong place, and most varieties of matter are in the wrong place when on our skin. At the same time, some kinds of matter are much worse than others, and it often happens that the dirt which makes the most show is far from being the most foul. If we are to understand the unhealthy as well as the unsightly effects of dirt, we must examine more closely into the substances to which the name is ordinarily applied.

Dust of trades.—(1) The dust of sand, earth, coal, soot, and various dusty trades. These dusts in themselves are clean. They do not harbour germs and become foul; but they are irritating to the skin, and especially to the lungs. The skin, if kept reasonably clean, would never suffer from them, though soot does, when neglected, even produce cancer.

Dust of chemicals.—(2) The dust and vapour resulting from the manufacture of poisonous chemicals, such as lead, mercury, phosphorus, copper, and some other substances. Dirt of this kind is of course poisonous; but when great care is taken to wash the hands before meals, and the other directions which are given in all such factories are thoroughly carried out, no harm follows.

Organic dirt.—(3) The dirt resulting from handling animal and vegetable substances, especially when decomposed or diseased. All those who are engaged in handling flesh in any form should be particularly clean, because the juices of meat which stain the fingers or clothing are the natural food of germs. When such stains are not carefully washed off, germs settle and grow in them, making them foul, poisonous, and harmful to us. If the substances which have to be handled are already decomposed, as is the case with hides and with much household refuse, especial care and scrupulous cleanliness are necessary. The dirt from decomposed and diseased substances is the *worst* of all.

Dirt from secretions of the skin.—(4) The dirt which results from the accumulation of perspiration and other secretions drying on the skin. This occurs in everyone, and for purposes of health, comfort, and respectability must be frequently removed by washing. Such dirt is also of an animal nature, and the food of germs; the longer it remains, the more foul it becomes. As a general rule, the healthier the body the less objectionable are the substances given off by it. Consequently, a vigorous, healthy workman, who is usually supposed to require much more washing than people in a higher grade of society, really, if his trade is a clean one, requires less. Those who are indolent and over-fed need it more, as their secretions are charged with the products of indigestion and unused food.

Fig. 95.—Magnified View of the Surface of the Skin, showing the Pores.

Varieties of dirt.—Thus we may regard the various kinds of dirt as affecting us personally in very different ways. First, there is the most noticeable, but least harmful kind of dirt, the ordinary dust of trades. Second, the poisonous dust of chemicals. Third, the foul stains of animal and vegetable matter in which germs grow, and which may be the source of innumerable diseases. Fourth, the dirt which collects from the action of our own skin, and which also becomes foul if not regularly removed.

The skin.—In Chapter XII a short description of the skin has already been given, but it will help us to understand the value of cleanliness if we again refer to some of its features.

Scarf skin.—The surface of the skin consists of loose cells called the scarf skin. These cells are frequently shed, and if not removed, collect on the surface, clog the

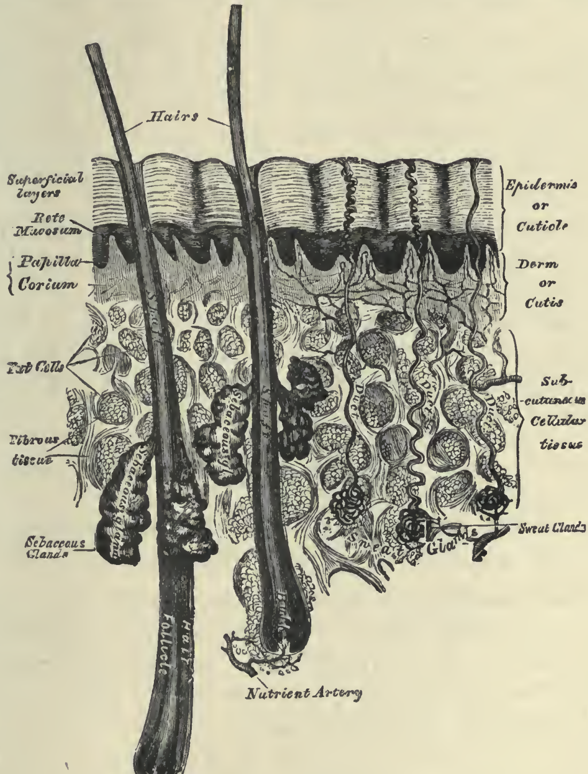


FIG. 96.—Vertical Section of the Skin (highly magnified)

pores, and interfere with the action of the glands. In a Turkish bath, quantities of this worn-out scarf skin may be rubbed off, leaving the surface beautifully fresh and clean.

Glands of the skin.—The deep or true skin contains two kinds of glands, which are always at work secreting more or less fluid. One kind, the sebaceous glands, secrete an oily fluid, which keeps the skin smooth and supple. The other kind, the sweat glands, secrete the perspiration to regulate the temperature of the body, and to get rid of some of the foul products in the blood. Both these secretions contain solid matters, which, when allowed to dry on the skin, become equally unpleasant and unhealthy.

Action of the skin.—Another duty of the skin is that it helps the lungs in their work of purifying the blood. The cleaner the skin the better it can do this.

Lastly, the skin is the organ of common or tactile sensation. It is full of sensory nerves. Thus the tone and vigour of the body are much influenced by the condition of the skin.

CHAPTER LVIII

CARE OF THE PERSON—DAILY WASHING—THE BATH, WARM, COLD, AND SHOWER

Daily washing.—For ordinary cleanliness it is necessary to wash the face, neck, hands, and arms with soap and water every morning. The hands should also be washed before each meal, and especially so when the work soils them with harmful products. Before the evening meal, when the day's work is usually over, a more extensive wash is as refreshing and as enjoyable as it is wholesome. Those who are strong, and can do so, should take a cold bath every morning. Those who cannot should take a warm bath twice if possible, and not less than once a week at night. A good substitute for a cold bath, when the real thing cannot be had, is a wet sponge followed by a good towelling. The friction is almost as useful as the wetting. With short hair, the head may be washed frequently. With long hair, once a fortnight will suffice, but it must be well brushed twice daily. The teeth should be cleaned morning and evening.

Soaps.—The best soap for washing the skin is white unscented curd. Common yellow soap has too much alkali, and all but the best scented soaps are less pure than a good curd. If you have to pay for appearance or scent, you cannot expect as good quality for the money. Moreover, the cheap scents are prepared from chemicals which are not good for the skin. When the skin is very delicate, as in the case of new-born infants, or people subject to skin disease, a 'super-fatted' soap should be used. This is a soap in which there is no free soda. Those who have to handle unwholesome or infectious things should wash their hands with carbolic soap in order that the impurity may be entirely removed.

Chapped skin.—When the skin is rough or chapped from cold or other cause, a little glycerine should be applied after washing and before drying. The skin should then be only partly dried, when sufficient glycerine will remain to heal it after a few applications, without causing an unpleasant sensation of stickiness.

The bath: action of the bath.—Everyone knows the refreshing effect of a good wash when one is hot and tired. This is less due to the cleansing action of the soap and water, than it is to its stimulating effect on the nerves and blood vessels of the skin. The effect of a complete bath is, of course, more decided than that of a partial wash, and we have in the bath variously used, not only a cleanly and healthy habit, but also a means of treating disease.

The warm bath.—The warm bath is usually taken at a temperature of from 98° to 100°. It opens the pores of the skin, and renders cleansing with soap much more easy and effectual. It encourages a free circulation, and promotes a healthy action in the glands. It is soothing to the nerves, but weakening if too hot or too prolonged. A deep bath is much more exhausting than a shallow one; consequently, hotter water may be used in a shallow sponge bath than when the body is much immersed. The warm bath should be taken just before going to bed, as it predisposes to chill on exposure, but encourages sleep. Ordinarily, it should not be used for longer than from ten to fifteen minutes.

The hot bath.—A still hotter bath may sometimes be used, ranging to 104° for deep water, and even 110° for shallow. This raises the bodily temperature, and should be followed by free perspiration. It is used as a cure for colds, and in pains and stiffness the result of rheumatic and other affections. The patient should dry quickly and get at once into a warm bed well covered with blankets, as more harm than good will result if perspiration is not induced.

The cold bath.—The cold bath is one of the healthiest habits. It is tonic and refreshing to the system, and keeps the skin in excellent order. The temperature of a cold bath varies according to the season, from 70° downwards even to freezing-point, but only vigorous people should take it below 50°. That is, in winter the chill should be taken off with a little hot water. Cold water acts as a direct stimulant to the nerves of the skin. It contracts the blood vessels and muscular fibres, making the skin shrunken and pale. It should be taken directly after getting out of bed in the morning whilst the body is still warm, and should only be used for a few minutes, then followed by a vigorous towelling, when the blood should rush back to the skin with the feeling of a warm and refreshing glow. Should the bath be followed by a sensation of chilliness and fatigue instead, it is a sure sign that the shock of cold water is depressing and unsuitable. Such a person must either use tepid water, or replace the morning tub by an occasional warm bath in the evening.

The morning bath at most seasons of the year in England requires a little effort, but that little effort, repeated daily, is an excellent moral exercise. It helps us to face cheerfully throughout the day many things that are a source of worry and trouble to those who too readily yield to self-indulgence.

The shower bath.—The shower bath may be taken either hot or cold, but it is not usually supplied with hot water in private houses. The cold shower is a much more powerful shock to the nerves than the sponge bath, and should only be used by those who are in strong health.

CHAPTER LIX

PERSONAL CLEANLINESS—SEA BATHING—TURKISH BATH—VAPOUR BATH—MEDICATED BATHS—PUBLIC BATHS—CARE OF THE TEETH AND HAIR

Sea bathing.—In sea bathing we have, without doubt, the most healthful kind of bath. It combines every advantage: the bracing action of cold water increased by the presence of salt, the inspiriting effect of sea air combined with charming surroundings, and the association with the bath of one of the best of athletic exercises, namely, swimming. All these render sea bathing the most delightful and invigorating of baths. Almost the only drawback is the short time each year during which we in England are able to enjoy it.

Bathing places.—In selecting a place for sea bathing, a small town or village with a sandy shore is the best. In large towns the sea is usually polluted with sewage, and shallow water is not only safer but also warmer than the deep water of steep, rocky shores. In the beautiful but deep Scotch lochs the water, even in August, is very cold, whilst on a sandy shore, heated during low tide by the sun, it often feels quite warm.

Rules for sea bathing.—When bathing in the open air, certain rules should be observed. 1. It is unwise to bathe either fasting or directly after a full meal. The best time is about eleven o'clock in the morning, between breakfast and dinner. 2. The body should be warm and fresh when bathing. If chilled or exhausted, cramps or faintness may occur. 3. The bath should be short, and followed by a brisk walk to establish a warm reaction. Unless the weather is very warm, five to ten minutes is enough for children, ten to fifteen minutes for women, and fifteen to twenty minutes for men. 4. Whilst bathing, the body should be immersed. Nothing is so chilling as standing about wet in a cold air or wind. Lastly, every bather should learn to swim. Only the swimmer can thoroughly enjoy and fully benefit from sea bathing.

The Turkish bath.—The modern Turkish bath is the offspring of the luxurious Roman baths of old days. It is a hot-air bath, and requires several rooms to give it properly. First, there are the dressing-rooms. Second, the hot-air rooms. Third, the shampooing and washing rooms. Fourth, the cooling room. The bather, having removed his clothes, enters the hot rooms wrapped in a sheet. Here he reclines in a dry air, ranging in temperature from 120° to 220° or even 240°. In such a temperature a copious perspiration is soon established, and is usually allowed to continue for about an hour.

He is then shampooed, in which the skin is well rubbed, and all the loose scarf skin removed. Lastly, he is washed down with soap and douches of hot and cold water, and then rests in the cooling room until the skin becomes quite cool and dry again. Notwithstanding the temperature of the hot rooms, which is often above boiling point (212°), the bodily heat remains almost unaffected. This is due to the cooling effect of free perspiration.

The Turkish bath is very cleansing, and for this purpose may be taken by anyone, but, owing to its free action on the skin, it is specially used as a cure for colds, chronic rheumatism, and some other complaints.

Vapour baths are commonly used only in very cold countries like Russia, Norway, and other northern parts of Europe. In these baths the hot room is filled with vapour by throwing water on stones or bricks which have previously been heated in a fire. The vapour bath is much more oppressive than the Turkish bath, and causes a still more copious perspiration. Instead of shampooing, the custom is to switch the skin with fine twigs, which acts as a stimulant to the nerves and circulation. Finally, the pores are closed again by a douche of cold water. In England the vapour bath is not much used, and then only in a modified form for medicinal purposes.

Medicated baths are baths in which some medicinal substance has been dissolved, and are usually made to resemble one of the natural mineral springs, or sea water. The latter, made by adding sea-salt to fresh water, is the only kind frequently used, except where mineral springs naturally occur. It is good for weak joints.

Public baths.—Large towns are now always supplied with public baths and washhouses, which they are allowed by Act of Parliament to build out of the rates.

This enables the people to obtain hot, cold, or swimming baths at a nominal cost.

Care of the teeth.—The conditions present in the mouth are such as to favour decomposition—warmth, moisture, germs, and food. The germs are inhaled with every breath of air, and we cannot prevent their presence. Small particles of food remain about the teeth after each meal, and if we were to get rid of them there would be nothing to decompose. When they are allowed to remain, they undergo an acid kind of decay. The acid attacks the enamel of the teeth, and a small hole once produced gradually increases until it has destroyed the tooth. In a healthy person the teeth would rarely decay if they were kept perfectly clean. We ought, then, to make it a rule to clean the teeth twice a day, morning and evening, and people who suffer from indigestion would be wise if they were to clean them after each meal. Children should also be encouraged to clean their teeth even when quite young. If the temporary set are lost before the permanent set are ready to take their place, the latter are usually overcrowded and irregular, and decay early.

Tooth powder.—There is no better tooth powder than camphorated chalk. The camphor is purifying, and the chalk kills any acid which may be about the teeth. As a mouth wash, a weak solution of pure carbolic acid acts very well. It should be about one part to a hundred of water. It is a common ingredient in dentifrice waters.

Care of the hair: use of oil.—Owing to the difficulty of drying long hair, women get rather too much into the habit of neglecting to wash the head. It is best to make a definite rule to wash it once a fortnight with soap in warm water, followed by two or three changes of fresh water. In children the head should be washed oftener, as in them it is especially liable to get dirty, and the abode of troublesome insects. Short hair is best for all children, girls as well as boys. As the girls approach womanhood it should be allowed to grow. Girls cannot be too strongly advised not to descend to the artifices of dyeing, crimping, and other troublesome and deceptive practices. They are harmful to the hair, untrue to nature, and rarely attain the desired end. Oil or pomade if used freely makes the head dirty, but a very little rubbed into the roots of the hair is beneficial. It prevents the skin from becoming dry and scurfy, and the hair from falling out.

CHAPTER LX

WORK AND REST—THE EFFECT OF MUSCULAR AND MENTAL WORK UPON THE BODY

Every action involves work.—It has already been explained that vital force or energy is derived from food, that it is, in fact, due to the combustion of food. Some of this energy is necessary for every action of the body, even the very least, and even though the action requires no apparent effort. Every movement, every thought, even the formation of a drop of digestive fluid, needs energy, and is therefore accompanied by the combustion of food with its resulting products, heat and carbonic acid gas.

Work of the internal organs: of the brain and muscles: effect of muscular work on the body: work and health.—The daily work of the body in carrying on the various vital processes, circulation, respiration, digestion, and excretion, involves a considerable amount of work, much more than one would think; but what we call human work is the work of the voluntary muscular system and the brain. The former involves the use of the bulk of the body, the latter of only a very small part of it. Active muscular work produces at once an effect felt throughout the body. When we run, for instance, the blood begins to flow more rapidly, the breathing is deeper and quicker, and the skin becomes hot and moist with perspiration. Brain work is not accompanied by any such effect upon other parts of the body. When we study hard the circulation through the brain is increased, but this organ is so small in bulk compared with the muscles that an increased combustion of food in it does not influence the general circulation. It is not, therefore, remarkable that health stands in closer relation to the training of the muscles than of the brain.

Changes accompanying muscular action.—When a muscle is in action, the blood supply to it is increased; food and oxygen are used; heat, which is the source of its power, is developed in it; and carbonic acid gas is produced. All these changes are regular and definite, and in exact proportion to the amount of work done. Dr. Edward Smith has shown that the amount of air breathed under varying conditions of the muscular system is as follows:—

Lying	1·0
Sitting	1·18
Standing	1·33
Walking, one mile an hour	1·9
,, two miles ,,	2·76
,, three ,, ,,	3·22
,, four ,, ,,	5·0
,, six ,, ,,	7·0

Thus with each increase of work done there is a corresponding increase in the amount of air respired, and it has also been shown that there is a similar regular increase in the amount of carbonic acid gas breathed out. Other observers have estimated the entire amount of oxygen used and carbonic acid gas given off during a day of work and a day of rest respectively. During the work-day a man is found to use about 4,000 grains more oxygen, and to give off about 6,000 grains more carbonic acid gas. Increased work requires more food, more breathing, more beating of heart, and more action of the skin; and therefore muscular work involves not only exercise of the muscles, but also of all the important parts and organs concerned with the above duties.

Effect of non-use on the muscles.—When the muscular system is insufficiently used the muscles waste and become soft and fatty, their healthy tone and vigour is lost, and even slight exertion is fatiguing. The blood is charged with the excess of digested food which ought to be used by the muscles, the circulation is sluggish, the aëration of the blood in the lungs is imperfect, and the skin is inactive. Thus people who take no exercise are usually pale and flabby, with a poor circulation and an unhealthy skin. In some the unused food is deposited as fat; in others it acts purely as a waste product, and the work of getting rid of it makes the body unnaturally thin.

Effect of muscular exercise.—When muscles in this state are trained to regular action again the fat and waste products gradually disappear. The muscles become firm and strong, and capable of sustained action without fatigue. The circulation improves, the lungs expand better in breathing, the blood is more nutritious and better aërated, and consequently every part of the body is healthier and more efficient.

Dependence of health on muscular exercise: of brain power on health.—It may be accepted as a fact that perfect bodily health is impossible without a reasonable amount of bodily exercise. Now, the working power of the brain is dependent upon the health of the body; therefore, if the body is not healthy the mind cannot be trained to its greatest perfection. The highest development of the brain is impossible without health, and perfect health is impossible without exercise; therefore the pure bookworm who altogether neglects muscular training debars himself from reaching the highest standard of his capacity.

Effect of neglecting to train the brain.—On the other hand, it is a still greater error to train only the muscular system and entirely neglect the brain. In this way man becomes a mere animal, possessed, perhaps, of splendid health and great brute force, but unable to perform any of the higher kinds of human work. Manual labour, cut off from education and all intellectual pursuits, is the lowest kind of work; fortunately, such a condition is scarcely possible in a civilised country in the present day. Skilled labour is one of the higher kinds of work, for it involves the training of both brain and muscle, and is often associated with fine bodily health and great intellectual power. Book work alone leads to a deterioration of bodily health, and consequently to a deterioration in the vigour and capacity of the brain.

Combined mental and physical training.—To reach the highest development of manhood, the muscular system must be exercised for health, and the brain trained for intelligence. Therefore, the best men and women are derived from the muscular workers who combine intellectual training with their trade, and from the students who combine muscular training with their mental work.

CHAPTER LXI

WORK AND REST — PHYSICAL EXERCISE — GYMNASTICS — RECREATION—SLEEP

Physical or muscular exercise.—The healthiest muscular exercise is that which is undertaken out of doors. When the work of life is chiefly of a muscular character, and is carried on in the open air, or in large well-ventilated workrooms, all that is necessary in the way of physical exercise is accomplished, and leisure may be spent in intellectual pursuits. But when the daily work is chiefly sedentary or studious, outdoor exercise is required for health, and should be taken with regularity whenever the time can be afforded for it. The best outdoor exercises are walking, cycling, riding, swimming, skating, and boating. They are equally suitable for both sexes, and may be enjoyed at almost any period of life.

Gymnastics.—Gymnastics and calisthenics are health-giving and very useful for training the muscles to prompt, energetic, and well-regulated action, and for giving a graceful carriage and movement to the body. They are particularly useful for young people, and should be used in all schools in conjunction with—never in place of—outdoor exercises and games.

Recreation: games and sports.—Recreation is neither a mere physical exercise nor a simple rest from work. It is a change of condition by which a jaded body or mind is invigorated and restored to healthy action. Its character varies with the nature of the daily work, for perhaps the most essential feature of a recreation is that it shall offer a contrast to the routine work of life. The vigorous, healthy, outdoor worker finds recreation in study, music, painting, and various indoor occupations. The sedentary town man, on the other hand, finds great delight in digging in his garden, or some other laborious outdoor pursuit. But for the mass of the people recreation involves something more than a change of work; it requires that the change shall combine pleasure and excitement, which stimulate the nerves, with a vigorous use of the muscles. Such a combination is found to perfection in English outdoor games, such as cricket, football, golf, tennis, fives, baseball, athletic sports, &c.; and in English field sports such as hunting, shooting, and fishing. These recreations, used according to age, sex, and position of life, have been one of the chief means of maintaining the vigour, courage, and health of the English nation, and it may be well hoped that they will long remain our national pastimes.

Sleep: condition of body during sleep.—Sleep is the physiological rest of the whole body. During sleep the vital processes are reduced to the lowest activity consistent with the maintenance of life and health. The work of all the internal organs is lessened, as is evidenced by the decrease in the oxygen consumed and the carbonic acid gas exhaled; the beats of the heart and the respirations are reduced; the digestive process is slow, and the movements of the intestines are quieted; above all, the muscular and nervous systems rest.

Necessity of sleep.—Sleep is absolutely necessary for life. The loss of a single night's rest is fatiguing; of two or three nights serious; whilst continued sleeplessness must end in madness or death.

Cause of sleep.—The actual cause of sleep is not known. It is associated with a decrease in the circulation through the brain, but that may be either a cause or a consequence. The conditions which encourage sleep are moderate muscular fatigue, a warm skin, and an absence of anything tending to excite the brain or stimulate the sense organs. If the muscles are in want of exercise, there is often a fidgety restlessness in place of repose. If the skin is cold, the blood is not withdrawn from the brain, and its activity continues. If the nerves of the eye, or the ear, or the skin are stimulated by light, sound, or an uncomfortable bed, the brain often will not rest; nor can we get to sleep if we go to bed whilst the brain is still excited by recent study, pleasure, trouble, or any other cause. But when the body is healthy and the mind at ease, it very rarely happens that a good day's work is not followed by a good night's rest.

Time for sleep.—The length of time required for sleep varies with age. A baby needs about sixteen hours out of the twenty-four; a child of two years, fourteen hours; four years, twelve hours; eight years, eleven hours; twelve years, ten hours; sixteen years, nine hours; twenty-one years, eight hours; and the same during health through the remainder of life.

DOMESTIC ECONOMY

PART II

CHAPTER LXII

THE HOME—REQUIREMENTS FOR A MODERN HOUSE—SITUATION—ASPECT—ELEVATION—SUBSOIL

The home.—A house is primarily intended as a shelter from the inclemency of the weather; but what we ordinarily mean by a house is much more than this. It is a substantial building, fitted with all the modern contrivances for comfort and convenience which the tenant can afford. A simple shelter, such as a canvas tent or a wooden shed, boasts of none of these conveniences; but with the conveniences there are introduced many concealed sources of danger to health, from which the structure itself is perfectly free. Tents and huts are only suitable for a mild climate and a hardy people; but those who live in them are not likely to suffer from bad ventilation, poisoning by sewer gas, and other insanitary conditions common in town houses.

A modern house.—A modern house, in addition to its furniture, is fitted with the necessary apparatus for the following purposes: (1) ventilation; (2) heating; (3) lighting; (4) water supply; (5) removal of waste matters. This introduces a complication of pipes and other fittings, which, so long as they are all in good working order, are quite free from danger, but which, if they break down at any part, are at once a source of risk. The gas we burn, the products of combustion, and the emanations from the sewers are all deadly poisons. If the air of the house is contaminated by them, health must suffer accordingly, and thus we are more or less dependent for our well-being upon the condition of the pipes, traps, and ventilating apparatus of our houses.

Drains.—At the present day, in every well-regulated town, the sanitary authorities exercise a strict supervision over the way in which the builder makes the drains connected with new houses. But, however perfect at first, drains sooner or later are liable to get out of order. Every housekeeper should therefore understand enough about them to know when they are right, so that an outbreak of serious illness may not be the first thing to call attention to some fault, which, had it been recognised earlier, would have been remedied before the danger was incurred.

Sanitary influence of ventilation, water supply, heat, and light.—The management of ventilation, heating, lighting and water supply is almost equally important, though perhaps we do not trace disease so directly to mismanagement in these matters. Bad ventilation, for instance, tells very slowly on the health. By reducing the strength it makes us an easy prey to some disease, such as consumption, which we should otherwise not have contracted, and thus the real cause is unnoticed and escapes blame. Far more diseases in the latter half of life are brought about by influences acting slowly on our health, than by sudden acute attacks. These insidious causes are due, for the most part, to neglect of the laws of health in matters like eating, drinking, clothing, cleanliness, work, worry, and insanitary dwellings.

The choice of a house: situation.—One may often hear it said that certain people have a beautiful house, with the most perfect sanitary appliances, and yet are never healthy in it. This shows that to build, furnish, and fit up a house on the most approved principles is not sufficient. It is almost equally important to put it in the right place. Conditions of air, sunshine, and subsoil or ground vary considerably, and are by no means limited to the wide choice between one district and another, but even affect houses which are side by side in a town. These conditions, as well as the sanitary matters already referred to, must be taken into consideration in establishing a healthy home.

Aspect: value of sunlight.—Sunshine is one of the conditions essential to good health. Men and women deprived of sunlight grow pale and sickly as plants do. Children need it even more than grown people, and should, if possible, have the sunniest rooms in the house. Very frequently the nursery is a dark back room; this is a bad arrangement, and helps to make the children delicate. 'A dark house is a sick house,' as Dr. Richardson, the health reformer, says; so, when choosing a house, let us always look out for one with a sunny aspect. Sun bleaches the furniture, and we often draw the blinds to keep it out on that account; but it has the opposite effect upon people, for it makes them ruddy and healthy. The more our occupation keeps us indoors, the more need we have for sunshine in the house.

Conditions affecting amount of sunlight.—When selecting a house never fail to notice and give due consideration to its aspect in regard to sunshine. In fig. 97 a common example is given to show how houses vary in this respect. The houses in an ordinary town street are built each with a wing projecting backwards, the wings of two adjoining houses being placed back to back. In house No. 2 the windows of the wing face north, and the wing prevents the sun from shining into the back sitting-room, except in summer when the sun is high enough to top the houses behind. In No. 3 the windows of the

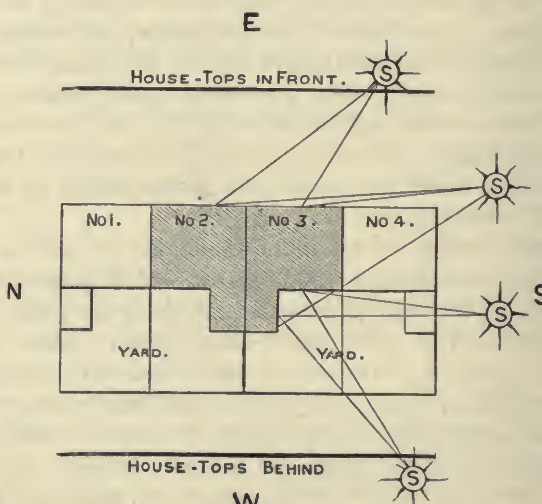


FIG. 97.—Diagram illustrating the Relation of Sunshine to Aspect in two ordinary adjoining Town Houses during the Winter Months.

wing face south, and the wing of the next house to the right—No. 4—is too far off to keep the sun out of its back sitting-room. During both winter and summer No. 3 can get what sunshine there is, whilst No. 2 only gets it in the summer during the early part of the morning and the late part of the afternoon, and in the winter not at all if the morning is thick, as it frequently is in town. Other things being equal, No. 3 will be a more healthy house than No. 2.

Elevation.—Hills are healthier than valleys. On the hills the air is crisp, dry, and bracing; in valleys it is heavy, damp, and stagnant. In cities the same conditions are present on a smaller scale. The air in the hollows is often damp and foggy—what is called muggy—whilst at the higher parts of the town it is quite bright.

Subsoil.—The ground on which a house is built should, if possible, be dry and porous. Sandstone and gravel are excellent subsoils, as they are very porous, and surface moisture, like rain, soon drains away through them. Clay and marshy grounds are bad, as they are always damp; but what is called made ground is often the most unhealthy of all. The latter is common in towns where the hollows are filled up with rubbish. If the refuse is carefully inspected the made ground is all right; but the contents of ashpits, and other animal and vegetable refuse, are often thrown in, when diseases like diphtheria are very likely to break out in the houses built on the ground.

Various subsoils in the same town.—In some towns there are all three kinds of subsoil. For example, in Liverpool large tracts of the city are built upon sandstone, and these houses are always dry. Other parts are built on the boulder clay which rests in the hollows of the sandstone rock; these houses are damp unless special precautions are taken to prevent it (see p. 226). Still other parts are built on made ground, where the clay has been dug out for bricks and the pits filled with rubbish. Only harmless refuse, like earth, clinkers, and building rubbish, is now allowed to be thrown into these clay pits; but in times past all sorts of filth were emptied into them, and that was how we learnt that diseases were produced in this way.

From what has been said regarding aspect, elevation, and subsoil it will be seen that even though a man has to live near his work, and in the heart of a great city, he still has a choice in these matters, and will choose well or ill according to his knowledge of them.

CHAPTER LXIII

CONSTRUCTION—WALLS, ROOF, WINDOWS, AND FLOORS

Construction: parts to examine.—The next consideration to the situation of a house is its construction. If we are satisfied as to its aspect, elevation, and subsoil, we next look at the fabric itself. Has it been built in such a way as to make it weather-proof, comfortable, and convenient? With this object in view we examine the walls, roof, windows, floors, fireplaces and chimneys, arrangement of rooms, gas and water supply, waste pipes, bath-room, and lavatory.

Walls: thickness: porosity of bricks: damp course.—Substantial walls are useful not only on account of strength, but because they are warmer in winter and cooler in summer than thin walls. Ordinarily a house wall varies in thickness according to its height, as it is required by law to be of sufficient thickness for strength, and only those who build for themselves are likely to exceed the necessary thickness. On the outside the walls should be smooth and the pointing good, otherwise the rain soaks into the bricks and makes them damp. Bricks are very porous and readily absorb water; many bricks will suck up nearly as much as a pint, holding it like a sponge. For this reason, when a house is built on damp soil, what is called a *damp course* is introduced just above the ground. The damp course usually consists of a layer of glazed stoneware, or some similar material, through which water cannot pass. It prevents the moisture of the ground rising up and passing on from brick to brick, and so making the whole wall damp.

Area : foundations : ventilation of floor spaces : cement lining.—When the rooms of the basement are below the level of the ground, the soil should always be kept away from the walls by an area. The foundations are the portions of the walls which are beneath the ground. They bear the weight of the whole structure, and are usually much thicker than the parts above the ground. Opposite the position of the floors there should be small gratings or perforated bricks to admit air from the outside to the spaces under the floors. On the inside the walls should be coated with a layer of good hard cement, on which the paint, paper, or distemper is applied. The harder it is the more damp proof it will be.

Points to notice about the walls.—When looking at a house with a view to taking it, the following are the more important points to ascertain in reference to the construction of the walls : (1) outside brickwork smooth and well-pointed ; (2) no cracks in the walls or ceilings, or displacement of fireplaces, window or door frames, indicating 'jerry' building ; (3) inside walls cemented and free from damp marks.

Roof.—Slates make the cleanest and best roofing. In England the supply is good, and they are generally used. Glazed tiles also answer very well, and are popular on account of their picturesque appearance. Thatch makes the warmest roof in cold weather and the coolest in summer owing to its non-conducting quality ; but it is dangerously inflammable, and needs such constant repair that it cannot be regarded as a serviceable roofing. Slate and tile roofs are good conductors; consequently the rooms or attics beneath them are much affected by the outside temperature, being very hot in summer and very cold in winter. A leaking roof is a bad point in a house, so always examine the ceilings for the damp marks left by old leaks. Nothing is more disheartening than to have a newly decorated room spoilt by the first heavy shower.

Windows: for light and ventilation: varieties.—Windows are required for two purposes: light and ventilation. Both are very important; therefore a good house should have plenty of windows to light well all the rooms, passages, stairs, and hall. The usual window consists of two sashes, which are opened by lowering the top or raising the bottom one. Iron weights concealed in the framework of the window are attached to the sashes by cords, balancing them so that they are easily raised or lowered. Sometimes French windows are used. These reach to the ground and open like a door. In very large rooms, where the windows are big, usually only a part opens, and in public buildings, like churches and hospitals, the movable part is generally so constructed as to direct the air upwards, which prevents a draught when they are opened. This is called a hopper window (fig. 112). See that the windows of the house are sufficient to light every part of it, and that they open, close, and fasten properly.

Floors: rafters: floor-boards: and ceilings.—When a house is built, the foundation of the floors is laid as the walls are raised. This consists of the rafters, which are long wooden beams running from wall to wall. To the top of the rafters the floor boards are nailed, and to the bottom the laths, which, when covered with plaster, make the ceiling of the room below. Thus the rafters, which support all the weight in the room above, are contained in a closed space between the ceiling and floor. This promotes dry rot, and hence the importance of ventilating the floors referred to under the head of walls. Floor boards should fit quite close together, so that no dirt can get down between them nor water when the floor is scrubbed. They should be what a joiner calls tongued and grooved (fig. 98), so as to be almost air-tight.

Good woodwork.—The woodwork of a new house is a good test of its general character. Well-seasoned timber

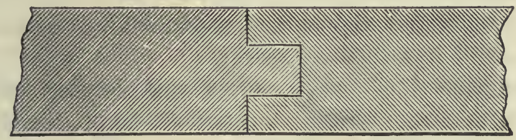


Fig. 98.—A Section through the Joint between two Floor Boards, showing how they should be tongued and grooved.

is not employed in cheaply built houses. The jerry builder uses green wood, which shrinks as it dries, causing the floor boards to gape, and the windows, doors, drawers, and other parts to fit badly, and very often to crack.

In the basement and kitchen the floor is usually made of tiles, stone, or concrete; but such floors are not healthy for living rooms unless covered with linoleum or matting.

CHAPTER LXIV

CONSTRUCTION—FIREPLACES AND CHIMNEYS—ARRANGEMENT OF ROOMS—GAS AND WATER SUPPLY—BATH ROOM—WASTE PIPES

Fireplaces and chimneys: for warming and ventilation. Every room in the house should possess a fireplace. It is required sometimes for warming and always for ventilation. The smaller the bedroom the more necessary the fireplace to ventilate it. Each fireplace should have its separate chimney carried up to the top of the house, and there should be no near building higher than the chimneys, or they are certain to smoke. The varieties of grates and stoves, and the best kinds to use, will be explained in a future chapter.

Arrangement of rooms: living and sleeping rooms.—The sitting-rooms should, if possible, be on the ground floor, as this is the most convenient position, and is as healthy as any part of the house. The sitting-room which is to be most frequently used should be that which is the sunniest. The basement, being below the ground, is generally cold, damp, cheerless, and badly lighted. When this is the case it is not suitable for living rooms. The best sleeping rooms are those between the attics and the ground floor. Rooms under the roof are too much affected by the outside temperature, and downstair rooms are too noisy in town. The bedroom which we frequently meet with in the back wing of a cottage house above the scullery, is a very cold place in winter, owing to the thin outside walls. Houses which occupy a little more ground, but have the kitchen and sitting-rooms on the ground floor, and sufficient bedrooms without using the attics, are much better and more easily worked than those high and narrow houses which, with the same number of rooms, involve the use of underground kitchens and attic bedrooms.

Hall: corridors: cupboards.—The hall should not be unnecessarily large, or it will need a stove in winter, and it should be well lighted. In every house there is sufficient room for a good window between the top of the hall door and the ceiling. Long corridors or passages should be avoided, especially if dark. They are only necessary in houses in which the rooms have been badly arranged, and are a cause of much trouble and expense in cleaning and carpets. Cupboards and shelves are indispensable conveniences for the accommodation of cooking utensils, crockery, stores, clothing, and household linen. Their presence or absence should be taken into consideration when selecting a house.

Gas and water supply.—The town authorities are responsible for the gas and water supply outside the house, and the landlord or tenant inside. The gas comes from the street main through an iron pipe to the meter, an apparatus which measures the amount of gas used. There is a tap in the main just before it enters the meter. From the meter the supply is carried on through the house by means of lead pipes, which are mostly concealed in the walls, window frames, and floor spaces. The landlord is responsible for the pipes, but the tenant supplies the removable brackets and chandeliers. The importance of gas pipes being sound and properly laid is so great that there is not often any serious fault in them.

The water supply is more complicated. The water main usually enters from the street beside the gas main, and there is a tap outside the house by which the supply can be entirely cut off in case of a leak. The main pipe is continued up to the cistern at the top of the house, frequently supplying the scullery and some other places on the way. Then from the cistern a descending pipe supplies the bath, housemaid's sink, wash basins, pantry, and the hot-water apparatus.

Points to notice about water supply.—The chief points to notice about the water supply are that the pipes are placed well within the house where they are not likely to burst with every frost, that there is a separate cistern for the lavatory, that if the town supply is intermittent the house cistern is large enough for the wants of the house, and that the hot-water apparatus is a good one. All these matters will be more fully explained in another chapter.

Water supply in country houses.—In country houses there is no gas supply, and the water is usually drawn from a well. It is a matter of the utmost importance to ascertain that the *source* of the water supply is quite free from contamination by cesspools or other impurities, as the water has often been the cause of fatal illnesses in otherwise perfectly healthy country houses.

Bathroom.—In years gone by a bathroom was an almost unknown luxury in a small house. Now one is placed as regularly as a kitchen in every 20*l.* house, with its proper supply of hot and cold water. Never think of taking a town house without a bathroom, and see that its waste pipe opens *over a grating* in the yard or area below.

Waste pipes.—The waste pipes carry the liquid refuse of the lavatory, bath, wash-basins, and sinks from the house to the sewers. They are a great source of danger if improper or out of order, and cannot be too carefully inspected before taking a house. It is not a very difficult matter to learn how they ought to be placed, trapped, and ventilated—points which are fully described in Chapters LXXXVI to LXXXIX.

CHAPTER LXV

MATERIAL AND TREATMENT OF THE FLOORS

Material for floors: floors of rooms, hall, passages, and kitchen.—Wood being a poor conductor of heat is a good substance for floors. Taking into consideration its durability and cost it is the best material for the purpose. The chief drawback to wood is its inflammability, and for this reason the floors of public buildings are frequently made of cement, on the top of which the wood is laid. Stained and varnished or polished wood is the best, as it can be so easily cleaned; indeed, a polished floor is more perfectly cleaned with a damp cloth than ordinary boards are by a laborious scrubbing.

Wooden floors are almost universal in sitting and bedrooms. Stairs and passages are usually also floored with wood, though sometimes the stairs are of stone and the passages of concrete. The advantages of stone or concrete floors are that they are not inflammable, they are silent to walk on when covered with carpet, and they are easily cleaned. On the other hand, they are much more expensive to lay down, and cost more in wear and tear of carpets. The hall is often floored with tiles or concrete with mosaic pattern, and the kitchen and scullery are generally paved with stone or a cheaper kind of glazed tile.

Floor coverings.—In a general way carpet is the best covering for wooden floors, and linoleum for stone floors. In the hall a strip of linoleum or oilcloth is the cleanest and best covering. It need not reach to the wall on either side; the exposed border of tiles, concrete, or painted woodwork making a suitable margin. Some people also like linoleum on the stairs. In a cottage house, where there is often a good deal of traffic up and down stairs, it is clean and quiet; moreover, in cottages the stairs are sometimes so made that stair-rods cannot be used, and the covering has to be nailed to the boards. When this is the case the clean, easily washed linoleum is certainly better than carpet. The stair-border is usually painted. In the passages strips of hemp carpet or coir matting are cheap, neat, and serviceable. If they do not reach to the wall the borders should be stained or painted.

The kitchen floor should not be entirely covered, unless it is with linoleum or oilcloth. These wash so well that they may be laid permanently; but strips of matting which are often used should never be put in places where they cannot be easily removed for cleaning. Floorcloth wears out quickly on stone floors, especially when irregular, so it is a common plan to spread sawdust underneath it. If the sawdust keeps dry and is changed occasionally there can be no objection to it, as it is of a decidedly purifying nature.

For sitting-room floors a central square or oblong carpet is certainly the best covering, the border being stained and varnished. The latter is easily accomplished by anyone, as the combined stain and varnish is now sold in tins ready for use. The brown or oak, and the black or ebony, are the favourite colours; they both look very well. The carpet should be large enough to extend up to but not under any of the heavy furniture placed against the wall, so that it can be taken up by simply removing the chairs and table. If the floor is old and irregular and there is much traffic on it, a cheap, thick paper felt will save the carpet very much, and be soft and pleasant to walk on. Old boards are sometimes too bad for staining; when this is the case an oilcloth or linoleum border answers the purpose very well.

Carpets: English and Foreign.—Carpets may be had in qualities varying in price from a few pence to many shillings per square yard. The cheapest are made of coarse jute printed after manufacture in bright patterns; but jute neither dyes well nor wears well, so these carpets soon get shabby. The Kensington art squares are made of good material and are reversible; but they are too thin for hard wear. Tapestry is the best kind of printed carpet, the pattern being printed on the yarn before it is woven; but it is not so good as Brussels, in which the pattern is woven from well-dyed yarn, each thread of which is of the same colour throughout. Carpets having a velvet-like pile resemble Brussels, only that the loops of woollen yarn are cut where they come to the surface. The Wilton and Axminster pile are amongst the best and most expensive of carpets; but the cheaper kinds of pile carpet are not nearly as good as Brussels, which is decidedly the best for general household purposes.

Yorkshire is the great seat of the carpet industry; but it is at Kidderminster in Worcestershire that Brussels carpets are chiefly manufactured, and there are several other towns in both Scotland and England occupied in the same class of trade. Turkey and Persian are the best kinds of foreign carpet. Both are expensive. Rugs of good pattern and quality are imported in large numbers from India; they wear well and cost less than English rugs, though they have not quite the same finish.

The bedroom floor.—Carpets always collect dust, and for this reason there is some objection to their use in the bedroom. A bed is an article of furniture which is too heavy to move out of the way, and too low to get under for sweeping; consequently the carpet under the bed is generally in a bad state. The healthiest method of treating the bedroom floor is of course the cleanest, and the cleanest is to stain and polish it all over, as is done in hospital wards. Rugs may be laid down just where it is necessary to keep the feet from contact with the bare floor. The saving in carpet compensates for the cost of the varnish.

Floorcloth.—Oilcloth and linoleum are the only kinds in ordinary use, and of these linoleum is by far the better. Oilcloth is made by applying several layers of paint on a strong backing of canvas, the topmost layer being printed in pattern. Linoleum is composed of powdered cork mixed with oil, resin, and pigment. This compound is pressed into canvas between heated rollers to produce the well-known sheets of plain linoleum. The figured kinds are printed in oils on the surface, as in the case of oilcloth. Of course the pattern wears out long before the substance is appreciably damaged, and on this account a new process for producing a mosaic pattern has recently been adopted. This consists in stamping the tile-like pieces out of differently coloured plain sheets, and cementing them together again in the form of a pattern on a thin canvas backing. In this kind the pattern goes quite through, and consequently does not disappear until the material is entirely worn out.

CHAPTER LXVI

TREATMENT OF THE WALLS—PAINT, VARNISH, WHITEWASH, DISTEMPER, WALL PAPERS, PAPER HANGING

Treatment of the walls.—The internal walls of the living rooms consist almost invariably of smooth plaster or cement, the latter being the proper finish. Round the floor there is a skirting of wood, and near the ceiling usually a moulding or cornice of plaster. There is also the woodwork of the doors and cupboards. The hall and passages are finished in the same way; but in parts of the basement, the coal cellar, and outhouses, the bricks are usually left bare. Woodwork should be painted or varnished; bare bricks coated with plain limewash or distemper; ceilings with whitewash, or sometimes with paper or paint; and smooth walls with distemper, paper, or paint.

Paint: house painting.—The paint used for houses consists of a pigment or colour mixed with linseed oil and turpentine. Linseed oil is selected for this purpose on account of its property of drying. Mineral, olive, and other oils which do not dry would be quite useless for making paint. It is not necessary to grind the colours and mix the paint when required, as it can be obtained ready for use at any colour shop in large or small quantities. House painting is not a very difficult art, although it requires some practice to lay on a smooth and regular coat. The chief points to observe are, first, that the wall or woodwork is clean, smooth, and dry; that the brush is clean, and the paint well mixed. Second, that it is laid on evenly, using the brush freely and the paint sparingly. Thirdly, that one coat is allowed to dry thoroughly before another is put on the top of it. Paint makes a clean and healthy coating for walls, as it has no tendency to catch dust, and stands washing better than any other method of treating them. It has a colder appearance than paper, and is more expensive, therefore it is only usual to paint the walls of the hall, staircase, and passages, as well as the woodwork throughout the house.

Varnish.—Varnishes consist of gum-resins like copal, mastic, shellac, and other similar substances dissolved in boiled linseed oil and turpentine or spirit. Bright varnish is very suitable for nice woodwork like pitch pine, as it dries bright and hard, and shows the grain of the wood. Black varnish like Brunswick black, which contains asphalt, is the best coating for the iron work about the fire grate, &c. Varnish washes well and is easily renewed, so it is a clean and healthy treatment for wood or metal, as well as being an excellent preservative.

Whitewash and limewash.—Whitening (chalk) and lime, used as whitewash or limewash, are applied to ceilings and walls. They are mixed with water to the consistence of cream, and are then laid on with a broad brush. When to be used on walls a little size (very thin glue) or starch is often added, to prevent them rubbing off. They are very cheap and easily put on, and as the limewash is considered purifying it is commonly used for the basement, cellars, yard, fowl houses, and similar places.

Distemper —Distemper is a kind of limewash in which pigments and size are used. It looks a good deal like paint; but is much cheaper and more quickly put on. It may be used in any of the rooms, hall, or passages, as it looks well and is cheap, clean, and healthy. A neutral shade of colour is the best for the general coat, which should be set off with a bright dado, put on by means of a stencil plate.

Wall paper: popularity: varieties: sanitary and varnished papers.—Wall papers may be had in a great variety of colour, design and quality. Notwithstanding that they are considered somewhat less clean and healthy than paint or distemper, they are certainly much more popular, and very much more commonly used than both put together. The reason no doubt is that they are more decorative, and lack the cold and formal appearance of the others. Wall papers may be arranged in three classes: (1) The ordinary paper printed in water colour, in qualities varying in price from a few pence to many shillings per piece of twelve yards. (2) The sanitary wall paper, a smooth paper of good quality and moderate cost, printed in oil colour. (3) Varnished wall papers; clean, durable, and good, but rather expensive. The sanitary papers are especially suitable for bedrooms. Their smooth surface tends to catch less dust than the ordinary wall paper, the oil colour is less liable to fade, and it bears cleaning better; indeed, it is said to stand washing. Varnished papers certainly may be cleaned with a damp cloth. They are made to represent panels of wood, and glazed tiles. The latter are so bright and clean looking, that nothing but the real thing could be nicer for the bath-room or dark passages. Of ordinary wall papers those with a smooth surface are the best; the rough, flock surface papers being one of the worst kinds of wall decoration. The very worst kind is a paper which has been printed with arsenical colours, especially that known as Scheele's green, as the arsenic is given off from the paper and causes slow poisoning. However, this fact is so well known nowadays, that manufacturers are more careful in the selection of their pigments. Under no circumstances should several layers of wall paper be put one on the top of another; such an accumulation of old paste and paper being decidedly injurious to health.

Paper hanging.—Paper hanging is more difficult than painting; but by no means beyond the reach of a skilful amateur. Many a self-taught housewife can proudly point to a neat and clean room which she has painted and papered entirely with her own hands. The first thing to do is to thoroughly wet the old paper and scrape it off. Then whitewash the ceiling, and clean and paint the woodwork. Next take the rolls of paper, cut off the left-hand margin, and divide some of them into lengths a little more than the height of the room, in each of which the pattern must exactly correspond. Paste the back of one of these pieces and put it on the wall, say on the right-hand side of the window. Having loosely attached it here, take the top and stick it in a true line along the top of the wall. Then stand below it, raise all the rest from the wall again and let it fall back in a straight and true line along the margin of the window frame. Lastly gently press it with a soft cloth so that it adheres smoothly throughout, and cut the lower edge off level with the top of the skirting board.

The succeeding pieces are to be put on in the same way, each one overlapping the right-hand margin of the last in such a manner that the pattern is exactly continuous. When going round a corner the paper should not be cut to extend beyond it in one piece, or it will be certain to wrinkle or tear. Very thin and very thick papers are the most difficult to manage, especially in lofty rooms where long pieces have to be handled at once. The sanitary are as easy as any, as their texture is good and the oil colour does not readily smear.

CHAPTER LXVII

TREATMENT OF THE WINDOWS—THE BEDROOM—SIZE—VENTILATION—CLEANLINESS—FURNITURE

The windows: treatment of the windows.—Windows are always furnished with blinds, and frequently with curtains as well. The blinds are required to prevent people outside from seeing in, especially when the rooms are lighted up after dark; and the curtains to keep out draughts.

Blinds.—Blinds are of many kinds. First there are half blinds, intended to prevent people from looking into the room during daylight. Either these or muslin curtains are necessary in a street, as without them anyone passing can usually see into the room. For sitting-rooms half blinds are made of wire gauze, lattice-work, cane, coloured glass, or art muslin. All answer the purpose equally well, but the last is of course much the cheapest. For bedrooms muslin in some form is almost invariably used. A perfect model for full blinds has not yet been invented; the old style of plain roller blind being as good as any. The various spring kinds are very liable to get out of order, and those gathered in folds, though very pretty, catch the dust too much. Venetians are expensive, heavy, dirty, and in frequent want of repair.

Curtains: as dust traps: material: half curtains.—Sanitarians always object to heavy curtains, as they are such dust traps. In town houses, which are invariably dusty, heavy curtains are not usually necessary; but in exposed situations in the country one can hardly do without them, and fortunately there is much less dust in country houses. Muslin curtains are quite free from this objection, but then they are useless as screens against draught. Good woollen tapestries make handsome heavy curtains for sitting-rooms, and last almost a lifetime. Chenille velvet is particularly beautiful and artistic. Plushette, a comparatively cheap material, also makes rich-looking heavy curtains; but all these have the great fault of retaining the largest possible amount of dust. The old-fashioned repp was a much better material for the purpose. Cheap tapestries are very poor materials, as they are composed largely of jute, a fibre which dyes, cleans, and wears badly. The cheap kinds of 'Oriental' curtain are also thin and poor; art serge is better than either, and very inexpensive in regard to its quality. For bedrooms cretonne is a very pretty and clean material.

Half curtains, that is curtains extending only to the top of the bottom sash of the window, are sometimes used. They are certainly cleaner, but are not in great favour with the public, and, of course, are not very serviceable as regards draught. The so-called half blinds only cover the lower half of the bottom sash of an ordinary sized sitting-room window; so the two may be used together.

The bedroom.—Bedrooms are the most important rooms in the house as regards health. During the day-time we are out of doors, or moving about from room to room; but at night we pass the hours in an unconscious condition of sleep all the time in the same room. About eight hours out of every twenty-four, that is one-third of our whole time, we spend in the bedroom, and yet any little room is often considered good enough for this purpose so long as there are nice rooms for visitors. It would be better, however, if people would pay more attention to the bedroom; not in the matter of luxuries, or even appearance, but in reference to the following points: size, ventilation, cleanliness, and furniture.

Size.—The cubic space required for each person is 1,000 feet; that is, a bedroom intended for one person should not measure less than 10 feet long, by 10 feet broad, by 10 feet high. If two people sleep in the same room, the space should not be equal to less than 2,000 cubic feet, and so on. This rule is very frequently broken in the nursery, where three or four children and the nurse often sleep in a room not properly large enough for two people. Children, of course, require less space than full-grown persons, but pure air is of more importance to them.

Ventilation.—If a person were shut up in an air-tight space of 1,000 cubic feet, the air would gradually become so impure, owing to its being breathed over and over again, that it would be fatal to breathe it any longer. Ventilation means the changing of the air in a room to prevent it from becoming thus deteriorated by respiration or the combustion of gas; it consists in the constant and gradual substitution of fresh air for impure air by the methods which will be explained in Chapter LXXIII. In order that 1,000 cubic feet of air may remain in a pure state through the night in a room inhabited by one person, it requires to be changed three times an hour. If the room is larger, the air needs less change; if smaller, more change. Now, long experience has shown that the only way in which this change of air is likely to take place in an ordinary bedroom is by means of the chimney. Other methods let in draughts, or fail in some way so that they are not used, therefore make it a constant rule that every bedroom shall have a fireplace in it. The smaller the room, the more necessary is this means of ventilating it.

Cleanliness.—Cleanliness is best secured by furnishing the room in such a way as to make it as easy as possible to keep clean. The walls, floors, and windows should be treated in accordance with the advice already given, and the other furniture should be limited to that which is really necessary for use in the bedroom.

Furniture.—Heavy cumbrous furniture takes up the air space, and makes the room difficult to keep clean. Moreover, it encourages the storage of quantities of clothing in the room, which always produce a stuffy condition of the air.

The bed is the most important article. It should have a strong iron frame, with a good woven wire or chain spring mattress. Those made in three pieces are the best: a head piece, a foot piece, and an oblong frame and spring mattress all in one (figs. 99 and 100). On the bedstead there should be a hair or wool mattress, a bolster and a feather pillow. The bedclothes should consist of an under blanket and one, two, or three upper

Figs. 99, 100.—Messrs. Billington's Spring Beds, hospital pattern.
(Fig. 100 shows the bed taken to pieces for removal.)

blankets, according to the weather; a pair of cotton sheets, a cotton or linen pillow-case, and a counterpane or rug. A short cretonne valance not reaching to the floor gives a nice appearance and does no harm, unless it encourages that dirty and unwholesome practice of hiding away all sorts of old boxes and rubbish under the bed.

In addition to the bed, a combined dressing-table and chest of drawers, a washing-table and toilet-service, and some kind of wardrobe are necessary. The hanging wardrobe is an excellent idea. It consists of a wooden top to which a row of pegs and a curtain rod are attached. The top is fastened to the wall, preferably in a recess, and curtains of art muslin or cretonne are suspended round it by the rod. It costs a mere nothing, and, being airy, never contracts that stuffy odour so common in a closet filled with worn clothing. A few ornaments and pictures are of course permissible, but decorations placed in the fire-grate must not be such as to obstruct the free passage of air up the chimney.

The furniture of the sitting-rooms, kitchen, and hall, apart from what has been said as to the treatment of the floors, walls, and windows, may be left to the taste and pocket of the owner. It has not a sufficient influence upon the health of the occupiers to make it necessary to lay down definite rules regarding it.

CHAPTER LXVIII

AIR—CHARACTERS, WEIGHT, CURRENTS, COMPOSITION

The atmosphere: characters.—Surrounding and enveloping the earth is a layer of air. It is in the form of gas, and has neither colour, taste, nor smell. It is so light, and is so easily displaced as we move about in it, that we are only conscious of its presence when the wind blows; yet we know that there is something in it which sustains life, for we could not continue to exist without air to breathe.

Weight of the air.—The whole depth of the atmosphere surrounding the earth is estimated to be about fifty miles, and though in itself so light this great thickness of air naturally presses with some considerable force on the surface of the earth. We do not feel its weight any more than fish feel the weight of the water they swim in, because in each case the pressure is equally distributed and balanced on every surface of the body. We know that water has weight because we can handle and weigh it. With proper scientific apparatus, the weight of the air can be just as certainly determined, and it is found to be equivalent to a pressure of fifteen pounds on every square inch of surface at the sea level.

Air of hills lighter than in valleys.—If you were to take fifteen one-pound weights and place them like a pile of coins one on the top of the other, they would press on the surface on which they stood with a weight of fifteen pounds; but the first would only bear on the second with a weight of one pound, and the second on the third with a weight of two pounds, and so on. In the same way, the higher we ascend the less is the pressure of the atmosphere. Now, air is very elastic, so weight means compression. Consequently, the nearer we are to the sea level the heavier and denser is the air, but the higher we ascend a mountain the more light and rare does it become. This is one of the reasons why mountain air is so light and invigorating.

Currents of air caused by heat.—Air, like other substances, expands with heat and contracts with cold. When it expands it becomes lighter, and when it contracts it becomes heavier; consequently, hot air ascends, and cold air descends. Wherever air is being heated the hot air is rising up, and the cold air on all sides is rushing in to take the place of that which is ascending. On a large scale the sun heats the air at certain places, and the currents produced are called wind. On a small scale the fires and lights in our houses heat the air in them, causing currents which are utilised for ventilation.

Air in water and earth.—Air is contained in water in which it is dissolved, and where it supplies fish with oxygen for the combustion of their food; it also penetrates to a considerable depth into the ground; thus both earth and water are affected by the state and purity of the atmosphere.

Composition of the air.—The air consists almost entirely of a mixture of two gases called *oxygen* and *nitrogen*. The other constituents are comparatively infinitesimal in quantity, yet they are of vast importance to the world. They are (1) other gases, namely, carbonic acid gas, ammonia, and ozone; (2) watery vapour; (3) solid particles, such as mineral and organic dust, and living germs. The following is a complete list of the constituents of the atmosphere:

(1) *Oxygen* (O), supports life and combustion; forms one-fifth of the total bulk. (2) *Nitrogen* (N), dilutes the oxygen; not used by plants or animals; forms nearly four-fifths of the total bulk. (3) *Carbonic acid* (CO_2), the carbonaceous food of plants; when excessive is poisonous to animals; only 4 parts in 10,000 of air. (4) *Ammonia* (NH_3), a nitrogenous food of plants; excess indicates bad air; only 1 part in 1,000,000 of air. (5) *Ozone*, a condensed form of oxygen; indicates great purity; exists only in traces. (6) *Moisture*, the cause of clouds, rain, mist, and dew; exists to a variable extent in the air at all times. (7) *Mineral dust*; dust caused by trades, sand, &c.; injurious to the lungs. (8) *Organic dust*; scales, hairs, seeds, and other particles of plants and animals. (9) *Living germs*, the agents of decomposition and infectious disease.

CHAPTER LXIX

OXYGEN, NITROGEN, CARBONIC ACID

Oxygen.—Oxygen, for which the chemical symbol is O, is the most important constituent of the earth. It forms one-fifth of the bulk of the atmosphere, eight-ninths of the *weight* of water, and about one-half of the solid earth. In the air it is in a free state, being simply mixed with nitrogen in the proportion of one volume to four. In water it is chemically combined with the lightest known substance—hydrogen gas—in the proportion of one volume to two (H_2O)—note O is sixteen times as heavy as H. In the earth oxygen is also chemically combined with the other elements; indeed, almost every natural substance is partly composed of oxygen.

Oxidation: combustion.—So strong is the tendency of oxygen to combine with many things that it is difficult to prevent the union from taking place. For instance, bright iron has a great tendency to rust, and rust is merely iron combined with oxygen, or oxide of iron. It combines with carbon with a much greater energy than with iron; or, indeed, most other substances, giving out heat and resulting in a gas (CO_2), instead of a solid like iron oxide. The oxide of carbon (CO_2) is called carbonic acid gas, and on account of the heat given out by the energetic union of oxygen with carbon the process is called combustion.

Though carbon or coal undergoing oxidation or combustion appears to burn up into nothing, it is really only changed into this invisible gas, which escapes up the chimney. Not a particle is lost, any more than a particle of iron is lost when iron is changed into iron rust. Every grain of carbon which existed in the coal before it was burnt exists afterwards in the CO_2, and will again be converted into carbon by the natural processes going on in the world.

Use of oxygen in the body.—As oxygen, by combining with coal in the steam engine, produces heat and power, so by combining with the carbonaceous food in the body it yields heat and vital force. The object of breathing is to inhale the free oxygen of the air that it may circulate in the blood and combine with food to keep us warm and give us brain and muscular power.

When oxygen combines with carbon in food, coal, wood, oil, candles, coal gas, or any other combustible material, of course carbonic acid is always produced. Therefore, wherever there is life or combustion, carbonic acid is being produced and turned into the atmosphere.

Nitrogen.—Nitrogen, of which the chemical symbol is N, is not used by either plants or animals in the free state in which it exists in the air, but is a very important element when combined with others, as in nitrogenous food. In the atmosphere nitrogen appears only to dilute the oxygen, forming four-fifths of its bulk. It has not the same tendency to combine with other substances, and is, of course, quite incapable of supporting life or combustion.

Carbonic acid.—Carbonic acid (CO_2) is a very heavy gas, much heavier than the air. Although 4 parts in 10,000 seem very little, the amount contained in the whole atmosphere is enormous, no less than three billions of tons, or, in figures, 3,000,000,000,000 tons. It is a common gas, frequently met with in the pure state, but perhaps not recognised, for, like air, it has neither colour, taste, nor smell. Carbonic acid is the gas used to aërate bread, by whatever process it is made; the gas which is given off from soda water, beer, champagne, and all effervescing drinks; the gas of limekilns, coal mines, and volcanoes, as well as being the gas derived from combustion and exhaled in the breath of all animals. There is a constant supply of carbonic acid, and yet the percentage remains the same. The reason of this is that there is an equally constant demand for its consumption. Plants feed on it. Their leaves absorb and decompose it in the presence of sunlight, the carbon being used for the growth of the plant, and the pure oxygen being returned to the air. Thus, on the one hand, animals absorb oxygen and combine it with carbon to obtain heat and energy; whilst, on the other hand, plants absorb carbonic acid, make the carbon into food or fuel, and return the oxygen to the air. Animals are always decreasing the oxygen and increasing the carbonic acid in the air, whilst plants are always increasing the oxygen and decreasing the carbonic acid. In this way the natural balance is maintained.

Carbonic acid harmful to animal life.—Carbonic acid gas does not support life, and a lighted candle introduced into it at once goes out. It is worse than useless for respiration, it is harmful, its ill effects beginning to be felt even so soon as the proportion rises to 8 or 10 parts in 10,000 of air. It is, therefore, very necessary that in dwelling-houses, where there is a constant production of carbonic acid going on, means should be taken to keep the air in a pure state. These means will be described under ventilation.

Use of carbonic acid in the world.—Whilst we cannot too carefully avoid carbonic acid gas in our immediate neighbourhood, bearing in mind its harmful qualities towards us, we must not forget to recognise its importance and usefulness in the world. Without it plants would lose their chief food and life become impossible to them. Without plants animals also would have no means of subsistence; hence carbonic acid, though directly bad for us, is indirectly necessary for all living things.

CHAPTER LXX

AMMONIA—LAW OF DIFFUSION OF GASES—OZONE—MOISTURE

Ammonia.—Ammonia (NH_3) is a compound of nitrogen and hydrogen. It is lighter than the air, and is quite colourless, but it has a very pungent taste and smell. It is the gas given off by smelling salts, and when of full strength an attempt to breathe it would be at once fatal.

Source of ammonia.—Ammonia in nature is derived from decaying animal and vegetable matter, and though in much larger proportion than it naturally occurs in the air—namely, one part in a million—it would be quite harmless to us, its presence in excess is always objected to as indicating an excess of decomposition in the neighbourhood. In fact, inhaling the ammonia from smelling salts is no more harmful than swallowing carbonic acid in bread or beer. Where there is life there must be death and decay; so, throughout the world, ammonia in small quantity is constantly passing into the air. But, as in the case of carbonic acid, it is consumed as rapidly as it is produced, for NH_3 is a form of nitrogenous food for plants. They absorb it, and use it for the growth of their seeds and fruit, which in turn become again one of the most valuable foods for men and animals.

Value of ammonia in the world.—This trace of ammonia, then, which exists in the air, 1 part in 1,000,000, is also an important constituent of the atmosphere. It is a valuable food for plants, and thus indirectly is equally serviceable to animals. When the amount rises above the standard, as it does in towns, and especially in dirty, ill-kept towns and other places, it indicates an impure atmosphere, not because the ammonia itself is harmful, but because its presence in excess points to the close proximity of an excess of decomposing animal or vegetable matter.

Law of diffusion of gases.—Although carbonic acid and ammonia are chiefly produced in some places and chiefly used in others, their percentage in the outside air remains practically constant all over the world. The reason for this is found in the law of the diffusion of gases. If a glass jar is filled with any kind of gas, and its mouth closed with bladder or parchment, the gas will not remain in it as a fluid would. In the course of a short time it will be found that a quantity of gas has passed out of the jar and its place has been taken by a similar amount of air. The lighter a gas is, the more rapidly it diffuses; thus hydrogen diffuses very quickly, and carbonic acid more slowly; but the tendency all gases have to diffuse through the air is so great that nothing but absolutely impermeable substances can keep them in.

Ozone.—Ozone is not an invariable constituent of the air, but is present in the pure mountain and sea air, and in towns when the air has been purified by a storm. Its presence is always taken as indicating an especially healthy atmosphere, for it is a powerful, deodorising, and disinfecting agent. When it comes in contact with impurities, it combines with them and renders them harmless, hence the small trace which exists in the air is very rapidly removed when that air reaches a town. Ozone consists of oxygen in a compressed and very active form.

Moisture: uses: relation to health.—The vapour of water is always present in the atmosphere. How readily it is dissolved and rendered invisible may be observed by watching the steam as it issues from an engine on a fine day. The dense white cloud escaping from the funnel vanishes into the air almost immediately it appears. It is dissolved by the air as sugar is dissolved by water. The warmer the air the more vapour it can take up. The amount that it actually contains is not constant, like oxygen, nitrogen, carbonic acid, and ammonia, but usually varies between 50 and 70 per cent. of that which it is capable of dissolving according to the temperature.

Under no circumstances is the air devoid of moisture. Without moisture in the air the surface of the earth would be uninhabitable. There would be no clouds, rain, mist, or dew, and no rivers, lakes, ponds, or ditches. The surface would consist only of rocks and dust or sea. Moisture is therefore another essential constituent of the atmosphere.

When we speak of a dry air we do not mean one that is really dry, but which is capable of absorbing more moisture. In this sense a moderately dry air is the best for health, especially when free from dust.

CHAPTER LXXI

COARSE DUST—FINE DUST—LIVING GERMS

Coarse dust: irritation of mineral dust.—Solid particles do not properly belong to the atmosphere, but they are always present in it, and where life is busiest there dust is the most prevalent. In a strong wind or a thick town fog visible particles fill the air, and we feel their irritation, especially in the eyes. The lungs have a much more delicate structure, though not the same sensitive nerves as the eyes, and they suffer exceedingly from constant exposure to coarse dust. Fortunately fogs and winds only last for short periods, and the dust inhaled during their prevalence is soon coughed up in the form of discoloured mucus.

Dust of trades.—In certain trades, such as knife and other steel grinders, sand-paper makers, coal miners, stonemasons, flax dressers, &c., hard, irritating particles are thrown off and fill the air of the places in which the people work. So well recognised are the lung diseases caused by such trades that they are named after them; as, knife-grinders' consumption, stonemasons' consumption, and so on. Indeed, these trades in former times were so fatal that the people who worked at them were not expected to reach middle age. Now, however, by the use of proper respirators which filter out the dust, their lungs may escape altogether.

Dust bad for weak chests.—The danger of constantly inhaling dust should be especially observed by those inheriting a natural tendency to chest delicacy. They ought to avoid a dusty occupation: it is worse for them even than a draughty one; and when consumptives are sent abroad windy and dusty places should never be selected. The absence of dust is no doubt one of the reasons why a long sea voyage does so much good in these cases.

Fine dust: fine organic dust less harmful.—Fine atmospheric dust is invisible in an ordinary light, but when a strong ray of sunlight gleams through a dark room the little particles may be plainly seen dancing about in its illuminating course. The stiller the air, and the further from the busy haunts of men, the less of this fine dust there is, but the air is never entirely free from it. For the most part it consists of light particles of matter derived from the wear and tear of surrounding objects—our skin, clothes, furniture, houses, and plants and animals generally. Such débris as this is not of much practical importance to us. Unless excessive in amount it is not harmful, and then chiefly as indicating, like ammonia, the presence of too much organic matter in the air.

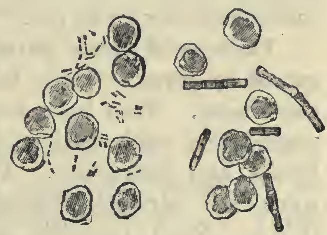


Fig. 101.—Blood Corpuscles and Disease Germs.

The large germs to the right are the cause of a form of fever in cattle (anthrax); the small ones to the left of blood-poisoning.

Living germs.—Mixed with the foregoing particles, and forming the finest dust recognisable under the highest powers of the microscope, are numerous minute specks which, on close examination, prove to be definite forms of life. They are small beyond conception, for a blood corpuscle appears a giant beside most of them (fig. 101); but they bring about some very important changes both for good and evil in the world.

Germs cause decomposition: use of germs.—In the first place, these germs are the great cause of decomposition, as was explained in the chapter on the preservation of food. The decomposition of food is, however, a very small matter in comparison with the part they play in the universe. Consider for a moment what would happen if dead things did not decompose—that is, if dead organic matter did not return to its inorganic or mineral condition, and the vast yearly accumulation of dead plants and animals remained unchanged. Why, in a few years at most, the surface of the earth would become choked and unfit for living things. Dead things, when not devoured by any higher kind of life, invariably become the food of germs, and so inevitably perish and make room for fresh life.

Varieties of germs: parasitic or disease germs: diseases caused by germs.—These minute germs are not all of the same kind. They have their varieties, like animals and plants, and each variety has its own particular food, habits, and characters. Also, like animals and plants, some are parasitic, feeding on and inhabiting living things. Such parasitic germs, when they infest the blood of an animal, bring about the most profound changes, and are the cause of the most serious of all diseases. The chief germ diseases attacking man are the infectious fevers, blood-poisoning, cholera, dysentery, erysipelas, influenza, ague and consumption. In animals anthrax, pleuro-pneumonia, foot and mouth disease, consumption, fowl cholera, salmon disease, and some other affections are due to germs. And in plants they cause the well-known forms of blight which so frequently attack the growing crops.

These diseases, and probably many more which are not yet attributed to them, are brought about by germs, which float in the air or in water, and may be inhaled or swallowed by us unconsciously. When the circumstances are suitable for their development they multiply and flourish in us, and having expended their lives they leave behind them myriads of spores or seeds, which, if we survive, are again scattered in our breath, in particles of skin, and in the excretions, to take their chance of another victim.

Good and evil effects of germs.—That germs cause much trouble and much suffering is an undoubted fact, but as a class we must remember that they are not altogether bad. The great part they play in the universe is not only a useful but a necessary one. That they take our food and become parasitic in us is rather our misfortune than a fault in them. Such attributes are characteristics of many higher forms of life.

CHAPTER LXXII

VENTILATION—IMPORTANCE OF PURE AIR—TEST FOR IMPURITIES—MODE OF CALCULATING AMOUNT OF FRESH AIR REQUIRED BY EACH PERSON

Ventilation.—We can now approach the subject of ventilation with that preliminary knowledge which is necessary to understand it. The knowledge referred to is:

(1) The composition of the atmosphere, and the nature of carbonic acid.

(2) The effect on the air of respiration and combustion.

(3) The law of the diffusion of gases.

(4) The production of currents in the air by heat.

Necessity for ventilation.—In a house where the ordinary rules of cleanliness are observed, and the sanitary arrangements are not defective, the sources of impurity in the air are simply the exhalations of the inmates, and the products of combustion derived from artificial lights. Either or both of these causes are at work in every dwelling, and bearing in mind their action on the air—that is, the exhaustion of oxygen and the production of carbonic acid—it is perfectly clear that if a room were an absolutely closed space, and people were shut up in it, they could only live for a definite length of time.

Natural ventilation.—So rapid, however, is the diffusion of carbonic acid in every possible direction, and so easily are currents of air set up by even the heat of our bodies, that it is practically impossible to poison people outright in a confined room, except under conditions approaching the terrible barbarity of the Black Hole of Calcutta. Air finds its way into a room between the frames of the doors and the windows, between the floor boards, and through every other possible crevice (fig. 102). It escapes easily and rapidly up the chimney, and actually diffuses to a greater or less extent through the solid walls.

Effect of impure air on health.—Though it is difficult by overcrowding to contaminate the air in a room to such an extent as to make it immediately dangerous, it is very easy and a very common thing to allow it to become sufficiently impure to be decidedly detrimental to health. It is difficult to convince people of this because they do not suffer from it at once. They cannot trace the cause and effect. Hence, when the harm comes, as it must do in time, in debility, consumption, premature age, or whatever form it may take, it is put down to some other fancied cause. And yet a very little reflection ought to impress people with the value of pure air, for it is certainly the chief reason why people are healthier in the country than in the town. The average town workman has better food, better clothes, and a better home; he has less exposure, and, as a rule, less hard work. Yet he does not live as long, and his children are more sickly, and die in greater numbers. Of course there are other things against the town man besides this, but the principal evil is that he breathes a less pure air. Therefore let him make the best of such air as his town affords, and endeavour to keep it as pure inside his house as it is outside.

The art of ventilation.—This is the aim and object of ventilation, a word derived from the Latin, ventus, wind. Ventilation is accomplished by causing a sufficiently rapid change in the air of a room or building to keep it in a state of purity; the more people or lights there are in the room, the more rapid must be the change. The art of perfect ventilation is to secure this change of air without producing cold or draught.

Air space for each person.—In Chapter LXVII., dealing with the bedroom, it was definitely stated that 1,000 cubic feet of space should be allowed for each adult. This is taken as the standard, as it is the smallest space which can be kept in a state of purity by natural ventilation without causing a draught. When expensive mechanical processes are employed half this space is sufficient, but such means are too costly for private houses, therefore in the house 1,000 cubic feet should be allowed for each individual.

Amount of fresh air for each person.—Next we have to determine how often it will be necessary to change the air in this space to keep it pure, a point which is settled by ascertaining the rate at which it becomes impure. To do this we must know how to test the purity of the air, and how much impurity a man exhales per hour.

Tests for purity of air.—The purity of the air in a room is commonly judged in two ways: (1) By estimating the amount of carbonic acid present. (2) By the very simple process of exercising the sense of smell. The first is an exact scientific method. The second, though less exact, is really much more satisfactory than would be supposed when used with good judgment. The essential point is that the room should be entered directly from the fresh air outside, when, if the least stuffy odour characteristic of close rooms is detected, the air may be regarded as in the first degree of impurity. Such air, when analysed, yields about ·06 per cent. of carbonic acid, which is ·02 per cent. more than fresh air contains (4 parts in 10,000, or ·04). If the room smells decidedly stuffy, it will contain about twice as much excess of carbonic acid, and if very stuffy indeed, there may be any amount above ·1 per cent., which is the limit of the sense of smell in detecting impurities of this nature.

Ratio between various impurities.—Now, carbonic acid has no smell; it is, therefore, not this, but other emanations in the breath and perspiration, which are detected by the nose. However, the ratio between the amount of carbonic acid and other organic impurities is so constant, that any means by which you can judge of one enables you to estimate the other. An excess of carbonic acid in an inhabited room means an equal excess in human emanations, and also in germs; and *vice versâ*, the close smell of an unventilated room is a fair indication of the amount of carbonic acid present.

Mode of calculating amount of fresh air needed.—For practical purposes we may be guided by the sense of smell, carefully exercised in the manner directed. It will warn us as to whether a room is well or badly ventilated, and as to whether the space is sufficient or insufficient. Still, it is better to have definite rules to go by, and these can only be arrived at by the use of figures. Hence, in making calculations, we regard the carbonic acid alone, as that can be exactly estimated. The first degree of impurity as judged by smell, or more accurately determined by analysis, is found to represent an increase of ·02 per cent. of carbonic acid. Now, a man in a room containing 1,000 cubic feet of space will pollute the air to this extent in the third part of an hour; therefore it follows that to keep the air of such a room pure it will be necessary to change it three times an hour; or, in other words, that a man requires 3,000 cubic feet of fresh air per hour. Children only require about half as much air as adults; but adults, when working hard, need something like twice as much as when at rest, work being the result of the combustion of more food, and, of course, accompanied by the exhalation of more carbonic acid.

These, then, are the accurate facts by which we are guided when laying down rules for ventilation: (1) Adults at hard work require 5,000 or 6,000 cubic feet of fresh air per hour. (2) Adults during rest require 3,000 feet. (3) Children require 1,500 to 2,000 feet. Thus we see that though overcrowded bedrooms are bad, overcrowded workrooms are worse—a lesson which has been severely taught at the cost of many lives from consumption.

CHAPTER LXXIII

VENTILATION—METHODS—PRINCIPLES—NATURAL VENTILATION—SPECIAL APPARATUS—INLETS

Methods of ventilating.—It is now time to answer the practical question, By what means are people to be supplied with the proper amount of fresh air in their houses? Or, in other words, How is the ventilation of rooms to be effected?

The air may be changed in two radically different ways: (1) By periodically opening all the windows and doors, and so rapidly changing the entire amount. (2) By allowing a constant stream of fresh air to enter whilst an equal amount of impure air escapes, thus continuously maintaining a pure standard. The former plan has its advantages under special circumstances, but cannot be employed for the ordinary purposes of ventilation on account of the cold and draught introduced by it. Crowded rooms can only be properly ventilated by the use of expensive machinery supplying fresh air previously warmed; if, therefore, a schoolroom, church, lecture room, theatre, or similar building, is thoroughly flushed with fresh air during a short interval, it lessens or removes the harm of insufficient ventilation during the period of its use. This plan can be most effectively used in schools, where at each change of the class the windows on both sides of the room should be opened for a few minutes to permit a stream of fresh air to flow through the room.

Principles of ventilation.—The continuous method is, however, the only form of ventilation suitable for the inhabited rooms of a dwelling-house. In this way the air of the room is kept pure, as it is in the lungs, by the process of respiration. In the lungs there are about 200 cubic inches of air, which is kept pure by constantly respiring small quantities of fresh air, 30 cubic inches. The lungs are not emptied and filled at each respiration, only just sufficient of the warm air they contain is changed to maintain the standard of purity. So in ventilation, our object is to keep up a continuous supply of fresh air, which will be sufficient for the purpose, without affecting the warmth and comfort of the room. A difference between respiration and ventilation is that in breathing the air is drawn in and expelled through the same opening, the windpipe; whilst in the latter the air passes by two apertures, or sets of apertures. Those through which the air enters are called *inlets*, and those by which it leaves are called *outlets*. One of the chief difficulties is so to arrange these apertures that fresh air shall always pass by the inlet, and foul air by the outlet

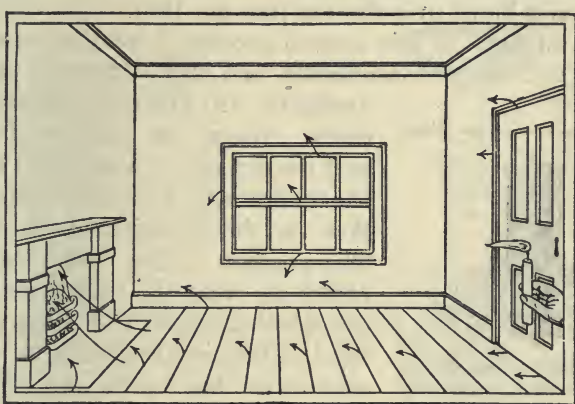


FIG. 102.—Natural Ventilation.

Air entering through the crevices between the floor boards and window and door frames, and leaving by the chimney. A candle flame near the door is deflected by the draught. (After Teale.)

Natural ventilation : natural inlets and outlets : faults.— After what has been said (p. 261) as to the rate at which the air of inhabited rooms becomes impure, it stands to reason that some natural process of ventilation must go on without our paying any special attention to it. If this were not the case the air would become unfit for respiration. The natural inlets are as shown in fig. 102— the various crevices between the window and door frames, and between the floor boards. A careful examination of these crevices will prove that a greater or less current of cold air enters by them whenever the room has no proper inlet for ventilation. The natural outlet is the chimney. When a fire is burning the draught up it is very great, and even when there is no fire the chimney still maintains a steady current of air drawn from the room. In the latter case, the chief agent in causing the draught is the action of the wind, which draws air out of the chimney as it blows over the top (see fig. 103).

The faults of this natural process of ventilation are: (1) The inlets are insufficient, and of a nature to cause draughts. (2) The outlet is too low down. When the chimney draws well the draught is usually felt near the window and door and along the floor in the direction of the fire. The position of the outlet should always be near the ceiling, as foul air, whether expired or from artificial lights, is always warm, and ascends to the top of the room; thus much of the fresh air entering the room is wasted as it flows along the floor to the fire, and only a small proportion mixes with the air of the room to purify it.

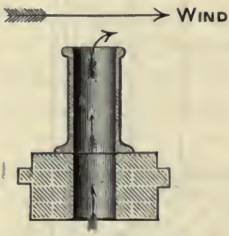


FIG. 103.—Draught up the chimney caused by the wind blowing over the top.

Special inlets: characters of a good inlet.—An inlet for cold air should have three qualifications: (1) It should be above the heads of the inmates. (2) It should be so constructed that cold air can enter by it without causing draught. (3) It should be of sufficient size to purify the room under all circumstances. The best height for the inlet is from eight to ten feet from the floor. If too near the ceiling it acts irregularly, sometimes as an inlet and sometimes as an outlet, according to the heat of the room, and the action of other inlets and outlets. Draught is prevented (1) by directing the current of air upwards as it enters (see figs. 104 to 107), and (2) by making the inside opening larger than the outside one, as is sometimes done in perforated bricks. The former plan is much the better, as cold air is heavier than that in the room, and having been directed upwards on entering, falls gently like the spray from a fountain. In calculating the size of the

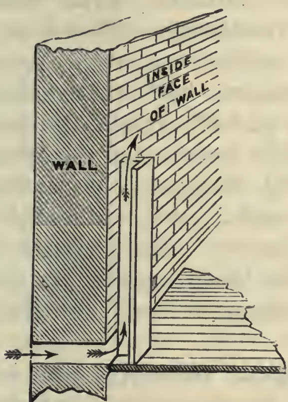


Fig. 104.—Tobin's Ventilating System.

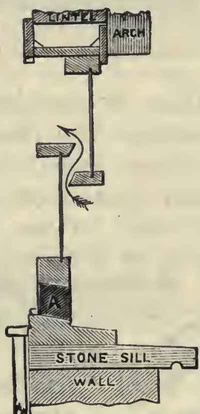


Fig. 105.—Hinckes Bird's Plan of Window Ventilation.

inlet, we bear in mind that it is required to transmit 3,000 cubic feet of air per hour for each inmate. This can be accomplished by an opening of about twenty-four square inches for each individual; that is, one of five inches by five inches for one, and seven inches by seven inches for two, and so on.

Tobin's tube (fig. 104).—This is one of the simplest and best inlets, probably the best. It consists of a wooden shaft or tube entering the room near the floor, and then turned up along the wall for a height of six or eight feet. In the tube is a flap valve by which it can be closed when not required, and sometimes a tray of water, which collects the greater part of the blacks, always suspended in town air. It is important that the external opening should be in a place where fresh air has free access to it.

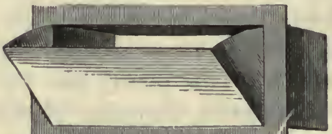


Fig. 106.—Sherringham Valve.
A special inlet to direct the air upwards.

Hinckes Bird's window ventilation.—This is an ingenious contrivance for ventilating by opening the window without causing a draught. The illustration (fig. 105) explains the device. The lower sash is raised a few inches, and the opening closed by a board (A) exactly fitting it. Air can now only enter between the two sashes, and is directed upwards, as indicated by the arrow. This plan requires nothing but the board, and it is, therefore, a very cheap as well as effective inlet.

Fig. 107.
Louvre Ventilator.

The Sherringham valve (fig. 106) is an aperture which can be opened and closed at will, and is arranged to direct the current of air upwards. It should be placed nine or ten feet from the floor; but is more draughty than the Tobin's tube.

Perforated bricks and gratings.—These are always draughty; though this trouble is lessened by making the inner openings much larger than the outer ones. They are generally placed high up in the room, where they act irregularly as either inlets or outlets.

Louvre ventilator (fig. 107).—This may be made of glass or wood. The pieces are arranged like a venetian blind, and are either fixed or made to open and close. The louvre ventilator is always draughty.

CHAPTER LXXIV

VENTILATION—SPECIAL OUTLETS

Special outlets.—The only outlet acting constantly by natural means is the chimney. Other openings intended for outlets generally act irregularly, and are practically useless. Now, the fireplace is too low down to carry off the foul air, which always ascends towards the ceiling, therefore the only efficient outlet is by an opening leading into the chimney near the top of the room. Such an outlet was invented by Dr. Neil Arnott, and is called Arnott's exit valve (fig. 108). The idea has been improved by Boyle, who has made the valve perfectly self-acting by the use of light flaps of talc. These permit a free current of air from the room to the chimney; but flap to at once and check a current in the opposite direction. A good outlet is the essential feature in ventilation. If the bad air is removed, fresh air will find its way in somehow ; the chief object of special inlets being to let it in without draught. For an outlet to be reliable it must be connected with an aspirating force such as is produced by heat or fans. Now, the only aspirating force acting in an ordinary room is the chimney; therefore, if a special outlet is to be reliable, it must be connected with the chimney.

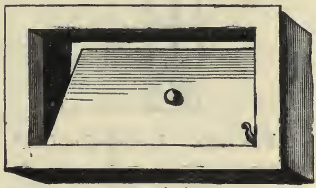


Fig. 108.—Dr. Arnott's Valve.

Ventilation of large rooms: of small rooms: of bedrooms: of workrooms.—To sum up, in reference to dwelling houses we may say that, when the rooms are large, the inmates few, the consumption of gas moderate, and the doors frequently opened by people passing in and out, the ventilation supplied by natural means may be sufficient; but the rooms would be both more comfortable and healthy if proper inlets and outlets were fixed. When the rooms are small, overheated with gas, or overcrowded, special inlets are necessary, and Arnott's improved exit valves are certainly advisable. In bed-

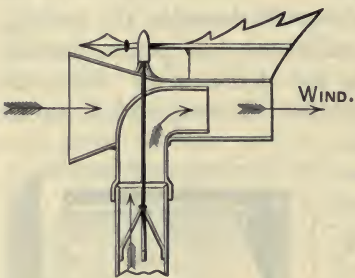


Fig. 109.—A revolving Cowl.

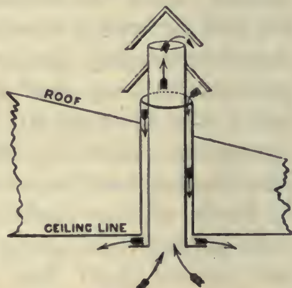


Fig. 110.—McKinnell Ventilator.

rooms sufficient space and an open chimney are very important, as the doors and windows are usually kept closed for about eight hours, during most of which time the occupants are unconscious. If the chimney causes a draught it should not be blocked up, but a proper inlet provided. Every morning the windows should be freely opened to change the air of the room completely.

The thorough ventilation of workrooms is essential. It is not only of the first importance to the health of the employés, but to the interest of the employers, as people can do much more work in pure air. Each workman employed should have at least 1,000 cubic feet of space and 3,000 cubic feet of air per hour, and in the case of hard muscular work 5,000 or 6,000 feet.

Ventilation of single-story buildings.—Schoolrooms, churches, concert halls, theatres &c. are usually warmed by hot pipes or hot air. They are not generally provided with a chimney; but an outlet is easily made through the roof. Such outlets are of various kinds. (1) Cowls, revolving or fixed (fig. 109). The revolving kind would be the best if they were not so liable to get out of order. (2) McKinnell's ventilator (fig. 110), a double tube which acts both as an inlet and outlet whilst the room is closed, but directly a door or window is opened it acts irregularly, and is therefore not very satisfactory. (3) An opening along the top of the roof covered by an elevated ridge carried well down on each side to prevent the rain getting in. (4) An extraction shaft heated by gas, as in the case of the large sunlight burner in the dome of a theatre (fig. 111); or in connection with a furnace or a fan. This is a very satisfactory outlet.

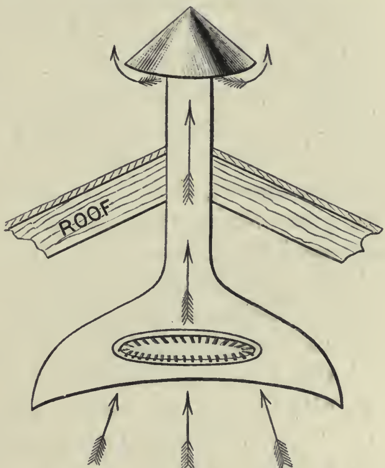


FIG. 111.—Ventilation by Sunlight Gas-burner.

The best inlets for such buildings are those supplying warm air, which should enter through iron gratings in the floor, and should be supplemented by window ventilators directing the air upwards (fig. 112).

Artificial systems of ventilation: mines: large buildings.—When ventilation is required on a large scale, as in mines, factories, and other large buildings, the cheapest and most effective process is that of extracting the air by means of a heat shaft or chimney. This is merely an extension of the principle on which the ordinary house chimney acts. In mines, for instance, the subterraneous passages are all connected with a tall chimney, in which a big fire is kept burning. The fire creates a great draught, and is so arranged that the air supplying it must be drawn from the mine. Another shaft descends into the mine to supply fresh air to take the place of that extracted, thus a constant and powerful current of air is maintained through every part of it. The chimney is called the upcast shaft, and the other the downcast shaft. Similar upcast shafts may be connected with any large building, and made to extract the foul air from the rooms through openings near the ceiling; fresh air being admitted by some of the special inlets described. Frequently the fire is made to do double duty, to warm the fresh air as well as to extract the foul air. Under these circumstances the warm air is admitted through iron gratings in the floor, as is usually the case in churches.

Ventilation by propulsion: ventilation of special buildings.—Another system employs force to propel air into a building instead of for the purpose of extracting it. Propulsion is effected by fans driven by machinery. It is a system which may be rendered very perfect, but is expensive. In the basement of St. George's Hall at Liverpool fresh air can be washed by passing it through an artificial rain, heated in cold weather, cooled in hot weather, moistened if too dry, and actually perfumed, before being propelled into any or every part of this magnificent building.

In the Houses of Parliament both propulsion and extraction are in use; the foul air being extracted by

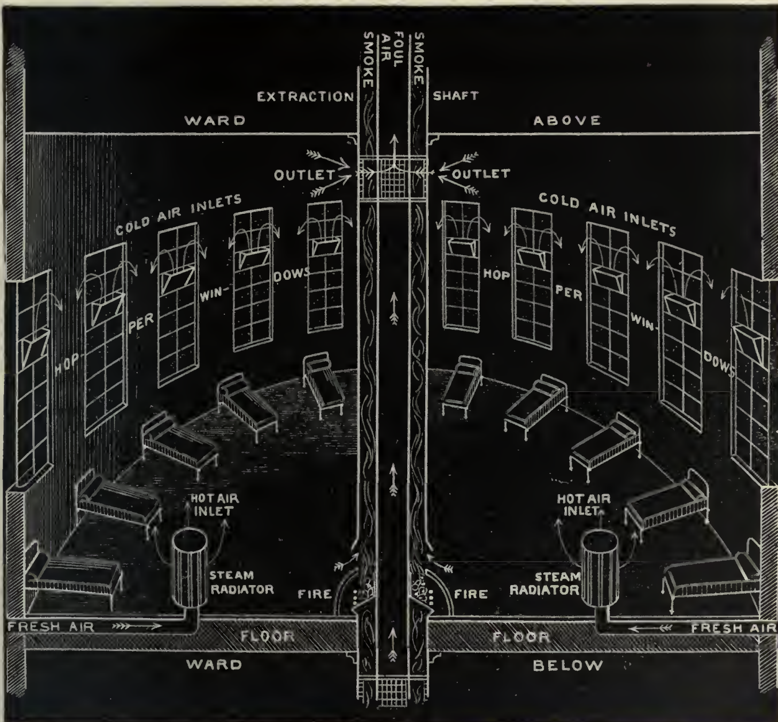


Fig. 112.—A Circular Ward in the Liverpool Royal Infirmary, showing extraction shaft heated by the ward fires, fresh warmed air entering through the steam radiators, and fresh cold air by the hopper windows.

heat, and duly warmed and prepared fresh air being driven in by fans. Fans are also sometimes used instead of heat in extraction shafts; but are not so effective as for propulsion.

In the Liverpool Royal Infirmary, admitted to be one of the most perfect hospitals in existence, the wards are ventilated by extraction shafts passing from basement to roof through the centre of each, and heated by the ward fires (fig. 112). Fresh warmed air is admitted through steam-heated radiators, and supplementary ventilation can be obtained by specially constructed windows (hopper), which admit air in an upward direction at a height of twelve feet from the floor. The sanitary blocks are entirely cut off from the wards by short passages, with cross ventilation from louvre windows on each side.

CHAPTER LXXV

HEATING: ASSOCIATION WITH VENTILATION — NATURAL SOURCES OF HEAT—INDOOR TEMPERATURE—ARTIFICIAL SOURCES OF HEAT

Heating: relation of heating and lighting to ventilation.—The artificial heating and lighting of dwellings are intimately associated with ventilation. It has already been mentioned several times that the chief products of combustion are the same, whether it occurs in a fire or in the body. A gas burner and a man each use up the oxygen and pollute the air of a room with carbonic acid; therefore each alike calls for ventilation. Another association is that we take advantage of the currents in the air produced by fires and lights for the purposes of ventilation. Hence, when we are discussing the merits of any particular stove or light, we do not consider its heating or lighting power alone, but also its bearing upon ventilation.

Natural sources of heat.—The natural source of bodily heat is the combustion of food. With proper and sufficient food and clothing man is capable of withstanding great cold without any assistance from artificial heat. Even in arctic explorations, men not previously acclimatised have borne the most intense cold, sleeping under a canvas tent, and with no fuel but a lamp to thaw their food. In such cases the bodily heat is of course entirely derived from the combustion of carbonaceous foods, especially fat, and is carefully economised by using the warmest woollen and fur-lined clothing. The direct rays of the sun are also a great natural source of heat, but one that is very unequal at various parts of the globe. The regions of extreme temperature are not favourable to the development of strong and energetic races; the tropics being enervating from excessive heat, and the arctic regions depressing from excessive cold and the prolonged absence of sunlight during the winter. Temperate climates produce the finest races, as they enjoy an invigorating temperature combined with sufficient sunlight.

Indoor temperature.—In the house it is almost more important to guard against heat than cold in the case of healthy people. 60° F. is regarded as the best temperature for a room. Overheated rooms tend to make people less vigorous; but a moderately low temperature unaccompanied by draught certainly does no harm. The very young and the very old are less able to withstand cold, and so are the sick, and to some extent those who lead sedentary lives. Young babies and old people often do best at a temperature of 70°, whilst that for invalids varies with the complaint. In febrile affections the room generally should be kept cool, about 55°; but during convalescence and in exhausting illnesses 60° to 65° is advisable. In bronchitis and similar chest affections a moist heat of 65° should be employed. For practical purposes it is sufficient to remember that, for the strong, the temperature indoors should not exceed 60°, and for the weak it should not be less than 60°.

Artificial sources of heat.—Heat is artificially obtained for dwellings from the combustion of various substances containing carbon and hydrogen. Carbon (C) is a solid substance with which we are familiar in the forms of charcoal, coke, and soot. It burns without flame, but yields a considerable amount of heat. Hydrogen (H) is a gas; one of the constituents of coal gas, and one of the elements of water. It is much more inflammable than carbon, and burns in flames only. The dull red heat in the middle of a fire is due to the combustion of carbon, whilst the flames on the top are derived from the combustion of the gaseous hydrogen compounds.

Combustion of hydrogen and carbon.—Combustion is a process of oxidation associated with the production of heat. It was explained in Chapter LXIX. The combustion of coal means that in place of the carbon and hydrogen of which it consists, we have heat and these substances combined with oxygen. The carbon, as we already know, forms carbonic acid gas, CO_2. It also unites in equal proportions with oxygen, forming carbonic oxide gas, CO, which is even more poisonous, but is produced in much less quantity. It does not occur in the breath at all. Hydrogen combines with oxygen, in the proportion of H_2O, which is water, therefore heat and water represent the combustion of hydrogen, as heat and CO_2 represent the combustion of carbon. The presence of moisture in a flame is very easily demonstrated by holding a cold tumbler over a lighted candle, when the moisture carried off in the hot air is at once condensed on the cold glass.

Light: products of combustion.—Pure hydrogen burns with a non-luminous flame, but yields a great heat. The bright light of the oxy-hydrogen or lime-light lamp is due to the intense heat of the flame producing a white incandescence of the cylinder of lime: the light being entirely derived from the heated lime and not at all from the flame. The reason that the flame of coal gas is luminous is that the hydrogen is not pure, but is combined with particles of carbon, which become similarly heated to incandescence, and are the cause of the light. The gases derived from combustible substances are always thus combined, therefore the flame is always luminous, and, what is of quite equal importance, the product of combustion is not simply H_2O, but also CO and CO_2. Thus, though pure hydrogen when burnt yields water only, the hydrogen gases derived from all kinds of fuel, coal, wood, oil &c. yield CO and CO_2 as well. When considering the impurities of the air derived from combustion, water, of course, may be dismissed; the CO, though very poisonous, is only small in quantity, and is merged in the larger amount of CO_2. Hence we come back to what has been previously stated, that heat and CO_2 are, for practical purposes, the essential products of combustion.

CHAPTER LXXVI

FUELS: COAL—COKE—PEAT—WOOD—CHARCOAL—COAL GAS AND MINERAL OIL

Fuels: coal.—Coal is the chief, because the cheapest and most efficient, source of artificial heat. It occurs in seams or strata at various depths in the earth, and originally consisted of vegetable matter, the fibres and seeds of which are often still recognisable under the microscope. The most important changes it has undergone whilst in the earth are the conversion of vegetable fibre and essences into mineral carbon and mineral oils.

Varieties of coal: cannel, anthracite, lignite.—There are many kinds of coal, distinguished chiefly by the amount of gas they give off in burning, or, in other words, by the amount of hydrogen they contain. Those kinds containing a large proportion of this gas are very inflammable, and burn brightly with plenty of flame. They are called bituminous coal, and yield paraffin when distilled at a low temperature, and coal gas at a high temperature. The well-known cannel is a kind of bituminous coal. When the percentage of hydrogen is very low, and the coal consists almost entirely of carbon, it is slow to burn, like coke, but gives out a good heat. This kind is called anthracite, and is chiefly used in boiler fires for making steam. Lignite, or brown coal, is a substance intermediate between coal and peat. It is not a good kind, and does not occur in large quantities in England.

Composition of fuels.—The following table gives the percentage composition of fuels, excluding the ash:[1]

Fuel	C	H	O & N
Wood	52	5	43
Peat	60	6	34
Lignite	67	5	28
Cannel	86	6	8
Anthracite	94	3	3
Charcoal and coke	100	0	0

The coal industry.—The coal industry is the most important trade of Great Britain, not only on account of the enormous number of people employed in it, but because almost every other trade is dependent upon the coal supply for the motive power which is necessary to carry it on.

[1] Modified from Roscoe.

Coke.—Coke is obtained from gasworks. It consists of the carbon and earthy impurities of coal after the gas and other volatile substances have been removed by distillation. It is not so easily ignited as coal, but when burnt in a proper stove yields a good amount of heat without flames or smoke.

Peat.—Peat is a useful fuel in thinly populated districts where the transport of coal is difficult and expensive. It is largely used by the peasantry in many parts of Ireland and Scotland. Peat is composed of vegetable matter, chiefly species of bog-moss, which has undergone slow changes towards the formation of coal. It is met with on the surface of land which at one time has been of the nature of a bog, and is prepared for fuel by simply cutting it in suitably sized pieces and stacking them till dry.

Wood.—Wood can only be available as a fuel in new or sparsely populated countries, though owing to its inflammability it is generally used to start the combustion of coal, or, as it is called, to light the fire. Fir wood is the most inflammable, and is the best for this purpose; but hard woods, like ash, are much to be preferred when wood is used as a fuel, as they burn quietly and yield more heat.

Charcoal: charcoal fumes.—Charcoal is prepared by burning wood with an insufficient supply of air, when the more inflammable hydrogen compounds are consumed and the carbon remains. It is very little used in this country as a fuel, as it is of course more expensive than wood, and much more so than coal. Its chief use is for the manufacture of gunpowder, and it is also a valuable purifying agent, as it has the power of absorbing bad smells. Charcoal bears to wood the same relation that coke bears to coal. It burns easily, with a bright-red glow, without flames or smoke, leaving a white, feathery ash. The fumes of charcoal have always been considered especially dangerous, not because they are more poisonous than those of coal, but because we are not warned of their presence by the irritating smell of smoke or sulphur.

Coal gas and mineral oil.—Gas has come into much more general use of late both for heating and cooking. It is very clean and convenient, but more expensive than coal. Paraffin stoves are often used in places where gas is not obtainable, chiefly for cooking purposes. The nature and preparation of gas and mineral oil will be described under the head of lighting.

CHAPTER LXXVII

SMOKE—COMMUNICATION OF HEAT—HEATING APPARATUS—OPEN GRATES—THE KITCHEN RANGE

Smoke.—Smoke is one of the worst nuisances of town life, especially in England. It is due to the incomplete combustion of carbon. When combustion is perfect the fumes are invisible; but if the air is insufficient, or the draught over the fire is too cooling, some of the carbon remains unburnt in the form of smoke. These different conditions of combustion may be very well seen in an ordinary oil lamp. If you light it with the wick at its usual level, the flame smokes until the chimney is put on. It also smokes after the chimney is on if you turn the wick too high. In the first instance the smoke is due to incomplete combustion on account of the cooling effect of the air, and in the last because there is not enough air in the chimney for the combustion of a larger flame than that for which the lamp is intended. In each case incomplete combustion is also proved by the smell of paraffin in the room. When the flame is of the right size, and combustion is perfect, there is neither smell nor smoke.

Smoke and soot produced in open grates.—In the same way, when coal is burnt in a closed stove with the draught properly regulated, combustion is complete, and no smoke is produced; but in an open grate the cooling effect of the air is such as to check the complete combustion of the carbon which is burning in the hydrogen flames, and thus smoke and soot are produced. Coke or cinder fires burn without flames, and consequently without smoke. Part of the smoke produced remains in the chimney in the form of soot, but a good deal escapes into the air, rendering it hazy or murky, and causing the moist, stagnant air of fogs to become exceedingly thick and irritating to the lungs. Fine particles of soot are always floating about in the air of towns, and are harmful in various ways. Smoke interferes with trade, with pleasure, and with health, so we ought all to do what we can to lessen this evil.

Communication of heat.—Heat is communicated to surrounding objects in three ways: (1) radiation, or the shooting out of rays of heat; (2) convection, or the carrying of heat, as by air which touches the hot substance and immediately rises, carrying heat with it; (3) conduction, or the transmission of heat along substances like the walls, which are in absolute contact with the fire (fig. 113). The third method has very little influence in heating rooms, and may therefore be dismissed without further consideration. The other two methods produce such different conditions that it is important to know how this is brought about.

Radiated heat passes through the air without heating it, therefore the walls, people, and furniture in a room are warmed without the air being heated. In convection, on the other hand, the air which carries the heat is necessarily hotter than anything else in the room. We are equally well warmed by either process; but the former warms us *without* warming the air, whilst the latter warms us *by* warming the air. Now, hot air is

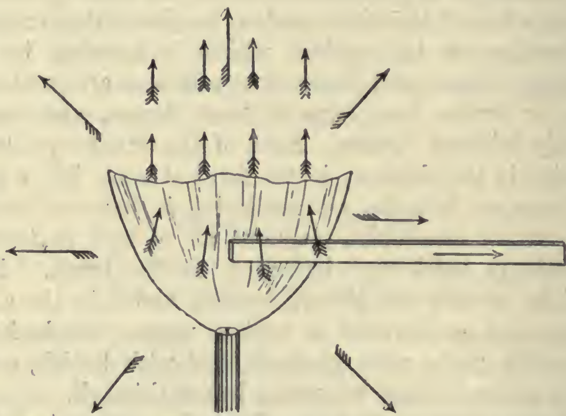


FIG. 113.—Diagram illustrating Communication of Heat.

The plain arrow indicates the *conduction* of heat along a bar of metal; the arrows feathered on one side the heat *radiated* or thrown out from the flame; and the arrows feathered on both sides the heat carried by the air which touches it (*convection*).

oppressive and drying, but cool air, if the body is warm, is pleasant and invigorating; therefore it is clear that radiated heat is more healthy than carried heat or hot air.

Most kinds of heating apparatus heat in both ways, some equally, others almost entirely by one or other. A closed stove, for example, heats equally by radiation and convection; an open grate almost entirely by radiation; and hot pipes almost entirely by convection.

Heating apparatus.—In estimating the value of the different heating apparatus we have to take into consideration: (1) the way they communicate heat to the room; (2) the assistance they afford to ventilation; (3) cost in fuel; (4) efficiency; (5) smoke.

Open grates: the most healthy.—An open grate is in England by far the most popular kind of fireplace. Its advantages are that it heats almost entirely by radiation, it is the best ventilator, and the most cheerful in appearance. Its disadvantages are that it is extravagant in fuel, it is inefficient for very large rooms, and it yields the most smoke. The advantages on the score of health are preponderant, smoke being the only hygienic defect. Public buildings are usually too large to be warmed by open grates, as radiated heat rapidly lessens in value at a distance from the fire; but for domestic purposes they are so obviously pleasant and healthy that, notwithstanding the smoke nuisance and extravagance in fuel, there is no likelihood of their falling into disuse.

In order to obtain the largest amount of heat the grates should be placed low, and covered as little as possible by projecting parts of the fireplace, which intercept the rays of heat.

The kitchen range.—The kitchen range is a form of open grate, to which there are attached, in addition to the ordinary big chimney, certain small chimneys called flues. The object of these is to conduct heat to the oven and the boiler. The nature of an oven flue is very well shown in fig. 114. It commences at the bottom of the fire (H), passes under and round the oven, and joins the main chimney at (O). When the oven is not required, the flue is closed by pushing in the damper (D). This cuts off the draught through the flue, and causes all the flames to pass up the main chimney. In a town house the boiler is placed at the back of the fire, not at the side, as shown in the figure. The flue for heating it passes directly underneath it, and then turns up to enter the

Fig. 114.—A Kitchen Grate and Oven, showing Flues and Damper.

main chimney about the same level as the oven flue. The flues are readily choked with either soot or cinders, and it is necessary to clean them out carefully, when the grate is cleaned, if they are to be efficient.

CHAPTER LXXVIII

HEATING APPARATUS: AMERICAN STOVES—SLOW COMBUSTION STOVES—GAS STOVES—HOT PIPES—HOT AIR

American stoves.—These well-known stoves heat both by radiation and convection. They are economical, burn any kind of fuel, have great heating power, give off very little smoke, are very convenient for cooking, and ventilate moderately well; but they render the air of a room hot and dry, and the red-hot iron allows some of the fumes of combustion, especially carbonic oxide, to pass into the room. Thus, with many advantages, there are a few serious drawbacks to the use of open stoves in houses. They are more economical, but certainly not so healthy as the open grate.

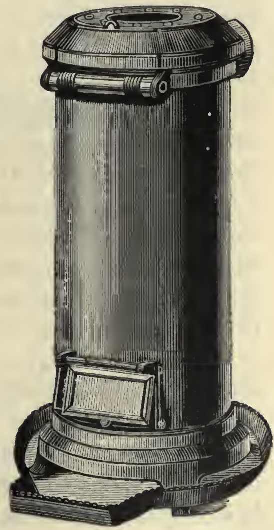


Fig. 115.—A Slow Combustion Stove.

Closed or slow combustion stoves.—These stoves are increasing in use, chiefly owing to their special economy in fuel, and the small amount of attention they require. Properly managed they never go out, if attended to twice daily. Like the last, they heat equally by radiation and convection, they are intended to burn coke, and are quite smokeless. They make the air hot and dry, but do not pollute it with the fumes of combustion, owing to an internal lining of fire clay. At the same time they are very little help to ventilation; therefore, in rooms heated with slow combustion stoves, special ventilating apparatus is always required. They are unsuitable for cooking. In houses, slow combustion stoves are excellent for warming halls and corridors, but are not so cheerful nor so healthy in the rooms as open grates (fig. 115).

Gas stoves.—If clay or asbestos balls are heated by gas in an open grate the effect is practically the same as that of a coal fire, except that the cost is very much more and no smoke is produced. This is, in fact, about the most expensive kind of heating apparatus. If gas is to be used at moderate cost for heating, it must be burnt in a stove projecting more or less into the room, when it will heat and dry the air as coal and coke stoves do. The majority of such stoves are poor ventilators; but some of the Fletcher's stoves and George's calorigen overcome this objection, as they supply fresh warmed air by means of an iron pipe passing through the stove from outside.

Gas for cooking.—Gas can be used much more economically for cooking than for heating. Its fumes do not flavour or smoke food, so a gas oven is heated by burning the gas in the oven, and thus there is no waste of heat. Moreover, it need not be lit until the moment it is required, and can be turned out the moment it is done with. Gas is becoming more and more popular for cooking.

In most gas stoves, whether used for cooking or heating, complete combustion is insured by mixing air with the gas before it is burnt. In this way a smokeless and non-luminous flame is produced (fig. 116).

Hot pipes.—Large rooms, extensive corridors, and public buildings of all kinds are commonly heated by means of hot pipes. Such pipes usually contain water, but they may be heated with steam. Low-pressure hot-water pipes are about four inches in diameter, and are always in a double row to allow of circulation. The diagram (fig. 117) illustrates the arrangement. The boiler is placed in the basement of the building, and is heated with a large fire. The main pipe, which is usually concealed under the floor, branches from the top of the boiler, and is carried to the furthest end of the building;

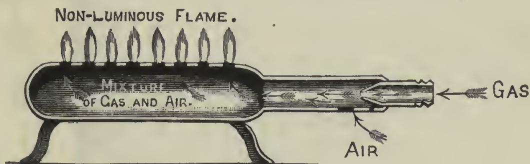


FIG. 116.—Fletcher's Smokeless Gas-burner.

it then returns underneath the other and re-enters the boiler at the bottom. Hot water being lighter than cold escapes through the pipe at the top, and, having given up its heat to the various rooms, returns cooled by the lower pipe; thus a constant circulation of water is going on in the main pipe. For every room or corridor that has to be warmed a coil or double row of pipes is brought up through the floor, one end of which is connected with the upper and the other with the lower main pipe, and in each branch of this kind a similar circulation is established. The heat of the pipes is controlled by a valve which can be opened and closed at will. A feed from the supply cistern enters the return pipe near the boiler,

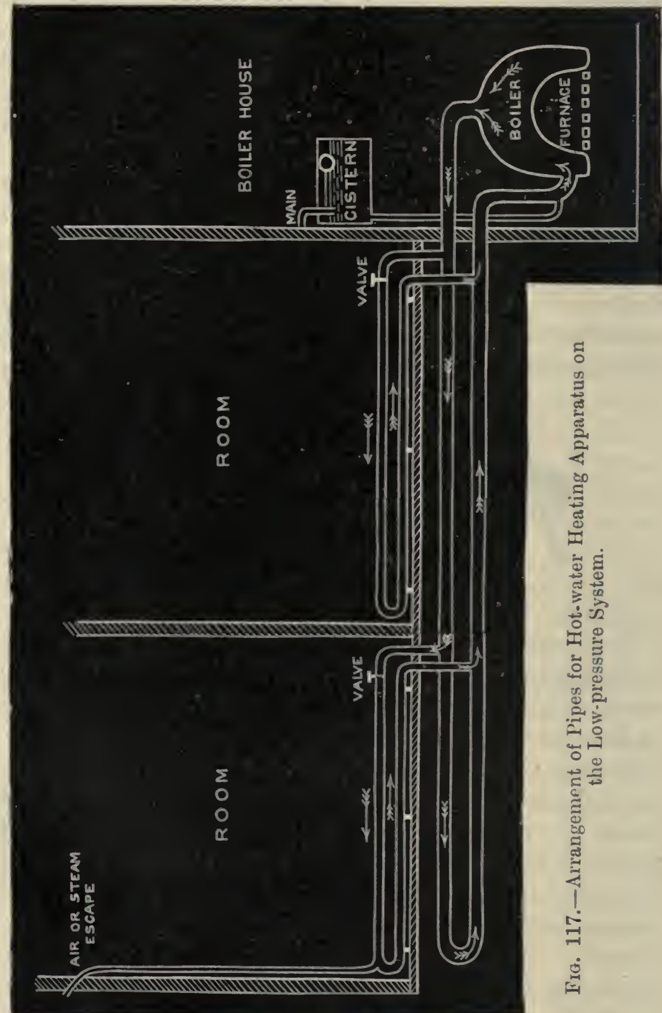


Fig. 117.—Arrangement of Pipes for Hot-water Heating Apparatus on the Low-pressure System.

and an escape for air is provided at the highest point of the system of pipes.

This is called the low-pressure system, to distinguish it from another form of heating apparatus in which the water is under high pressure, and can consequently be made much hotter. The latter requires very careful management, as a failure in circulation would at once result in explosion.

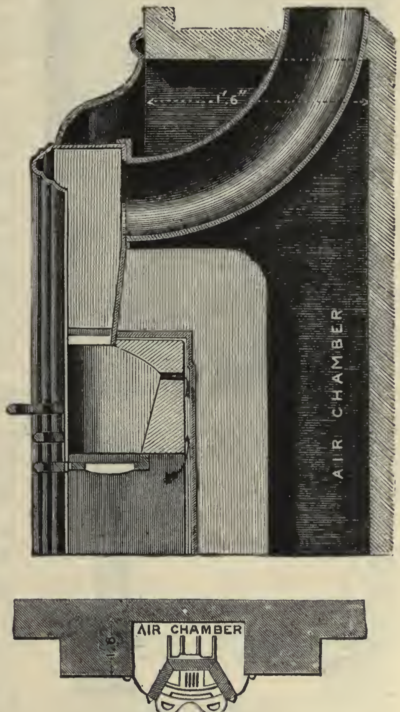


Fig. 118.—Section and Plan of Captain Galton's Grate.

Steam pipes. — Steam pipes are made much smaller than the preceding, but they are a very efficient form of heating apparatus. They require careful management, and it costs more to supply steam than hot water. No circulation is needed, the steam being led directly to the coils or radiators, as they are called, in the rooms.

Hot pipes heat almost entirely by convection, especially the ordinary low-pressure system; that is, they heat the air. Of course they do nothing for ventilation. Rooms heated entirely by hot pipes will always be rather oppressive, and will require special ventilating apparatus. Hot pipes are best as an adjunct to fires in rooms too large to be heated by the latter alone, and for corridors, churches, and other public buildings not regularly inhabited.

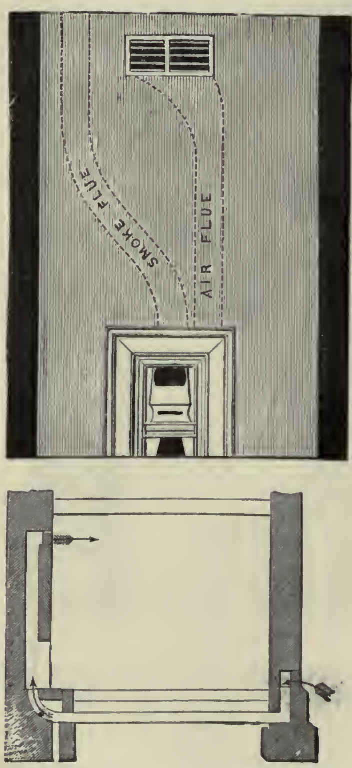


FIG. 119.—Elevation of Captain Galton's Grate, and Section of Room showing Air-duct and Flues.

Hot air.—Air driven by fans over hot pipes or bricks enters the room ready warmed, and is sometimes so supplied to public buildings. This plan insures efficient ventilation, but is too costly for general use.

An excellent stove has, however, been invented by Sir Douglas Galton, in which the fire which warms the room is also utilised to supply warm air (figs. 118 and 119). Stoves on this principle are employed at the Liverpool Royal Southern Hospital, and have been found to answer well, both for warming and ventilation; whilst at the Liverpool Royal Infirmary fresh-air pipes enter through the steam radiators and supply warmed air to the wards (fig. 112).

CHAPTER LXXIX

LIGHTING—CANDLES—FATS AND WAXES—COLZA AND MINERAL OILS—GAS—COAL TAR.

Lighting.—Artificial light is derived from two entirely different sources, combustion and electricity. In each instance the light is due to incandescence, the result of heat; but in the one case it is brought about by burning inflammable fats, oils, or gases, and in the other by interrupting a powerful current of electricity.

Candles.—Candles are a time-honoured source of artificial light. They consist of a cotton wick embedded in a cylindrical rod of tallow or other fat. Originally they were prepared by simply dipping the wick in melted tallow, the hard fat or suet of animals. The chief imperfections of these primitive 'dips' were feeble light, unpleasant smell, and the necessity for snuffing the wicks. The two former have been overcome by improving the burning quality of the fat, and the latter by plaiting the wick so that it curls to one side and consumes as the candle burns.

The materials now commonly used for the best candles are stearin and paraffin wax. Inferior candles are made of mixtures of these with other fats, whilst now as formerly the cheapest variety is the old-fashioned tallow dip.

Fats: purification of fat for candles.—Fat is a complex body. It consists of three chemically different fats, stearin, palmitin, and olein. They are usually met with together, but vary in relative quantity in the fats of different animals. Stearin is the hardest, and is the chief component of suet. Palmitin is softer, and occurs largely in beef fat. Olein is fluid, as in olive oil. Each of these consists of a fatty acid, stearic, palmitic, and oleic acid, in combination with glycerine ; just as carbonic and hydrochloric acids are in combination with soda in the carbonate and chloride of soda. The fatty acids burn well, but glycerine does not. Hence the first object of the candle manufacturer is to separate the glycerine. The next is to get rid of the oleic acid, because hard fat makes the best candles. The remaining mixture of purified stearic and palmitic acids is technically known as stearin, and is the substance used for the manufacture of stearin candles. The by-products of glycerine and oleic acid are of course valuable. The former is used in the arts, manufactures, and medicine, as well as forming one of the chief ingredients of nitro-glycerine or dynamite. The latter has a large demand as a lubricating oil.

Paraffin wax.—Paraffin wax is obtained from crude paraffin, one of the products of the distillation of bituminous coal ; and from petroleum, a natural mineral oil derived from wells in certain parts of America. When purified it is a hard, white, translucent wax, from which some of the very best candles are made.

Dips and moulds.—The old method of dipping has been almost entirely superseded by moulding. Stearin and paraffin candles are always made in moulds by machinery.

Wax candles.—Genuine wax candles are very costly. They are made of purified and bleached beeswax ; as they cannot be moulded they are dipped and rolled.

Sperm candles: the standard candle.—Sperm candles are made of spermaceti, a wax-like substance obtained from the sperm whale. The standard candle for comparing and estimating the value of various lights is a sperm candle burning 120 grains per hour. If a gas-burner is said to give a twenty-candle flame, it means that it gives twenty times as much light as this standard sperm candle.

Lamps: Colza oil.—The fuel used in lamps is necessarily fluid at the ordinary temperature, so that it may be readily taken up by the wick. Formerly colza or rapeseed oil was extensively used; but in the present day it has been almost entirely replaced by the mineral oils, paraffin and petroleum. Colza has the advantage of being quite safe; but is expensive, and requires a special kind of lamp. Owing to its somewhat viscid nature some mechanism is necessary for raising the oil to the level of the top of the wick, as in the Moderator and Queen's reading lamps, which are much dearer than equally serviceable lamps for paraffin.

Petroleum: paraffin.—Petroleum is imported from America. It is a mineral oil which is obtained from wells at certain parts, where it flows naturally from the rock. A similar fluid has been met with in some coal mines in England; but the English paraffin, a closely allied substance, is derived from bituminous coal, by distillation at a temperature lower than that used to obtain gas. The crude oil which distils over yields, when purified and re-distilled, four distinct products: (1) Naphtha; (2) Paraffin oil; (3) Lubricating oil; (4) Paraffin wax. Naphtha is very volatile and inflammable, and is unsafe for lamps. It consists of benzol compounds, and is chiefly used for dissolving substances like india-rubber, resin, and fat; and for cleaning things which will not bear washing, such as gloves and various dyed goods. The lubricating oil is a smooth, pure oil, suitable for machinery. The wax makes excellent candles, and the paraffin oil itself when thoroughly purified is the best illuminating oil. Not only is its use almost universal for household lamps, but it has gradually displaced the more expensive oils in such important institutions as lighthouses.

Gas: products of distillation of coal.—Coal gas is distilled from coal by heating it with fires in large iron retorts. Treated in this way it yields three varieties of product: (1) Solid: coke, which is the carbon residue of coal left in the retort. (2) Fluid: coal tar, which distils over and is received in tanks. (3) Gas, coal gas, which is collected in the gasometers.

Bituminous coal like cannel yields the most gas, but is the most expensive, and leaves a very poor residue of coke; so what is generally used is a mixture of ordinary coal and cannel. Anthracite makes good coke, but is otherwise useless for this purpose, as it contains so little gas.

Coke.—Coke has been described as a fuel; see page 277.

Coal tar.—Coal tar is a product of vast commercial importance. At one time it merely represented so much tar or pitch; but now owing to great triumphs of chemistry many substances identical, or almost identical, with the active medicinal principles and colouring matters of plants are extracted from it. Medicines and dyes obtained in this way yield excellent results, and are many of them very inexpensive when compared with the natural article.

The following are some of the more important substances derived from coal tar by proper chemical treatment: *Ammonia*, the source of all the commercial compounds of ammonia. *Naphtha*, including the benzol compounds. *Carbolic acid*, the important disinfectant. *Aniline*, and the host of valuable dyes obtained from it. *Creosote*, a disinfectant and preservative, largely used to preserve railway sleepers. *Lubricating oil*, for machinery.

Salicylic acid, *antipyrin*, *saccharine*, and many other medicinal substances; whilst *pitch* remains as a residue.

CHAPTER LXXX

COAL GAS—COMPOSITION—ILLUMINATING QUALITY—YIELD—STORAGE AND DISTRIBUTION—GAS POISONING—EXPLOSIONS

Coal gas—composition—illuminating quality.—Coal gas is not a single and distinct chemical compound. It consists of a mixture of whatever gases can be distilled from coal at a high temperature. These are: (1) Hydrogen, H; (2) Marsh gas, CH_4; (3) Olefiant gas, C_2H_4; (4) Carbonic oxide, CO. The last two form only a small proportion of the whole.

Hydrogen and marsh gas are both very inflammable, but of low illuminating power. Carbonic oxide is of no practical consequence; but olefiant gas, though small in quantity, is the chief source of light. The illuminating quality of a flame depends upon two features, heat and the presence of solid particles. The heat is chiefly supplied by H and CH_4, and the solid particles by C_2H_4.

The flame of a candle.—To understand this matter better, examine carefully the flame of a candle (fig. 120). It may be described as consisting of three parts or zones. (1) The central zone; the coolest part of the flame, and quite dark. This consists of unburnt gas volatilised by heat from the tallow or wax of which the candle is composed. It may be led off, as in the diagram, by a fine glass tube and ignited at the other end. (2) The intermediate zone, which is both hot and luminous. (3) The outer zone, which is the hottest, but again non-luminous. In both the outer zones the gas is in a state of combustion, and the reason that one is light and the other dark is because in one combustion is incomplete and in the other complete. In the light flame there are solid particles of carbon heated to incandescence, and in the hot dark flame these are burnt into CO_2. Heat alone produces no light; but if you heat a solid substance it gives out light. In the lime light the light is due to the intense white heat of the lime, and in the electric light to the incandescence of the carbon thread or points. In the flame of a candle or gas the hydrogen has the greatest attraction for oxygen, consequently it burns first, leaving the carbon scattered through the flame of the intermediate zone, in the form of a fine powder. In the outer zone, there is enough oxygen for both hydrogen and carbon, so both are burnt, and there are no solid particles to produce light. Thus the illuminating power of a flame depends upon the incandescence of minute solid particles of carbon suspended in the intermediate zone. The presence of these particles can be easily demonstrated by introducing a slip of cold glass into the flame, when it will at once be smoked, or in other words coated with these fine particles of carbon.

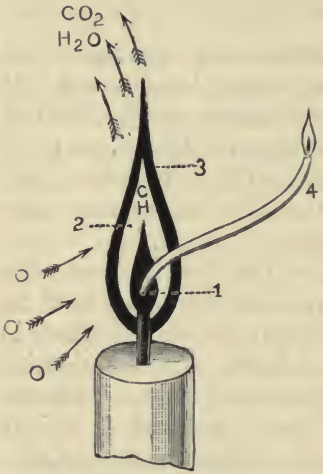


Fig. 120.—The Flame of a Candle.

1, the dark central area of unburnt gas, some of which is carried off by the tube and ignited at 4; 2, the luminous area; 3, the outer dark area. The arrows on the left side are intended to illustrate the oxygen of the air combining with the carbon and hydrogen in the flame to make the water and carbonic acid gas of combustion.

Importance of C_2H_4 in gas.—Coal gas is not nearly so rich in carbon as tallow, wax, or oil, consequently the excess present in olefiant gas (C_2H_4) is very important as the chief cause of its illuminating power. The more C_2H_4 the brighter the light, and as C_2H_4 is chiefly derived from bituminous coal, the more cannel the gas company use the better the gas yielded.

All fats and oils are rich in carbon, and burn with luminous and smoky flames. Alcohols have much less, and burn with very pale smokeless flames. Coal gas is intermediate; its flame is very hot and only slightly smoky; its light varying with the amount of olefiant gas, as already explained.

Non-luminous gas flame.—When coal gas is mixed with air before being burnt, as in the Fletcher's cooking burners (fig. 116), the flame is non-luminous; because combustion is complete throughout it, as there is enough oxygen for both hydrogen and carbon. This hot but non-luminous and smokeless flame is named after the great chemist Bunsen, who invented the original Bunsen's burners for producing it, and of which Fletcher's and similar burners are copies. Any kind of dust dropped into a Bunsen's flame will at once be heated to incandescence and for the moment render it luminous, thus showing still more clearly that the light of a flame depends upon the actual presence of minute solid particles in it.

Yield of gas per ton of coal.—Average coal yields 10,000 cubic feet of gas per ton, as well as 10 to 12 gallons of coal tar products, and over half a ton of coke. It is considered that if the consumer pays the value of a ton of coal for 6,000 feet of gas, the balance of 4,000 feet of gas with the coal tar and coke ought to yield an ample profit to the gas company. Thus if good coal costs eighteen shillings per ton, the price of gas ought to be three shillings per 1,000 feet.

Storage and distribution of gas.—Coal gas is collected in the immense gasometers which form so prominent a feature of all gas works. The pressure in these drives it through the pipes by which it is brought to our houses. In the streets it is conducted in large iron mains, from which smaller iron pipes bring it to the houses. Inside, the gas at once passes through the meter, an iron box containing a revolving drum which measures and records the number of cubic feet used. From the meter it is carried to the various rooms and corridors of the house, almost always by means of lead pipes, which are for the most part concealed in the walls and floor-spaces. The company are responsible for the safe delivery of the gas as far as the meter, but the householder is responsible for its distribution through the house, and must attend to the repairs required in his pipes and burners.

Water in the pipes.—Gas carries with it a certain amount of watery vapour, some of which, especially in cold weather, deposits in the pipes. Part of this water flows back to the meter, and in other places there are special dependent branches with a screw cap at the end to catch it. The presence of water in the pipes, or an excess of it in the meter, is indicated by 'bobbing.' If all the lights 'bob' the trouble is in the meter; and all that is required is to unscrew the opening which permits the excess of water to flow out of the front of the meter. If only certain lights 'bob,' look for a dependent pipe under the floor or in a corner of a passage below. The screw cap at the end shows its object. Gas pipes should be laid with a slight slope, so that water deposited in them drains back to the meter. It is only when this has not or cannot be done, that special dependent branches are required.

Poisoning by coal gas: explosions: escapes.—Coal gas has the misfortune to be both poisonous and explosive. Workmen have sometimes been suddenly overcome by a rush of gas from a large pipe, but this is fortunately very uncommon. Cases of poisoning by coal gas have generally been due to a slight escape in a sleeping apartment, when the great danger is that people gradually become unconscious without awakening from their sleep.

Gas explodes when mixed with a certain proportion of air. With less gas the mixture will not ignite, and with more it burns without explosion, as in the Bunsen flame. Its powerful smell renders the detection of the smallest escape certain. When a bad escape occurs, turn the gas off at the meter, and open the windows and door of the apartment. If the cause is not apparent, such as a tap turned on or a broken pipe, as soon as the air is pure again turn on at the meter, and carefully smell out the leak. Under no circumstances use a light when seeking for an escape of gas. One of the commonest causes of an escape, apart from the burner and its fittings, is an injury to the pipe due to knocking a nail into it as it lies concealed in the wall.

CHAPTER LXXXI

LAMPS AND BURNERS—PARAFFIN LAMPS—GAS LAMPS—ELECTRIC LIGHT—ARC LAMPS—INCANDESCENT LAMPS

Lamps and burners: characters of a good oil lamp.—The only popular oil lamps in the present day are those for burning paraffin oil. The chief requisites for such lamps are: (1) a suitable reservoir for the oil; (2) a good burner; (3) a chimney with a properly regulated draught; (4) a patent extinguisher. A globe and shade are ornamental and useful accessories.

The oil reservoir.—The reservoir for the oil is generally made of glass, china, or metal. The two former have an advantage over the latter in not heating the oil; but this is counterbalanced by the drawback that they are easily broken, and when an accident happens scatter the oil far and wide. The reservoir should not be too small, or it will need very frequent filling; it should hold not less than a pint for a duplex burner, and not less than half a pint for an ordinary single wick lamp. It should never be filled quite up to the top; nor be allowed to burn quite dry. If too full the oil may overflow and catch fire; and when burnt to the last drop, the smouldering wick may possibly ignite an explosive mixture of vapour and air in the hot lamp.

Burners: draught.—The ordinary burners are the single and duplex flat wicks, and the argand burner. The former are almost universally used, and are the simplest and safest. In the argand burner the wick is round, and air enters to supply the centre of the flame through a tube passing up from the bottom of the lamp. When the flame is spread by a flat disc of metal just above the wick this burner gives a very brilliant light. A properly regulated draught through the chimney is essential. This is maintained by the length of the chimney, and a correct inlet for air through the perforated metal below. An improper chimney checks complete combustion, and causes a smell of unburnt paraffin. In all good lamps this matter is carefully attended to by the manufacturers.

Patent extinguisher.—The patent extinguisher is a great element of safety. Most lamp accidents, not due to gross carelessness, have been caused either by turning a smouldering wick down into the hot oil chamber, or by blowing down the chimney, either of which may give rise to an explosion. When the lamp has no extinguisher, turn the wick down a quarter of an inch and wait: it will soon go out. Impatience is frequently the cause of danger.

Cause of smells: cause of danger.—Smells from paraffin lamps are due to (1) cheap, impure oil; (2) want of cleanliness; when the oil left about the lamp is volatilised into the room; (3) imperfect combustion; from turning the wick too high or too low, or having an imperfect chimney.

Danger is due to (1) carelessness and accidents; (2) cheap oil, from which the volatile naphtha compounds have not been removed; (3) over-filling; (4) any circumstance allowing a smouldering wick to drop into a

Fig. 121.—Fish-tail Burner.

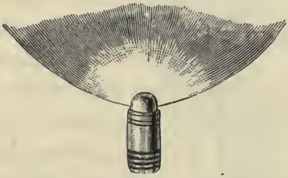


Fig. 122.—Batwing Burner.

hot reservoir; (5) any strong draught carrying the flame down the chimney, such as blowing down it, or quickly raising a lamp as in running upstairs with it, especially with a big flame.

Gas burners.—Gas burners are of various kinds: the common flat burner is called the fish-tail (fig. 121). In it the gas issues out of two small holes opposite to each other, which causes the flame to spread like a fish's tail. A larger burner of the same class is called the batwing (fig. 122), in which the gas issues from a narrow slit at the top. Both of these burn steadily without a chimney, and with a good pressure of gas.

The argand (fig. 123) is a circular burner, which allows air to pass up the centre of the flame. It requires a chimney, and only burns well with a low pressure of gas. The latter is attained either by having the tap at some distance from the burner, or by the use of a special gas-regulator.

The Bunsen's burner has already been described. It is used in most gas fires and cooking stoves (fig. 116). It gives out a very good heat, but no light.

Gas-regulator.—A gas-regulator is a simple contrivance for regulating the pressure of the gas throughout the house. It is attached to the main pipe after passing through the meter, and insures a steady flame with no waste of gas.

Fig. 123.
Argand Burner.

Gas lamps. — Gas lamps are more simple than oil lamps, and hardly require a special description. They are in the form of reading lamps, brackets, standards, and chandeliers. The latter hang from the ceiling, and are fixed to a strong iron gas pipe screwed to the rafter above. The tube of a chandelier has a ball-and-socket joint, which allows it to swing in all directions; and usually a draw-tube as well, which permits it to be raised or lowered. If gas escapes when it is drawn down, a little water should be poured into the top of the outer tube.

The healthiest gas lamps are those which discharge the foul air into the chimney or out of doors; but unfortunately these ventilating gas lamps are both clumsy and expensive, consequently they are very little used.

Electric lights: advantages.—Electricity is generally regarded as the future source of artificial light. The electric light possesses certain great advantages over illumination by coal gas, oil lamps or candles. (1) The light is more pure and brilliant; (2) its heating effect in rooms is inappreciable; (3) it neither consumes the oxygen nor pollutes the air; (4) it is absolutely free from smell, smoke, and chemical vapours. Thus it gives a better light without rendering the air impure, or affecting plants, or tarnishing decorations and ornaments. When the wires are properly laid, and all the machinery and apparatus are of modern construction and in good order, there is only one serious drawback, and that is cost. The electric light needs only to be cheapened to replace gas.

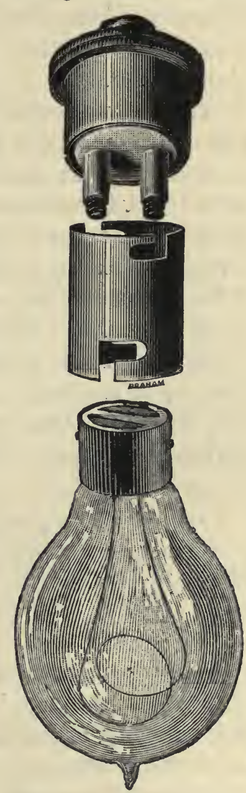


Fig. 124.—The Swan or Incandescent Electric Lamp.

Above are the metal fittings for connecting the lamp with the battery, and below is the glass globe with the delicate carbon thread suspended in vacuum.

Electric lamps.—The lamps at present in use are of two kinds: the arc lamp used in the streets, and the incandescent lamp used in houses. The former consists of two large carbon points inclosed in a glass globe, but exposed to the action of the air. A very powerful current of electricity is sent through these points which heats them to an intense whiteness, the cause of the brilliant light. The carbon points are slowly consumed, and herein lies the chief imperfection of the arc lamp. As they waste away it is necessary to bring them together again, and unless this is done with perfect regularity and steadiness, the light flickers and hisses. In the Brush form of arc lamp the mechanism is most effective. It is in general use when electricity is employed for outdoor illumination.

The incandescent lamp is quite a different thing (fig. 124). It consists of a delicate carbon thread suspended in a small glass globe from which all air has been removed and is excluded—a vacuum, in fact. When the current of electricity is sent through this thread it heats it to incandescence, but does not destroy it on account of the absence of air. The incandescent lamp invented by Swan is that which is in general use. It is made in sizes, from the tiny little globe giving only a one-candle light, up to larger globes of several hundred candle-power. The arc lamp gives a still more intense light, a large one having the power of 1,000 candles.

CHAPTER LXXXII

WATER SUPPLY—NATURAL SOURCES OF WATER—CHARACTERS OF WATER SUITABLE FOR DRINKING AND OTHER DOMESTIC PURPOSES

Water supply: relation to health.—It is hardly possible to over-estimate the importance of a plentiful supply of pure water for domestic purposes, especially in large towns. In beautiful summer weather, when health ought to be at its best, the death-rate invariably rises with a long drought, even although the town supply is fairly good. When we remember that the streets, houses, drains, even the air of towns, as well as our bodies and clothes, all require constant washing, the supply cannot very well be too large. A downpour of rain cleanses the air, housetops, streets, and sewers, in a way that cannot possibly be equalled by artificial means; but when rain is absent, it is so much the more necessary to use water with a free hand for every cleansing purpose to which it can be applied.

Domestic uses of water.—Twenty-five gallons of water per head daily seems a large amount to supply for domestic purposes; but when the work that it has to do is considered, it is not found to be too much. Water is required for drinking, for washing and bathing, for cooking and washing up, for scrubbing and cleaning the house, for washing clothes, for the lavatory, for keeping the house-drains clean, and for putting out fires. The supply should never be stinted, for economy in water means imperfect cleanliness in person, house, or drains, and this sooner or later ends in disease.

Qualities of water for domestic purposes.—Natural water varies greatly in its suitability for domestic purposes. Its source, and the way in which it has been stored and distributed, must be taken into consideration, as well as the qualities which render it appropriate for drinking and washing. Drinking-water must be perfectly free from all organic impurities, but is improved in quality by the presence of small quantities of mineral salts, such as carbonates and sulphates of lime and magnesia. Washing-water, on the other hand, cannot be too free from the hardness caused by saline substances, whilst a little organic impurity is of no consequence.

Natural sources of water: rain and surface water.—The water of springs, rivers, lakes, ponds and ditches, is derived from rain. As the rain falls from the clouds it is perfectly pure, but even before it reaches the earth it takes up from the air gases, dust, germs, and various small seeds. When collected in the ordinary way as it runs from the housetops, rain-water soon becomes full of microscopic life, both animal and vegetable. This is, of course, organic matter, and therefore, unless caught perfectly fresh from the clouds, rain is unsuitable for drinking-water. Rain which falls on the ground partly runs off the surface into streams, rivers, ditches, ponds and lakes, and partly soaks into the earth to form the springs which supply wells, and the source of some rivers and lakes. The surface-water picks up organic matter, and if it rests long in one place, as is the case in ponds and ditches, it soon becomes full of animal and vegetable life. If, however, it rushes down a mountain side into a rapid river or deep lake, the proportion of organic matter is but small, and as it consists chiefly of little dead portions of plants, it is easily removed by filtration. Surface-water contains but very little saline matter.

Spring and shallow well water.—Water which soaks into the ground loses by a natural process of filtration the solid particles which it may have picked up on the surface; but it dissolves out of the earth various saline substances, such as lime, magnesia, soda, iron, &c., and carbonic acid gas. Hence spring water is hard, especially in limestone districts, but it is pleasant and refreshing to drink, and is quite free from organic matter. If the earth through which the water soaks contains any decomposing substances such as sewage or manure, of course some of these will be dissolved, and will pollute the spring. Now the ground about houses and towns is never fresh and pure, so that shallow wells sunk in such neighbourhoods invariably tap impure springs, and afford the most dangerous kind of drinking-water. The impurities do not penetrate very deeply into the earth, so that deep wells are free from this most dangerous kind of organic matter, and even in the heart of London the deep artesian wells supply perfectly wholesome drinking-water.

Distilled water.—Distilled water is chemically pure. In ships the drinking-water is frequently distilled from sea water, but it is not much relished, as chemically pure water is insipid to the taste. Pure water has another disadvantage especially important to towns-people: it dissolves lead and other metals from the pipes used to distribute it, whereas spring water containing salines scarcely acts on the pipes at all.

Drinking and washing waters.—There are, then, many points to be considered in selecting water for domestic purposes. First, drinking-water should be free from organic matter, especially that kind dissolved out of foul earth, but it should contain a little saline matter. Therefore, it should be drawn from deep wells or springs in pure ground, or it should be taken from unpolluted rapid rivers and deep lakes, and subsequently filtered. Drinking-water should not be taken from shallow wells, nor from ponds, ditches, or other stagnant surface-water, nor from stored rain water. Second, washing-water should be soft; that is, should not contain salines, especially lime. Rain-water, therefore, answers the purpose very well, so does river and lake water from any but limestone districts. Deep spring and well water is generally too hard. In towns the rain water is neither clean enough nor sufficient for washing purposes, therefore the town supply must be, if possible, not only wholesome for drinking, but suitable for washing. Such water is practically only to be obtained from pure rivers and lakes, and these are the sources which are usually selected for the supply of large towns.

The following table, given by the Rivers Pollution

Commissioners, presents in a concise form a classification of the natural sources of drinking-water :

Wholesome	(1) Spring water	Very palatable
	(2) Deep well water	
	(3) Upland surface-water	Moderately palatable
Suspicious	(4) Stored rain-water	
	(5) Surface-water from cultivated land	Palatable
Dangerous	(6) River water to which sewage gains access	
	(7) Shallow well water	

An important point to notice in the table is that taste is no sure guide, for dangerous waters may be quite palatable. By upland surface-water, mountain streams and lakes are meant.

CHAPTER LXXXIII

STORAGE AND DISTRIBUTION OF WATER—CISTERNS—DISTRIBUTION PIPES—DISEASES DUE TO IMPURE WATER

Storage and distribution of water.—Water is collected and stored for towns in large reservoirs or lakes, where any sediment it may contain is deposited. If necessary it is passed through filter beds composed of fine gravel to render it perfectly bright and clear. It is then pumped up to a height sufficient to distribute it to all parts of the town and to the highest rooms of the houses. The distribution is conducted by means of large iron water-mains in the streets, and small lead pipes in the houses. The supply may be either continuous or intermittent; the former is, of course, much the better, as fresh water can then be drawn at all times from the main taps. The latter involves large house-cisterns, which are filled when the water is on, and have to supply the house during the time that is cut off.

Cisterns: material cleaning.—Cisterns are one of the sources of danger to drinking-water. It is important that they should be made of the proper materials, and that they should be kept clean. Slate is the best material for large cisterns, and glazed stoneware for small ones; but galvanised iron is generally used in the cheaper class of houses. The drawback to the latter is that water slowly acts on the zinc with which the iron is coated, and dissolves it; but the quantity dissolved is too small to do much harm. Lead is the worst material. Some kinds of water, especially the purest, dissolve lead, and even a very small quantity of lead constantly present in drinking-water causes lead-poisoning. The cistern is placed at the top of the house, often unfortunately in a position difficult to get at for the purpose of cleaning it out. People are strangely careless about cleaning the cistern. Those who would not drink out of a soiled glass will sometimes leave the cistern uncleaned for years. Yet dust and dirt collect in it freely, and actually such abominations as old boots and dead cats have been found there. The main tap ought to be turned off, the water run off, and the cistern cleaned once a month, or at the least once in three months.

Pipes connected with the cistern.—The pipes connected with the cistern (fig. 125) are: (1) the supply pipe from the main (not shown in the diagram), which enters at the top; (2) the overflow pipe, which passes out from the top through the outside wall of the house; (3) the distribution pipe, which leaves from the bottom, and is distributed to those parts of the house supplied by the cistern. The supply pipe is guarded by a self-acting tap called a ball tap. This is merely a form of tap, the handle of which is connected with a hollow metal ball floating on the top of the water. When the water falls the ball descends and opens the tap, and as the cistern fills again it rises and gradually shuts it off. The overflow pipe is very rarely put to any use, but is necessary in case the ball tap should at any time fail to act properly. The important point in connection with it is to make sure that it does

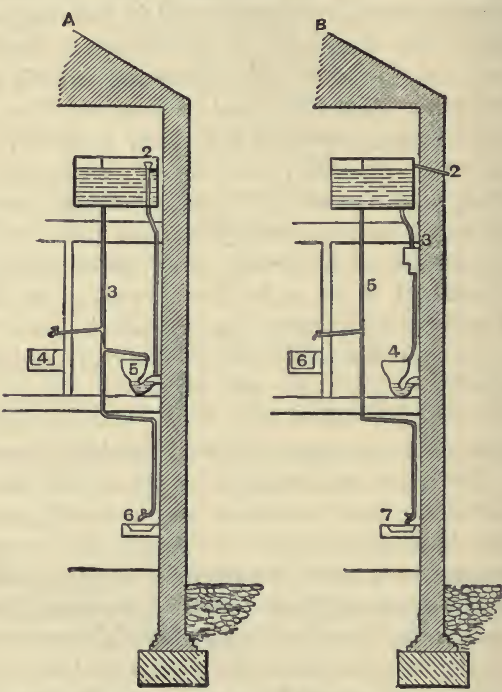


Fig. 125.—A. Insanitary System of Cistern Accommodation.
1, the cistern; 2, the overflow pipe entering the waste pipe of the lavatory; 3, the distribution pipe supplying the whole house *including* the lavatory.

B. The Defects remedied.
The overflow pipe (2) discharges outside; the distribution pipe (5) supplies all the house *except* the lavatory, which has a separate cistern to itself (3).

not discharge into a waste pipe going down to the sewer. No kind of waste pipe should have even the most remote communication with drinking-water, and yet in old houses the overflow pipe of the cistern frequently entered the discharge pipe of the lavatory. In such cases the foul sewer gas is carried by this pipe directly into contact with the drinking-water. The distribution pipe may supply the kitchens, bedrooms, bath, and every part of the house except the lavatory. That should always have a separate cistern, though it is a much less serious fault to supply the lavatory from the drinking cistern than it is to open up a communication between the latter and the sewer by means of the empty overflow pipe.

The distribution pipes.—The distribution pipes in the house are nearly always made of lead. Water remaining in them is liable to act upon the metal as it does in a lead cistern, but it takes no harm from merely running through them. For this reason the tap should be turned a few minutes before drinking-water is drawn: it is then both fresher and more wholesome. There is always a stopcock in the main pipe where it enters the house, in order that in case of accident the water may be cut off in a moment, a matter that is frequently urgent in frosty weather, when the pipes are liable to burst.

Diseases due to impure water.—The water of ponds and ditches does not, as a rule, do any harm, unless sewage or some equally impure matter finds access to it. But occasionally there may be present in such water the eggs of some intestinal parasite, which would if swallowed develop in the human alimentary canal. The most dangerous water is that which is contaminated by sewage, as river and shallow well water frequently is. Such water may contain the germs or seeds of certain diseases, such as typhoid, diphtheria, dysentery, cholera, ague, yellow fever, and some others. Perfect cleanliness, and a perfectly pure water-supply, ought to be able to stamp out this class of diseases.

Very hard water is not wholesome. After prolonged use it is liable to cause indigestion, and sometimes more serious illnesses.

Some natural waters are impregnated with an unusual quantity of mineral salts. They are called mineral waters, and are used in the treatment of disease. The waters of Buxton, Harrogate, Bath, Ems, Vichy &c. are of this nature.

Lead-poisoning.—Pure water like distilled or rain water is capable of dissolving a small quantity of lead from cisterns or pipes made of that metal, and this power is increased if the water contains organic matters and such salines as nitrates or chlorides. The presence of carbonates and sulphates, on the other hand, renders the water quite incapable of dissolving lead. It is, therefore, always dangerous to allow any kind of drinking-water, except spring water, to remain in contact with lead in either cistern or pipes. Spring water nearly always contains enough carbonates or sulphates to prevent it from acting on lead.

CHAPTER LXXXIV

PURIFICATION OF WATER—FILTRATION—BOILING—DISINFECTION—DISTILLATION—SOFTENING OF HARD WATER

Purification of water: characters of pure drinking-water.—Drinking-water should be perfectly clear, free from odour or taste, cool, aërated, and not too hard; but it sometimes happens that people have to drink what they can get, when a knowledge of how to purify foul water proves very valuable.

Filtration.—Unwholesome waters may for practical purposes be divided into those which are contaminated with sewage or other decomposing matters, and those which are not. The latter class includes the ordinary surface-water of ponds, ditches, streams, &c., the impurities of which can be removed by a *carbon filter*. Carbon filters off all the little particles of vegetable matter suspended in such water, as well as the eggs and animalcules which inhabit it. It even does more than this: when the carbon is fresh it has a purifying effect, helping to remove any stale or unpleasant odour. But it must be remembered that the carbon filter does not remove the soluble products of decomposition, nor the germs of disease, and is therefore quite useless for the really dangerous kinds of water. The carbon block becomes impure with use, and should be frequently renewed or purified.

Boiling: disinfection: distillation.—Water which is suspicious, but which has no unpleasant taste or smell, should be thoroughly *boiled* for ten minutes and filtered. Such water is frequently met with at seaside places and country villages, where worn-out townspeople go to renew their health, and sometimes fall an easy prey to typhoid fever. The water of shallow wells is always suspicious, and should be boiled, especially for children. Thorough boiling kills the disease germs, but of course does not remove the soluble products of decomposition. Fortunately in a civilised country we are not likely to be placed in circumstances in which it is necessary to drink water which is actually foul, though our countrymen as soldiers and travellers abroad are exposed to such conditions. It is then a matter of life and death to know how to deal with it. First, the water is purified by adding *Condy's fluid* to it until a slight pink tinge is retained. When Condy's fluid is not available, the next best thing is fresh *coke* or *charcoal*. The water is then well boiled and subsequently filtered. Under this treatment, unless very foul, it will be rendered wholesome. When very bad indeed after the use of Condy's fluid or coke, it must be *distilled*, for which, of course, a special apparatus such as they have on ships is necessary. In some places even in England rain water is the only drinking-water available. If it becomes foul in the summer, it should be treated with Condy's fluid, boiled and filtered.

Softening of water: Clark's process.—Hardness in water generally depends upon the presence of carbonates or sulphates of lime or magnesia, lime being the usual mineral. When sulphate of lime (gypsum) is present in marked excess, the water is not fit for domestic purposes; as, though it is improved for washing by the addition of a little soda, it cannot be softened on a large scale, and is not a good water for drinking purposes. Water, however, containing much gypsum is not very common. Sulphate of magnesia in excess acts on the bowels. Water containing much of it would be a mineral water like that at the Epsom wells.

Carbonate of lime (chalk) is the common cause of hardness, and is fortunately much more easily dealt with. Chalk only dissolves in water which contains carbonic acid gas, consequently any process which removes this gas from the water throws down the chalk as a fine sediment. Boiling will do it: the heat drives off the gas, and the chalk deposits as a fine white powder. But boiling cannot be used on a large scale, so when town water is too hard it is softened by Clark's process. This consists in adding lime to the water, certainly at first sight a strange way of getting rid of carbonate of lime. It acts in this way. The lime combines with the carbonic acid gas to make more chalk, but as there is now no gas left in the water, *all* the chalk falls to the bottom as a sediment. This process ought to be employed for softening the hard water derived from all the limestone districts like Derbyshire.

CHAPTER LXXXV

HOT-WATER APPARATUS—A DANGEROUS APPARATUS—THE WORM BOILER APPARATUS—THE RESERVOIR APPARATUS

Hot-water apparatus.—Almost every modern house is supplied with hot as well as with cold water. Hot water in the bath-room and bedrooms in addition to the kitchen is not only a great convenience, but an encouragement in habits of cleanliness. We read, however, occasionally of kitchen boilers exploding with disastrous results, and it is therefore only right that everybody should know something of the various apparatus used for this purpose.

Three kinds of apparatus.—They may be divided into three kinds. All others are simply modifications of one or other of the plans to be described. First, there is the cheap and dangerous apparatus (fig. 126) often to be met with in cottage-houses at low rental. Second, the safe but not very efficient worm boiler system, now practically gone out of fashion, but still to be found in a great many first-class houses. Third, the reservoir apparatus, very efficient, and very rarely a source of danger. This is the best kind at present in use. With proper knowledge every kind is safe; but even with complete ignorance of their construction an accident can only happen to the second and third varieties under most unusual circumstances.

Bearing in mind what has been said on p. 285 in reference to the circulation of water in all properly constructed hot-water apparatus, it will be easy to understand the working of these systems by studying the annexed diagrams.

A dangerous hot-water apparatus.—Fig. 126 illustrates the first variety. It consists of a feed or supply cistern at the top of the house; a plain boiler at the back of the kitchen fire; a cold feed-pipe from the cistern, entering the bottom of the boiler; and a hot supply pipe, leaving at the top of the boiler, and supplying the sink, bath, bedrooms, &c., and ending in an open escape-pipe over the top of the cistern. This is a simple and effective apparatus, and is quite safe whilst every part is in working order; but should the cold supply fail, or the pipes become blocked with frost, danger is at once introduced.

Fig. 126.—A Dangerous Hot-water Apparatus.

A common cause of accident is when both pipes become frozen during the night, at X and X, where they are near the roof and exposed to the cold. When the fire is lit and the water boils, there is now no escape by either pipe, consequently as the pressure of steam increases an explosion is inevitable. In other cases the cold feed to the cistern alone is blocked, or the cistern

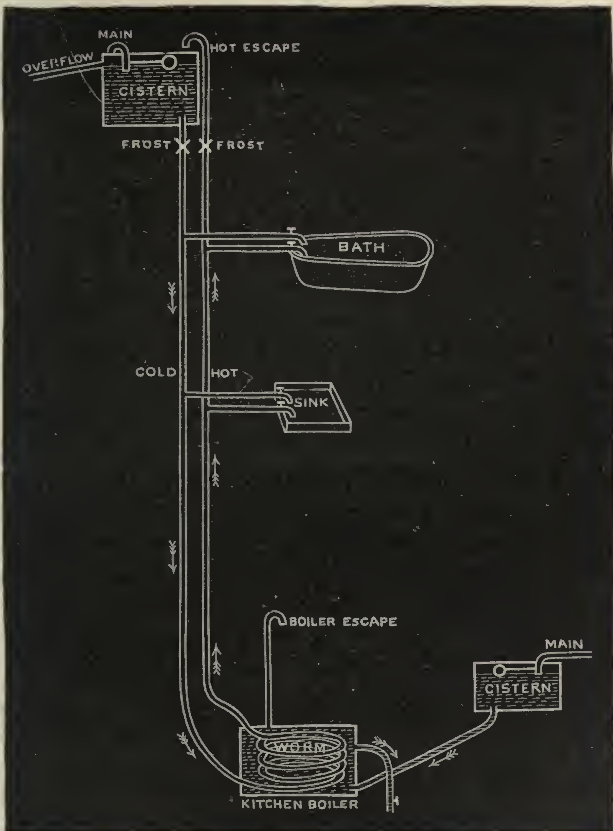


Fig. 127.—The Worm Boiler Hot-water Apparatus.

for some reason is empty. In course of time the water in the boiler boils away, and the latter becomes red-hot.

If, now, the cold supply is renewed, the water rushing into a red-hot boiler is suddenly converted into steam, and results in a violent explosion.

In this class of apparatus, whenever the water does not run properly from the taps the kitchen fire should at once be put out, and a tap should be left open by which steam can escape in case both pipes are blocked with ice.

The worm boiler apparatus.—Fig. 127 shows the details of the worm boiler apparatus. It really consists of a double system. First, the boiler with its small feed-cistern near it in the kitchen, and its hot supply and escape pipes. Second, the larger feed-cistern at the top of the house, with its cold feed-pipe to the worm which is contained within the boiler, and the hot supply pipe from the worm to the house, generally ending in an escape pipe above the cistern which is not necessary, as the water in the worm tube never boils. The worm is heated by the hot water in the boiler, but the water in one set of pipes does not anywhere communicate with that in the other set. This arrangement is perfectly safe whilst there is water in the little feed-cistern to the boiler, and as this is in sight in the kitchen, it would be noticed at once if the main failed to supply it. Of course it is too near the kitchen fire to be affected by frost. If the pipes belonging to the worm system are frozen, the kitchen fire need not be put out, as the worm is only heated by water, which heat is not sufficient for an explosion. All that is necessary is to see that the small cistern referred to does not get empty. The drawback to this apparatus is that the worm rapidly cools when the hot water is run, so that only a few gallons can be obtained at once, though in ten minutes it is as hot as ever again. It should be observed that the hot supply to the kitchen is drawn from the boiler itself, and not from the worm system; thus if much hot water is drawn

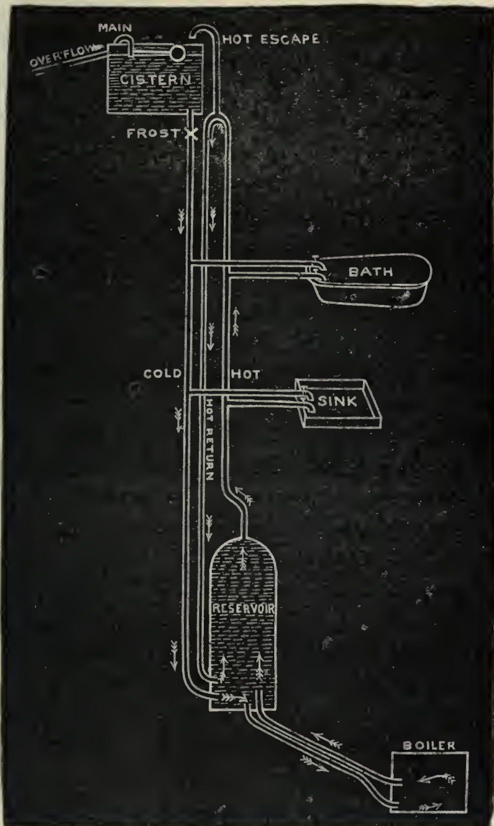


FIG. 128.—The Reservoir Hot-water Apparatus.

in the kitchen, the entire supply to the house is cooled down.

The reservoir apparatus.—Fig. 128 illustrates the more modern apparatus. It is perhaps a little more dangerous than that just described, but then it is very much more effective. If constructed as in the diagram, the water runs hot as soon as the taps are turned, and a large quantity can be drawn at once. In this apparatus a copper reservoir is introduced between the cold feed and the hot supply, in which the water is heated by circulation between it and the boiler. If the arrows are followed from the cold feed cistern onwards, the whole of this somewhat complicated circulation will readily be understood. The hot return pipe is sometimes omitted. Its object is to maintain a circulation in the hot supply pipes, which causes the water to run hot directly the tap is turned, and makes it almost impossible for the hot escape pipe to become blocked with ice.

The element of danger lies in the possibility of both supply and escape pipes becoming frozen, and then the water in the reservoir being brought to a rapid boil without thawing the ice in the hot escape: an almost impossible thing with circulating hot water so near it. Should the pipes become frozen, the boiler would take weeks to boil dry, as the reservoir cannot be emptied by means of the taps. Still, when the cold supply is cut off, the water in the reservoir soon begins to boil unpleasantly hard, and whilst the pipes remain blocked it is best to keep the fire small, or to place an iron plate at the back of it to shield the boiler from some of its heat.

CHAPTER LXXXVI

WASTE MATTERS—THEIR REMOVAL IN THE COUNTRY AND IN TOWN—THE CONSERVANCY AND WATER-CARRIAGE SYSTEMS

Waste matters.—The waste matters of an ordinary town house are as follows: (1) *Coarse waste*: ashes, sweepings, food remains, &c. (2) *Kitchen sink*: dish washings, of which fat is the most troublesome product. (3) *Bath waste*. (4) *Rain water*. (5) *Lavatory and bedroom slops*.

Of these, all except ashes, rain and bath water, contain a quantity of organic matter either in a state of decomposition or ready to decompose. If allowed to remain in the house for any length of time they would pollute the air, and encourage the spread of the worst kinds of fever. It is therefore of great importance to health that they should be quickly and thoroughly removed, and so disposed of as not to affect the healthiness of other districts.

Disposal of refuse in the country and the town.—In the country this is not a difficult matter, for fresh earth is the natural purifying agent of decomposing organic substances. When the house refuse is thrown on the garden or fields the soil is thereby rendered richer and better, and the vegetables or farm produce grown on it are perfectly pure and wholesome. Not only is the organic matter of sewage thus purified and utilised by nature, but the foulest water, after it has percolated through a considerable layer of *fresh* earth, runs away clear and sweet again. The abundant fresh air of the country, too, renders harmless manure heaps, refuse heaps, and other abominations which would breed disease in towns. Whilst therefore the removal and disposal of waste matters in the country ought to be accomplished without danger or difficulty, in towns the problem is the most serious one with which the guardians of the public health have to deal. Waste matters cannot be thrown into the streets. Even rain water unable to soak through the pavements would flood the lower parts of the town with every storm, if there were not efficient artificial means for carrying it away. Similar efficient means must be provided for the removal of every class of waste matter, in order that no accumulation of such products may be permitted to take place to endanger the public health.

Two systems: conservancy and water-carriage.—Now there are only two feasible methods of removing refuse. One is to cart it away, and the other to drain it away by means of sewers. The former is a laborious and expensive plan, and is consequently only employed for removing refuse which is too solid to be carried off by the sewers, such as the contents of ash-pits, street sweepings, &c. The latter is rapid, effective, and much the cheaper method, and is therefore employed for the removal of every kind of waste matter which is sufficiently fluid. The former is called the hand labour or conservancy system; the latter the water-carriage system. Conservancy systems have the advantage of removing the waste matters in a form in which they can be used as manure for the crops; but the expense is heavy, and the refuse is allowed to accumulate from day to day, or for weeks, or even months. The water-carriage system removes the waste matters immediately, and is the cheapest system, but is not free from dangers to health. Moreover, sewage is practically useless as a manure, and is difficult to dispose of except in towns with a suitable fall for drainage, and a large estuary or the sea to drain into. The advantages of the conservancy system are that: (1) all kinds of refuse can be removed in carts; (2) the refuse is in a form useful for manure. The disadvantages are: (1) very heavy cost; (2) the refuse is allowed to accumulate before removal.

The advantages of the water-carriage system are; (1) drains must be built, whether used for sewage or not, to carry off the rain water; (2) it is very much cheaper;

(3) it removes the refuse at once. The disadvantages are: (1) coarse refuse cannot be carried by water; (2) the difficulty of satisfactorily disposing of the sewage; (3) the dangers of sewer gas.

Economy.—Undoubtedly the best plan, if it were possible, would be to remove in carts all refuse solid or liquid, which was suitable for manure, and dispose of it on the neighbouring farms; using the drains for such waste water only as would not pollute a stream. But this is simply impossible, on account of the enormous labour and great cost involved in such a plan. Economic reasons render it absolutely necessary in all large towns to utilise the drains, not only for fluid refuse, but for every kind of refuse which can be carried by water, and so to limit the employment of hand labour as much as possible.

CHAPTER LXXXVII

CONSERVANCY SYSTEM — ASH-PITS, CESSPOOLS, EARTH CLOSETS—WATER-CARRIAGE SYSTEM—VENTILATION AND TRAPPING OF DRAINS

Conservancy system: ash-pits.—Ash-pits are usually constructed of brick. They should be well cemented inside and at the bottom. Food refuse and ashes are the two chief waste matters for which they are required, and fortunately the latter possess the purifying and deodorising qualities of coke and charcoal. The effect of ashes in arresting decomposition and checking foul odours is observed when the food refuse is stored separately in tubs for pigs. Notwithstanding that the tubs are emptied daily, they invariably acquire a foul smell, and are not fit to be near a human residence; whilst a carefully tended ash-pit rarely smells at all.

Management of ash-pit: Richardson's ash-pit.—The ash-pit should if possible stand quite clear of the house. It should be emptied at least once a week, and should be kept dry, as wet ashes have very little power to arrest decomposition. Under no circumstances should bedroom slops be thrown into the ash-pit. In reference to this matter, Dr. B. W. Richardson has made an excellent suggestion: namely, that the ordinary ash-pit should be removed, and in its place should be built a wall in which are some large pigeon-holes containing galvanised iron buckets. The refuse is put into the buckets, and when the dustman comes he has simply to carry them to his cart and replace them empty; a great saving in labour, and a great gain in cleanliness.

Ash-pits are an absolute necessity, as the refuse for which they are required cannot possibly be removed by drains; but this is the only kind of house refuse which should require removal by hand labour.

Cesspools.—By a cesspool is meant a covered pit or tank placed under the ground somewhere near the house. It may only receive the contents of an outdoor closet, or the entire drainage of the house. Sometimes it is a mere hole dug in the ground and covered over, when if the soil is porous the fluid drains away and the solid refuse is only removed at long intervals. In other cases, the cesspool is lined with cement, and has an overflow at the top by which the more fluid part drains into the nearest ditch or stream. In either case a cesspool is one of the most unhealthy modes of disposing of waste matters. Foul gases are generated in it, and if a shallow well is near, some of the contents are sure to percolate into it, and render the water dangerous. Cesspools are unfortunately still quite common in country houses, and in small inland towns. They are one of the frequent causes of typhoid fever.

Earth closets.—Dry earth is a potent disinfectant. When it is sprinkled over any foul decomposing substance, that substance at once becomes inodorous and harmless. This knowledge led to the invention of Moule's earth closets, in which the excretions are covered with dry earth. When properly attended to they are perfectly free from smell, and are by far the best form of closet for all houses in which the water-carriage system cannot be employed. Earth closets could not be used to replace water closets in a large town, on account of the enormous amount of labour which would be involved in supplying the earth, and in removing the vast daily accumulation of refuse.

The water-carriage system: advantages and drawbacks. Seeing that a town needs a plentiful water supply for other purposes than drainage (p. 303), and that a system of covered drains or sewers is necessary to replace the natural water-courses which carried off the surface water before the town was built, it is quite clear that there could be no cheaper way of removing refuse than by turning it into the street sewers. Certainly these sewers must be larger, more numerous, better constructed, and better attended to, if they are to carry house refuse as well as rain and waste water; but the additional cost of perfecting the drainage system is as nothing when compared with the enormous cost of removal of refuse by hand labour.

The chief difficulties that have to be met are: (1) That foul gases are developed in the sewers, which if not guarded against will find their way into the house, and cause outbreaks of disease; and (2) the difficulty of disposing of the sewage at a reasonable cost, and in such a manner that it shall not pollute streams, estuaries, and harbours, or otherwise become a public nuisance.

The first of these provisions is secured by efficient ventilation and trapping of the drain pipes. The second is for the most part a problem still unsolved.

Ventilation of drains.—Ventilation of drains is effected by letting the foul air escape from them through pipes opening above the houses, where it can very rarely do any harm, whilst fresh air enters at lower openings; or by making such numerous openings, as in the case of street sewers at the level of the ground, that the sewer gas becomes too much diluted with fresh air to be harmful.

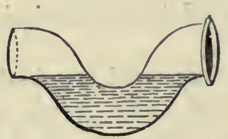


Fig. 129.—Stoneware Syphon Trap.

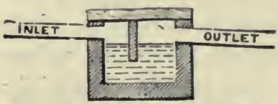


Fig. 131.—Dipstone Trap.

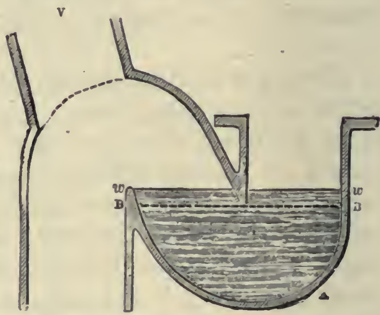


Fig. 130.—Ventilated Syphon Trap. V, the ventilation pipe.

Traps: the syphon trap.—Traps are bends or other receptacles made in the discharge pipes which always remain full of water. They offer no impediment to the downward flow of water, but prevent the sewer gas passing upwards. The almost universal form of water-trap used in the present day merely consists in a U-shaped bend in the pipe. It is called the syphon trap, and is shown in figs. 129, 130. Its advantages over other traps are cheapness, small bulk, and efficiency when well managed. Its disadvantages are liability to be emptied by the syphon action of the water descending the pipe beyond it, and liability to become choked with *débris*. The former is prevented by ventilating the pipe just beyond the trap (see fig. 130), and the latter is overcome by making a special opening for cleaning and flushing out the trap.

The dipstone trap.—The dipstone trap, fig. 131, was formerly used to trap the yard and street gullies, but is now generally replaced by a syphon gully, fig. 137. It consists of a square hole made of bricks set in cement, the entering and discharge pipes opening near the top. It is covered with a stone slab, and another is placed vertically dipping into the water held by the trap. If

Fig. 132.—Bell Trap with Cover on.

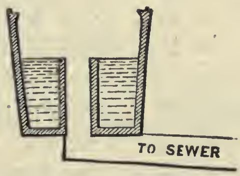


Fig. 133.—Bell Trap with Cover removed.

used for a gully, the iron grating would of course be placed to the left of the dipstone in the figure. The chief fault of this trap is its liability to leak under the edges of the covering stone, when the sewer gas readily escapes, and as a trap it is quite useless. A dipstone trap made in one piece of stoneware is perfectly reliable, and is sometimes used for small gullies such as those in the house area.

The bell trap.—The bell trap is somewhat similar to the dipstone in principle. It can readily be understood by referring to the illustrations, figs. 132, 133. It is not so good as a syphon trap.

Whatever kind of trap is used, it must be remembered that it is only efficient whilst it contains water. In dry weather, and at all times in houses when the pipe is not in use, the water dries up, and a direct communication with the drain is established. An occasional flushing with water will remove this source of danger.

CHAPTER LXXXVIII

THE HOUSE DRAIN: SINK WASTE—BATH WASTE—RAIN-WATER PIPES—YARD GULLIES

House drain.—The various waste pipes converge, usually at the back of the house, to a single drain pipe called the house drain, which connects them with the main sewer. The house drain is the most important pipe in the whole system, because it generally passes directly under the house to get to the sewer, which is in the street in front; and because it is buried in the ground out of sight. If there is any fault in it the ground under the house becomes soaked with sewage, and as the pipe is out of sight, the error is some time before it is detected, and involves a good deal of work and expense to correct it. The house drain is made of short lengths of 6-inch glazed stoneware pipe, the joints of which are carefully cemented together, and it is allowed a fall of about one in forty-eight on its way from the back of the house to the sewer.

The sink waste (fig. 134).—This is a short pipe made of lead, which is visible throughout its whole length. Just beneath the sink the pipe has an S-bend which forms a syphon trap. As a good deal of dirt from potato washings &c. passes through this trap, it is very liable to become choked, and is therefore provided with a screw plug, fig. 135, by undoing which it can be easily cleaned out. From this trap the pipe is continued on through the wall, and ends outside over the grating of a small gully in the yard or area. The pipe should never

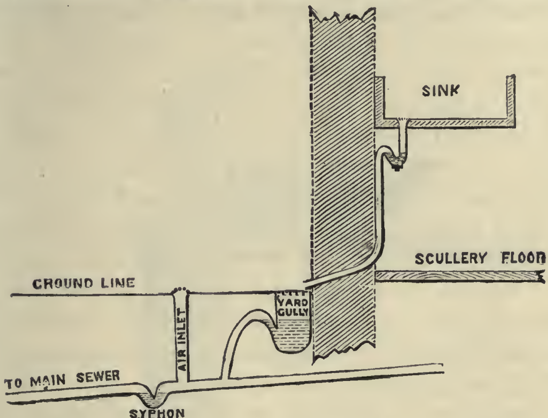


Fig. 134.—Waste Pipe of Sink, provided with S-trap and discharging over Yard Gully. House Sewer provided with Syphon Trap and Air Inlet.

be carried under ground, as this would mean that it was connected directly with the drain, and as the S-bend syphons empty each time a big gush of water is sent down the pipe, there is nothing to prevent the sewer gas passing up from the drain and entering the house. These small, unventilated syphon traps are absolutely unreliable, therefore the only safeguard with such waste pipes is that they should open in the air over a gully in the yard.

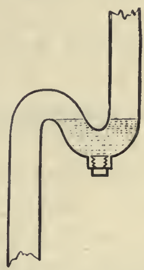


Fig. 135.—Lead Syphon (or S) Trap with Screw Cap foı Cleansing.

The bath waste.—An imperfect bath waste has several times been the cause of typhoid fever. Formerly it was not unusual to find in first-class houses a large bath in the bedroom, which was inclosed with wood-work to look like a cupboard or wardrobe. The bath waste would be one-and-a-half inch lead pipe, trapped only by a simple S-bend,

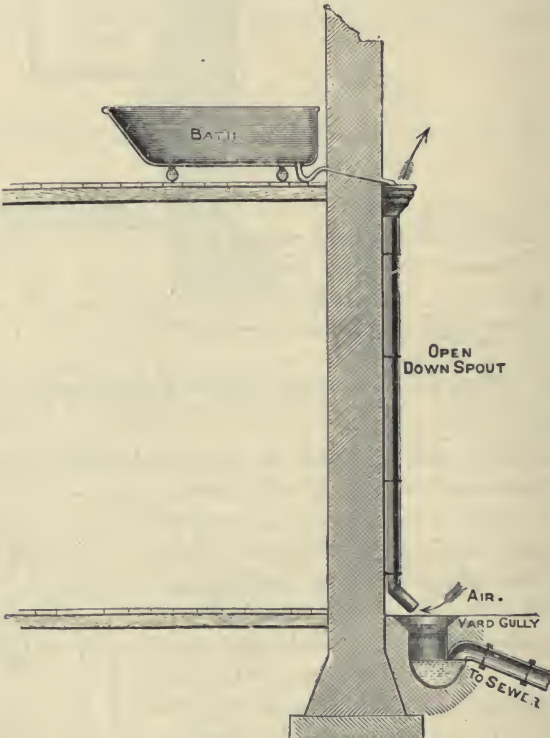


FIG. 136.—The Bath Waste discharging at once into the open head of a Downspout, which discharges over Yard Gully. There is a free circulation of fresh air through the Downspout.

and carried down through the middle of the house to the drain beneath. The force of the long column of water falling from the bedroom to the drain empties the trap every time, so that such a bath waste is more constantly employed in carrying sewer gas into the house than in discharging bath water. The proper form of waste pipe for baths or wash-handbasins is shown in fig. 136. The first discharge pipe is made of lead, and only passes from the bath through the outside wall, where it discharges into the open head of a downspout. The latter is continued to the ground, where it should always end over a yard gully. Thus there is interposed between the house and the drain a length of downspout open at both ends to the fresh air, and which can never be charged with sewer gas.

Rain-water pipes.—Rain water is a waste product in towns, as it is too dirty to be used for domestic purposes. The rain pipes have no direct communication with the house, and therefore it is commonly considered that they may be carried without trap or break to the sewer, thus permitting them to act as ventilation shafts. If the head of the downspout is well above the highest window there is no objection to this, as the more thoroughly the sewers are ventilated the better; but it often happens that windows are quite close to the top of the rain pipe, and sometimes just above it, when the sewer gas would pass into the house whenever the windows were opened. The safest plan is for the rain pipe to discharge, like the sink and bath wastes, over a gully.

Yard gullies.—The openings in the street gutters through which the rain finds its way into the sewers are called gully-holes, or more shortly gullies, and similarly constructed traps in the yard or area have received the same name. Until recently the dipstone trap was the usual form of gully, and it is still often used. When only a small one is required, as in a yard or area, a glazed stoneware dipstone trap answers very well; but a syphon gully made of the same material is better, and is the form which will probably be employed in the future, fig. 137. A gully consists of a hollow or receptacle, into which the water flows through a removable grating, and it has a trapped opening leading to the sewer placed rather high up on one side. Gullies occasionally become blocked with the dirt that is carried or swept into them, which falls to the bottom and accumulates, until the opening of the sewer pipe is choked. To clean them out all that is necessary is to remove the grating, ladle out the dirt, and throw down two or three pailfuls of water. If the blocked gully is that into which the kitchen sink discharges, the water should be boiling, as the cause of the block is most probably congealed fat.

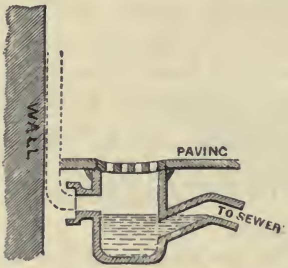


FIG. 137.—Stoneware Syphon Gully, with side Inlet.

CHAPTER LXXXIX

THE LAVATORY: SITUATION—APPARATUS—WATER SUPPLY—CONNECTION WITH THE DRAIN

The lavatory.—This is the most important sanitary arrangement in the house, as, when in fault, it is the most frequent cause of illness. The chief points to study in regard to it are the situation, the apparatus, the water supply, and the connections with the drain.

Situation.—In hospitals, where sanitation is of such paramount importance, the sanitary block, as it is called, is a separate building cut off from the main building containing the wards by short, well-ventilated passages. In a private house this is not convenient, and perhaps not necessary; still, there are a few points in reference to situation to which attention ought always to be paid. In the first place, the lavatory ought to be near an outside wall, so that the soil pipe may be carried outside at once. Secondly, it should not communicate directly with any room, but with a well-ventilated passage. And lastly, the higher up in the house it is situated the better, as foul gases tend to rise, and, if admitted at the bottom of the house, pass up throughout it.

Apparatus: the pan closet.—The apparatus still very frequently met with is the old form of pan closet, an

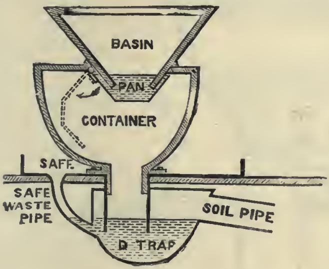


FIG. 138.—Pan Closet.

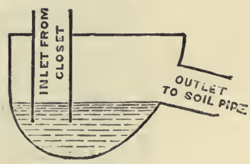


FIG. 139.—'D' Trap.

arrangement which is only mentioned and explained in order that the reasons why it should be condemned may be understood. It consists of four essential parts (fig. 138): the receiver or basin, the pan, the container, and the D trap (fig. 139). In connection with the pan is a handle, which, when raised, moves the former into the position indicated in the diagram, and causes its contents to be thrown into the container. Through this they fall into the trap, and then pass on into the soil pipe. The basin and the pan are the only parts in sight, and they can be kept quite as clean as in any other apparatus; but between the basin and the trap is a large surface always coated with filth, and giving off foul gas. This condition of the container makes it impossible to keep the air of the closet sweet and wholesome, and is by itself a sufficiently grave point to absolutely condemn the pan apparatus. There is, however, another fault. The D trap is cumbrous and dirty, and liable to leak at the joint which connects it with the

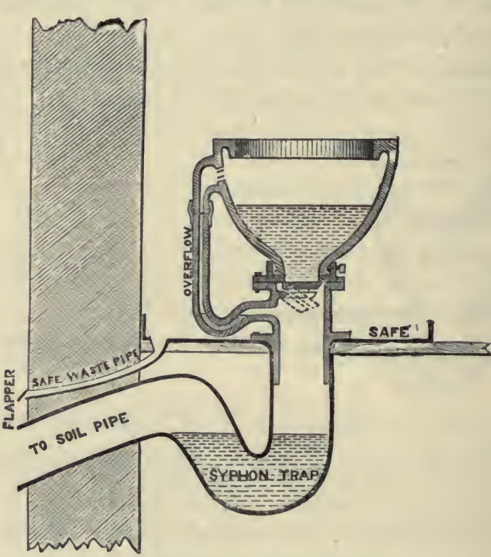


Fig. 140.—Valve Water-closet.

container, when of course it ceases to be a trap. For these reasons the pan closet must be considered to be an imperfect and unhealthy arrangement.

The valve closet.—The valve closet (fig. 140) is a marked improvement upon the pan, as the surface between the basin and the trap is much reduced, and the trap is a better kind. It has, however, been entirely superseded by newer and better forms, and is now chiefly of interest as the connecting link between the old and the modern style.

Modern apparatus.—The essential features of the modern apparatus are that they are entirely constructed out of a single piece of glazed earthenware or two pieces cemented together; that the surface between the basin and the trap is reduced to a minimum, and is all in sight; and that the trap is the best variety of syphon—a trap that is convenient to clean and flush out, and is ventilated so that it cannot syphon dry.

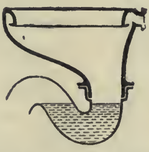


Fig. 141.—'Short-hopper' Water-closet.

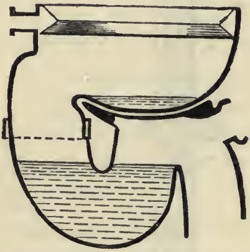


Fig. 142.—'Wash-out' Closet.

The 'Short-hopper' (fig. 141) is one of the best in principle: it is inexpensive, and is therefore generally adopted for small houses. The Wash-out (fig. 142) is also very good, but not quite so clean as the Hopper, as there is a considerable surface of pipe between the basin and the trap, and the basin itself is too shallow. There are now many slight modifications of both forms, which are satisfactory in proportion as they conform to the essential features given above. In all kinds the woodwork should be made to raise up for convenience in emptying slops into the receiver.

The water supply.—The water supply to the closet has already been referred to (p. 308); but the two chief points may here be mentioned again. One is that the water-closet should have a separate flushing

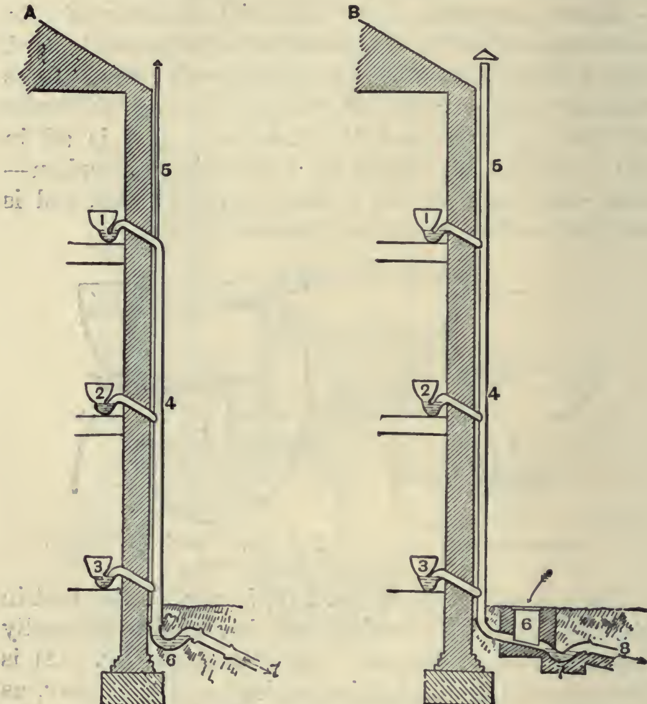


Fig. 143.—A. Insanitary Arrangement of Soil-pipe.
The ventilation-pipe (5) is too small, and there is no opening below at 6 for the air to enter.

B. These Defects remedied.
5 has the same diameter as the soil-pipe (4), and the pipe going to the drain is open at 6 to let in the air, and trapped at 7 to keep back the sewer-gas.

cistern, connected with the main if the water supply is continuous, and with the house cistern if it is intermittent. The water should never be supplied directly from the house cistern to the basin of the closet. The second point is that the overflow pipe from the house cistern should under no circumstances be allowed to discharge into any pipe connected with the lavatory.

The soil pipe.—The soil pipe (fig. 143) connects the water-closet with the drain, and is the most important of the waste pipes leaving the house. It commences at the syphon trap, and passes at once through the outside wall, where it joins with a long four-inch iron pipe, which ascends to the roof and descends to the ground. Above, the pipe is generally carried halfway up the slates, in order that any foul air which may escape from it may be discharged well clear of the windows. Below, it is often continued straight through to the drain. But the proper plan is that it should first pass through a gully in the yard, as in fig. B, in order that the fresh air may enter below; and thus, as in the case of the bath waste, there will be between the drain and the house a length of pipe filled with fresh air.

The advantages gained by thus ventilating the soil pipe are: (1) sewer gas is carried off quite clear of the house; (2) the descending column of water cannot suck the trap empty; (3) the connection between the house and the drain is intercepted by a length of piping always charged with fresh air.

CHAPTER XC

THE DISPOSAL OF SEWAGE: POLLUTION OF RIVERS—DISCHARGED INTO THE SEA—PURIFICATION OF SEWAGE—SEWAGE FARMS

The disposal of sewage: pollution of rivers.—Finally we have to consider what is to be done with the enormous bulk of liquid discharged every day from the sewers.

How great the quantity must be may be estimated from the amount of water supplied per head per day (see p. 303). For a town of 100,000 inhabitants the daily outpour would be something like 10,000 tons, all of which has to be got rid of at a reasonable cost, and without affecting the healthiness of the neighbourhood. Obviously the easiest way to get rid of it is to turn it into a watercourse or the sea, and this was the method universally adopted at first. But when sewage is turned into rivers the consequences are very disastrous. Not only are the fish destroyed, which is comparatively a small matter, but the chief source of water for domestic purposes is contaminated, and riverside districts are rendered unhealthy. What, for example, could be more unfair than to allow a little town like Welshpool, at the head of the Severn, to destroy the purity of that noble river for all the thousands of inhabitants who live by its banks on its way to the sea? A great deal has been done to check such pollution of rivers, and the time cannot be far distant when the most stringent regulations will be adopted concerning it. The cholera at Hamburg, and its relation to the pollution of the River Elbe, teaches a lesson by which the people of every enlightened nation should profit.

Sewage discharged into the sea.—To dispose of sewage by discharging it into a river may be regarded as one of the worst and least sanitary methods. To turn it into a land-locked bay or a harbour is not quite as bad, but is still very pernicious, for it will accumulate and render the neighbourhood unhealthy. When, however, a city has the good fortune to be placed, as Liverpool, Hull, and Southampton are, on the banks of large tidal estuaries, or on the sea-shore where there is a good set of tide, it may be allowed to use the cheap and ready method of getting rid of its sewage by turning it into the sea, where the tide will mix it with such a vast body of water that its organic matters cease to be harmful.

Purification of sewage.—But if only seaside towns are to use this method, what are the inland towns to do? At present there are only two ways suggested to help them out of their difficulty, neither of which is very satisfactory. The least satisfactory is that the suspended matters should be removed, and the purified liquid be allowed to flow into the river. The liquid can only be partially purified. The most valuable manure, ammonia, and the chief danger to health, disease germs, both remain in it. The plan, therefore, fails all round, for it is expensive, and the substance removed is not very valuable as manure, whilst that passed on to the river is almost as deleterious as ever.

Sewage farms.—The other method is to irrigate cultivated land with the sewage. This is a much more hopeful plan, for it is adopting nature's way of purifying foul substances. Such matters, if applied to a sufficient area, simply enrich the soil without conveying to it any unhealthy characters. Moreover, the soil is capable of extracting the whole of the organic matters, so that the water which flows from land irrigated with sewage with proper care is so thoroughly purified that it may be safely discharged into the river.

There are then but two methods of disposing of sewage which can be regarded as at all satisfactory: (1) To discharge it into tidal water, where, with careful management, it does but little harm, and is, perhaps, a source of nourishment to marine animal life; and (2) to dispose of it by irrigation on sewage farms—a scheme theoretically satisfactory, but at present somewhat too costly.

CHAPTER XCI

INCOME AND EXPENDITURE :—MONEY

Money : standard and token money.—Money is the form in which we receive our income, and the means through which we obtain the necessaries of life. Money is used in two forms, coin and paper. English coins are made of gold, silver, and copper. The gold coins are called 'standard' money, as their real and nominal value are the same. Standard gold bullion can be changed at the Bank of England for an equal amount of standard gold coin, and it is owing to this fact that an English sovereign is worth its nominal value in precious metal, that it can always be passed in foreign countries. Silver and copper coins are called 'token' money. Their real value varies with the market price of silver and copper, and is less than their nominal value as a fractional part of a sovereign. The manufacture of token money is limited to the requirements of the country. It is not legal to tender in payment more than a certain amount, namely twelve pennies or two pounds' worth of silver for one transaction. There is no such limit in payment with gold.

Paper money: bank notes.—Paper money occurs in many forms, of which the most important are bank notes, bank cheques, and bills of exchange. Bank of England notes vary in value from *5l* to *1,000l*. They are manufactured with such great care that forgery is almost impossible, and the credit of the Bank of England is such that they are generally easily passed in foreign countries. They are consequently a very convenient form in which to carry large sums of money both abroad and at home. Bank of England notes are legal tender in payment of sums of *5l*. and upwards. Many other banks issue bank notes.

Cheques.—Cheques are money orders drawn upon a bank. In business payments are generally made in this way. A cheque is made payable to 'bearer,' to 'order,' or is 'crossed.' If you receive a cheque payable to bearer, it is only necessary to present it at the bank on which it is drawn to receive the money. If payable to order, it must first be endorsed, that is countersigned on the back, by the person to whom it is made payable. If crossed, it can only be paid through a banking account. This is a very safe and convenient way of sending money by post, as such a cheque cannot be cashed; but it requires that both parties shall have a banking account.

Bills of exchange.—Bills of exchange are used in the following way in large commercial transactions. A merchant sells so many thousand bales of cotton to a manufacturer. He desires payment at once in order that without delay he may freight his ship for her outward voyage. Now the manufacturer is not prepared to pay the enormous sum required, until he has manufactured and sold to the retail traders at least a part of the goods; he therefore signs a bill of exchange, the amount of which is covered by the value of the cotton. The merchant takes the bill to a bank, where for a certain payment called discount it is cashed. Practically the bank lends the money until a specified time when the manufacturer will be prepared to repay it. The discount is the profit on the transaction charged by the bank.

Sending money by post.—For sending money by post, Postal Orders and Money Orders are the most convenient method for small sums, and cheques and bank notes for larger sums. Coin can only be sent in a registered envelope. It is never a good way of posting money. Bank notes should also be sent in registered envelopes,

CHAPTER XCII

EXPENDITURE—REGULATION OF—IN TOWN AND COUNTRY—RULES

Expenditure.—Every working man with proper self-respect desires that his family should be entirely supported by the income earned by him or them. If he trusts to the hospital in times of sickness, to the parish in old age, and to charity or credit on any sudden emergency or temporary loss of work, and if in the event of death he would leave young children or other helpless dependents unprovided for, he is not living within his means. Though every bill has been regularly paid, one payment has been neglected: the weekly payment to the reserve fund, by which means alone he can make himself really independent.

Weekly expenses.—The weekly expenditure may be classed under three heads: (1) The ordinary or current expenses, such as rent, taxes, food, fuel, light, clothing, and materials for cleaning; (2) occasional expenses, as for tools, books, new furniture, or a holiday; and (3) money reserved for provident purposes; that is, money saved, and money invested in some sick club or benefit society.

Regulation of expenditure.—To meet everything it is necessary that the weekly expenses should be properly proportioned, paid to time, and never in excess of the means. It is quite possible, even for the poor, with self-denial and careful forethought and planning on the part of the housekeeper, not only to pay their way when in the fulness of youth, strength, and prosperity, but also in times of sickness, loss of work, and old age. A common fault in expenditure is that too much is spent on little things. Small expenses like small savings add up considerably, and soon reach a goodly sum. Much money is wasted in pennies spent on things which are not wanted; pennies which would pay the subscription of a sick club, or serve some other useful purpose. One does not realise how much is spent on trifles, and therefore as a check an account should be kept. It is the duty of every housekeeper to keep an account of the way in which she spends the money. At the end of each week it should be added up so as to show the amounts received, paid, and saved. The items spent unnecessarily, and those for which too high a price was paid, should be marked as a guide for the future.

Proportion for various items.—It is impossible to state exactly how the weekly money ought to be divided amongst the various expenses, as the cost of the items will differ in accordance with the size and special requirements of the family, and the prices of the district in which they live. The following may be taken as a rough guide as to how the income should be proportioned: rent and taxes, $\frac{3}{20}$. Food and fuel, $\frac{10}{20}$. Clothing, $\frac{3}{20}$. Education and books, $\frac{1}{20}$ (rather less). Repairs and cleaning materials, $\frac{1}{20}$ (rather more). Reserve fund, $\frac{2}{20}$.

Income and expenditure of town and country workmen. These proportions must of necessity be altered according as a man and his family live in the town or the country. In town houses rent is high, and more fuel and light are used; but clothing and articles of food, with a few exceptions, are cheaper. Frequently a labourer in the country grows his own vegetables, and this item is cut out from his expenditure. The keeping of fowls, pigs, or bees often gives small profits, and in agricultural districts gleaning serves to lessen the amount of flour to be bought. Wood for firing is gathered free of cost, or bought for a mere nothing. On the other hand, a labourer in the country has less wage than a worker in town. The expenditure of the two (with wife and three children) might be as follows:

Artisan. Income, 30*s.* Week

	s.	*d.*
Rent and taxes	5	6
Fuel	1	6
Food	14	0
Clothing	4	6
Education	0	6
Light, cleaning, repairs	1	0
Reserve fund	3	0
	30	0

Labourer. Income, 16*s.* Week

	s.	*d.*
Rent and taxes	2	0
Fuel	0	8
Food	8	4
Clothing	2	4
Education	0	4
Light, cleaning, repairs	0	8
Reserve fund	1	8
	16	0

Food, 14*s.*, Artisan's Family

	s.	*d.*
24 lbs. flour 3*s.*, barm 3*d.*	3	3
¾ lb. butter 9*d.*, 2 lbs. syrup 6*d.*	1	3
2 lbs. oatmeal 4*d.*, 1 lb. rice 2*d.*	0	6
1 pint skim milk daily	0	7
1 pint new milk daily	0	10½
2 lbs. sugar 3*d.*, salt and pepper 1*d.*	0	4
¼ lb. tea 5*d.*, ¼ lb. coffee 3*d.*	0	8
Score potatoes 8*d.*, vegetables 4½*d.*	1	0½
Meat 4*s.*, bacon 6*d.*, cheese 6*d.*	5	0
Dripping 4*d.*, fruit 2*d.*	0	6
	14	0

Food, 8*s.* 4*d.*, Labourer's Family

	s.	*d.*
Flour and barm	3	3
Dripping 8*d.*, syrup 2*d.*	0	10
Oatmeal 4*d.*, rice 2*d.*	0	6
10 quarts milk at ¾*d.*	0	7½
Sugar 3*d.*, salt and pepper 1*d.*	0	4
Tea 2½*d.*, coffee 3*d.* (or cocoa)	0	5½
Lentils, peas, or beans	0	2½
Meat 1*s.* 8*d.*, cheese 4*d.*	2	0
Oatcake ½*d.*, bones 1*d.*	0	1½
	8	4

A slightly larger income, such as 2*l.* for the artisan and 1*l.* for the labourer, would not affect many of the items. A better house might be taken, or the food might be more varied, especially in the case of the labourer, but whatever changes are made the most important one is to add something to the reserve fund.

Advantages of cash payments.—However a housekeeper arranges her expenditure, there is always one thing she must manage—to avoid running into debt. The wisest plan is to pay ready money for everything. This saves all anxiety lest the bills cannot be cleared. Moreover, there is always a probability that a shopkeeper will take advantage of his debtors, either by serving them with inferior articles or by charging them more than he ought. This is not surprising, for how can he discharge his own bills if those owing to him are not paid? And if he lends money to his customers by allowing them food or clothing on credit, he must be repaid by a heavy interest, which interest he takes for himself by overcharging. Cash payments are equally advantageous to both tradesmen and customers.

General rules.—The following are a few general rules which it would be well for housekeepers to observe:

(1) Pay ready money, or settle bills at very short intervals.

(2) Proportion the income according to the expenses, and only buy what is actually needed.

(3) Try to have a small sum of money in hand; for instance, a week's wages in advance of payments.

(4) Buy at shops where only good articles are sold, and which have for their motto 'Cash versus Credit.'

(5) Find out exactly what is wanted and in what quantity, and the kind that will best of all serve the particular purpose; then consider the *quality* that can be afforded.

(6) In the matter of dress it is well to avoid peculiarities and all shabby finery. She is well dressed who considers her position, her work, and her means, and who buys her things accordingly. Tidy boots and gloves, clean and tidy underclothing, and a plain and well-fitting dress and jacket, are signs of such a one.

CHAPTER XCIII

THRIFT—OBJECT OF SAVING—HOW TO SAVE—THE SAVINGS BANKS—PENNY BANKS

Objects to be attained by saving.—Up to the present we have only dealt with the ordinary class of household expenses. We have next to consider in what way it is best to invest the reserve fund, but before deciding upon this we will state the chief objects to be gained by saving. They are: (1) sick pay; (2) superannuation, or old age pay; (3) money at death (funeral expenses, or for wife and children); (4) medical attendance and medicine; (5) a house to live in; (6) other property. In deciding where to invest the savings, the most important points are to put them where they will be perfectly safe, where they can be readily obtained if needed, and where a good return is offered for the investment. The reason why it is better to invest money than to keep it ever so carefully is because people who want money will pay for the loan of it. They give what is called *interest*, a sum generally varying between 2½ and 5 per cent. per annum for the use of it, besides returning the principal in full. Another good reason for investing money in insurance or benefit societies is that individual risks of sickness and death are lost by division amongst the many. The misfortunes which would ruin the few are not felt when averaged amongst, say, a thousand.

Where to invest.—The following are good ways of investing the reserve fund: (1) the post-office and trustee savings banks; (2) the friendly and benefit societies and clubs; (3) provident dispensaries; (4) some building societies and co-operative stores.

The post-office savings bank.—The post-office savings bank is certainly one of the best and most convenient institutions for the encouragement of thrift. It has many advantages: (1) It is absolutely safe, as the money is in the hands of the Government; (2) the interest is fair and regularly paid; (3) it is convenient, as the post-offices are open for long hours, and as business can be transacted through any post office, that is not necessarily using the same one each time; (4) no expense is incurred, as bank-books, forms, and even postage concerning savings, are free of charge.

The complete regulations may be obtained from any post-office, but the following is a short outline of the scheme for deposits, annuities, and insurance.

Deposits.—No sum less than 1*s*. can be banked. No more than a total of 30*l*. can be deposited in one year (except to replace withdrawals), and no more than 200*l*. in all. A yearly interest of 6*d*. is given on each complete 1*l*., that is at the rate of 2½ per cent. When the depositor has reached the limit, if he desires to continue saving through the post-office, he can give instructions to transfer a part of his money to Government stock. Such stock will be obtained for him in amounts from 10*l*. to 100*l*. in one year, subject to a total limit of 300*l*., irrespective of the limits of ordinary deposits.

Deposits made by married women in their own names are 'deemed, unless and until the contrary is shown, to be the separate property of such married woman.'

Any person under age but upwards of sixteen may leave any sum not exceeding 100*l*. standing to their credit to any person or persons nominated by them. If their savings exceed this amount, the balance is paid to their legal representatives (father, brother, son, &c.).

Small savings.—Owing to the labour and cost of collecting very small sums the post-office will receive nothing less than 1*s*., which is too large a sum for children to save at one time. To provide for this there are two schemes, stamp forms and penny banks.

Stamp forms.—The stamp form is a slip of paper marked with twelve spaces, over each of which a stamp is to be affixed as the child can afford to buy them. When the form holds twelve stamps it is complete, and can be taken to a post-office, and 1*s*. is placed to the credit of the child in his or her pass-book. Money can be deposited on behalf of children at any age, but children can only handle it themselves when they have attained the age of seven.

Penny banks.—These are now held in most schools. They are connected with the post-office or a trustees' savings bank, and all the money received into the penny bank is paid over to the higher bank for security and interest. The penny bank is usually held in the schools on a Monday or a Tuesday, when sums of 1*d*. and upwards are paid in. The amounts, together with the names or initials of the depositors, are entered in two books, the one as a check against the other, and also in each child's pass-book, which forms a sort of receipt, since it gives to the depositor a written evidence that the money has been received. When any child's deposits amount to 10*s*. or 1*l*. they are transferred to the higher bank, and interest is paid on each 1*l*.; and in future the child can, if he or she likes, deal with the savings bank instead of the penny bank. Open penny banks (unconnected with schools) have been established for adults in many towns, and have proved a great inducement to thrift. The chief object of the school penny banks is to encourage the *early* saving of *small* sums, with a view to induce children to continue habits of thrift after school life, by depositing in a post-office or other savings bank such as that to which their money is drafted.

CHAPTER XCIV

POST-OFFICE ANNUITIES AND INSURANCE—CO-OPERATION—BENEFIT AND FRIENDLY SOCIETIES—PROVIDENT DISPENSARIES

Post-office annuities.—Immediate annuities of 1*l.* to 100*l.* per annum may be purchased by a single payment; thus a man of sixty can buy an annuity for the rest of his life by paying a sum down at the rate of 11*l.* 8*s.* 9*d.* for each 1*l.* a year. Women pay at a somewhat higher rate, as their expectation of life is better. Older people of course pay less, and younger people more, in proportion to the time they may be expected to live. The entire tables can be obtained at any post-office.

A better plan, however, is to purchase early in life a deferred annuity, either by a single payment, or by yearly payments called *premiums*. In this way a man of twenty can obtain an annuity at sixty by the payment of 2*l.* 3*s.* 1*d.* down, or 2*s.* 1*d.* a year, for each 1*l.* of the annuity. A still better plan is to purchase the annuity on the money returnable system. By a single payment of 4*l.* 5*s.* 7*d.*, or yearly payments of 3*s.* 4*d.* for each 1*l.* of the annuity, a man of twenty can buy an annuity to commence at sixty; or in the event of death or necessity before that age is attained, the money paid will be returned.

Post-office life insurance.—Small life insurances are generally effected with the object of providing sufficient money for funeral expenses, and larger insurances in order to make some provision for relations, such as wife or children. In the post-office, lives between the ages of fourteen and sixty-five can be insured in amounts varying from 5*l.* to 100*l.*, and from eight to fourteen for 5*l.* only. The terms for life insurance are arranged on very similar principles to those for annuities. The younger the insurant, the less the annual payment, as the expectation of life, other things being equal, of course varies with age; insurances ought, therefore, to be commenced early. A man or woman of twenty-one can insure for 10*l.* by paying an annual premium of 4*s.* 4*d.* through life, or of 4*s.* 8*d.* till sixty, or by a single payment of 4*l.* 4*s.* With higher premiums the sum insured may be obtained at a specified age, such as sixty, or at death if it occurs sooner; but the better plan is to insure by the payment of annual premiums to terminate at the age of sixty, when one is generally getting too old to earn full wages. If, after two years' regular payments, an insurant has to cease paying, there will be returned to him 'such sum of money as the National Debt Commissioners shall specify.' When the sum insured is upwards of 25*l.* a medical examination is required; the medical examination costs only 2*s.* 6*d.*, and as it saves risk and trouble, it is better to have it in all cases.

Principle of co-operation.—Insurance is based upon the general principle of co-operation or association; that is to say, a number of people combine to save for a definite purpose. If each saved on his own account, some would die before they had put by a single pound, and others not until they had perhaps more than a hundred; but the savings of all combined would reach at death an average of 50*l.* or 60*l.* each. If, therefore, they combine together, they can assure to each member from the moment of his first joining a sum of 50*l.* or 60*l.*, even although he dies directly afterwards. Still more than this, a man on his own small savings usually only obtains a low rate of interest, whilst a sound, well-managed company or society can invest the funds at much greater advantage, and often obtain a considerable profit. When the profits are more than sufficient to meet the claims, they are divided amongst the members in the form of a *bonus*; that is as cash, or by lowering the annual premium, or increasing the amount insured.

Untrustworthy societies.—There are throughout the kingdom an enormous number of societies and clubs established on such co-operative principles. Some of these are excellent institutions, and have been the chief means of encouraging thrift in the working classes. Others have been the greatest possible hindrance to the same, having been designed rather for the profit of the managers than for the benefit of the members of the society, and whilst the former have paid themselves magnificently, the latter have lost all their savings. When a man is about to join some provident society he cannot be too cautious and particular in his inquiries about it. He is going to put a good deal of faith in it. He trusts it for help in times of sickness; he trusts his old age to it; his hopes of a decent burial, and perhaps also the provision he intends to make for his wife and children. He is bound therefore to do his best to ascertain that the particular society he joins is thoroughly trustworthy.

How to choose a benefit society.—In the first place, do not join a society simply because it is recommended to you, but because you are satisfied from your own inquiries that it is a thoroughly sound one. It is generally wise to select an old-established society; such a one has in its past history a guarantee of security. At any rate it should be registered, and its rules when read *with care* should seem perfectly fair and generous to the members. It is a good plan to obtain the rules of the post office savings banks, and compare them with those of the proposed society. The post office cannot offer high terms, because absolute security means low interest and small profits. The society ought to give better terms, but it cannot give fairer rules. Finally, avoid all societies in which the expenses of management are very high. This must necessarily include all collecting societies. The expense of collecting small sums is so great that such societies can only be made to pay (that is, to pay the officials) when a large number of members 'lapse' or fall out of benefit every year. The previous subscriptions of such members are of course all profit, as they will never receive any benefit.

Benefit and friendly societies.—In high class benefit and friendly societies a member, by paying a certain subscription or subscriptions, according to the number of benefits he wishes to insure for, can usually make provision for the following: (1) weekly money whilst off work from sickness or accident; (2) medical attendance and medicine; (3) superannuation money; (4) money at death for funeral or family. These benefits are arranged on the same general principles as in the post office savings bank.

Provident dispensaries.—Provident dispensaries are a distinct kind of society. For a small weekly payment members receive medicine and medical attendance when ill. Provident dispensaries usually include no other kind of benefit, and therefore they are practically devoid of risk. There are, however, so many sick clubs connected or not with benefit societies, that the regulation provident dispensary is not so frequently met with as it deserves to be, for it is unquestionably an admirable institution.

CHAPTER XCV

BUILDING SOCIETIES—CO-OPERATIVE STORES—CLOTHING CLUBS—TRADE UNIONS

Building societies.—Building societies are formed with the object of enabling a man to build or buy a house on easy terms. Such a society will buy for one of its members a house rented, say, at 9*l.* a year for 100*l.* In repaying this debt and the interest on it the member pays 12*l.* a year for 11 years, that is, a total of 132*l.*, so that the society gains 32*l.* If the member had been paying rent these eleven years, he would have spent 99*l.* without any gain to himself; but by paying 132*l.* instead of 99*l.* he has become the owner of the house. Practically, he has bought it for 33*l.*, as the other 99*l.* would have gone in rent.

Until the member has paid his debt, the house is really the property of the society, for their money bought it. If, therefore, a man fails to pay his subscriptions regularly, the society can take his house as their own right. This system of lending money with a pledge is called *mortgage*, from the French *mort*, dead, and *gage*, pledge, since he pledges his house against his payments, and if he does not fulfil the conditions the house becomes dead or lost to him.

The working of building societies.—A building society, of course, wants funds to work with, and these funds have to be raised amongst the members. Each member buys a share in the society, for which he usually receives four or five per cent. interest; and as many members only want to invest money and not to buy a house, the funds of the society may become very large. Thus, building societies are often engaged in large financial transactions, outside their legitimate business of building and buying houses for their members, and when these transactions are of too speculative a nature and fail, the society suddenly collapses. The members who have used the society for its primary object of enabling them to obtain their house on easy terms, cannot take much harm in the event of such a catastrophe; but those who have invested their savings in it stand to lose all. When proposing to join a building society, make careful inquiries as to its stability; read the rules, and make sure that you are not liable for a greater sum than your shares—that is, that the company is of *limited liability*—and if you wish to invest your savings in it do not be attracted by a high interest; above four per cent. is suspicious, and above five per cent. is dangerous.

Co-operative stores.—Co-operative stores are formed upon the principle of doing away with the 'middleman'—that is, buying direct from the producer or wholesale merchant. A number of people form themselves into an association to start a store. Funds are raised by shares, as in building societies, and directors are appointed to manage the business. The best system is the Rochdale, in which the stores are bought at wholesale prices, but sold to the members at the ordinary retail market price. Each member is, however, supplied with a ticket, on which every purchase made is entered. At the end of the quarter these tickets are sent in, the accounts are made up, and the profits are divided amongst the members in proportion to the amount they have each spent. Some of these stores have been so successful, that not only has a good interest been paid on the shares, and good quarterly *bonuses* or *dividends* returned to the members, but, out of the surplus, reading rooms have been opened, classes and lectures have been given, and evening entertainments provided; proving such co-operative stores not only to be a commercial success, but a most useful and valuable aid to thrift.

Clothing clubs.—Clothing clubs are established to help poor people to secure clothing, food, and fuel for the winter. The members subscribe a few pence weekly through the year. The funds resulting from the subscriptions are invested in a reliable bank to gain interest, and are often further increased by ladies and gentlemen interested in the work. During the winter each member receives his or her share of the principal, interest, and bonuses in the form of clothing, food, or fuel.

Trade unions.—Trade unions are combinations for trade purposes. Their chief object is to enable the workmen engaged in any particular trade to demand a fair rate of wages; and the chief purpose of their funds, which are derived from the subscriptions of the members, is to make a weekly allowance to men ordered out on 'strike.' Some trade unions, however, which have become permanently established, have founded, in connection with their association, provident institutions on the same principles as the ordinary benefit and friendly societies. Before joining such a provident institution, it is most important to ascertain that under no circumstances can the provident funds be used for trade purposes, since, if this were allowable, there would be the great danger that, at some period of excitement, the entire savings of the members would be swallowed up in strike money.

CHAPTER XCVI

THE CAUSE AND PREVENTION OF DISEASE—HOW TO BE OF SERVICE TO SICK PEOPLE—THE RELATION OF DISEASE TO POPULATION AND CIVILISATION

How to be of service to sick people.—The study of diseases with the object of learning how to cure them should only be undertaken by those who are prepared to devote a lifetime to the subject. Of nothing is it more true that 'a little knowledge is a dangerous thing;' but apart from medical treatment there are many ways in which women especially may be of service to sick people. In every house a sick nurse is occasionally required, and it makes all the difference to the patient whether her services are skilfully and intelligently rendered, or are clumsily and ignorantly performed. In very bad cases a fully trained nurse is of course desirable, but every woman should learn the rudiments of nursing, and take such opportunities as offer in her home or elsewhere for gaining a little practical experience. A good nurse is generally a good woman; she has many opportunities that others miss of being helpful to those about her.

Another way in which we may occasionally render very valuable service is by the knowledge of how to give what is called 'first aid' in cases of sudden emergency, such as fits, burns, or broken bones. It may be a matter of life and death to know what to do at once, before there is any time to fetch a doctor. With this object the St. John's Ambulance Association have for some years past held classes throughout the kingdom, and have been the means of teaching the police, railway porters, the fire brigades, factory hands, volunteers, and many other men and women how to give such help.

Finally, there is a still wider field for usefulness in which each one of us may render public service. This is in the prevention of disease. Every disease has its cause. In some cases we have not yet discovered the cause. In others we know it, but the circumstances of life are so exacting that we do not avoid it. But in many instances by knowing how diseases are caused we may not only avoid them ourselves, but help to prevent them from spreading amongst our fellow-creatures. It is to teach this useful knowledge that the free courses of lectures on Health are now delivered every year in most large towns.

Thus there are three subjects in relation to sickness of which some knowledge may be said to be almost indispensable in every home: (1) the prevention of disease; (2) sick nursing; (3) first aid in emergencies.

The prevention of disease.—'Prevention is better than cure.' Moreover, in sickness the prospect of prevention is more hopeful than the prospect of cure. If, for example, we drink water from an impure source and take typhoid fever, the fever must run its course, for there is no known method of stopping it. But we know how it is caused, and we know that it may be avoided by proper attention to the drainage and water supply. Again, the cause of cholera and the way in which it spreads are now understood. Half a century ago, under very similar circumstances, its ravages spread throughout England; but in the autumn of 1892, whilst hundreds died daily so near us as Hamburg, every time the disease was imported here it was at once stamped out. If we let it get a hold amongst us, and allow our water to become contaminated with its germs, without doubt very many of us will die from it; but if the people combine with the sanitary authorities in adopting the proper precautions, it will not succeed in establishing itself. The present condition of England illustrates how a disease like cholera may be prevented, whilst the terrible mortality of nearly 50 per cent. on the Continent shows how often it cannot be cured.

Wild animals have few diseases.—Diseases have a natural tendency to increase as the population of a country becomes more crowded, and as the struggle for existence becomes more severe. A healthy animal leading a wild life is rarely attacked with disease. If it can obtain sufficient food and meets with no accident it is almost certain to reach the natural limit of its life.

Domestic herds subject to fevers.—Animals herded together, like domesticated cattle, sheep, pigs, and fowls, though still leading natural lives, are subject to serious outbreaks of infectious disease; diseases due to infectious germs, such as cattle plague, foot-and-mouth disease, pleuro-pneumonia, swine fever, fowl cholera, and others. All communities of animals or men are susceptible to infectious fevers, even although they lead such natural and healthy lives as to be practically free from other kinds of disease.

Diseases increase with domestication.—In the case of animals still more domesticated, whose habits of life more nearly approach those of mankind, such as dogs and horses, chronic diseases of the digestive, circulatory, and other internal organs are more frequently met with. These diseases are very common in men, but are practically unknown in wild animals, and are evidently due to the difference between the habits of wild and domesticated or civilised life.

CHAPTER XCVII

CAUSES OF ILLNESS: THE PREVENTION OF CHRONIC DISEASES OF THE INTERNAL ORGANS

Causes of illness.—The causes of illness and premature death may, with some exceptions, be ascribed to three conditions: (1) injuries and accidents of all kinds; (2) germs, giving rise to infectious fevers and allied diseases; (3) habits of life, giving rise to various chronic disorders. Such are the causes of disease which we have to take into consideration when studying how they may be avoided.

Prevention of accidents: and fevers.—The precautions which may be taken to prevent accidents and injuries of all kinds need not be discussed in a class book. As individuals we must be guided by common sense, and as members of a community by the law, which, whilst usually allowing foolish people to risk their own lives, does not permit them to risk the lives or well-being of others.

The prevention of the spread of all kinds of infectious disease is a very important matter, and will be dealt with in separate chapters.

Prevention of chronic diseases.—Chronic diseases of the internal organs and tissues, such as diseases of the stomach, bowels, liver, kidneys, heart and blood vessels, lungs and bronchial tubes, brain and nerves, bones, joints, muscles, skin, &c., are due to the habits of our lives, and the lives of our forefathers. It is important to recognise the fact that *only a very small percentage of human beings die of old age.* Of those who escape death from either of the first two causes, the vast majority die from one or other of these chronic diseases due to our mode of living. It cannot be too clearly impressed upon young people that, whilst they must within reasonable limits run an average risk of death from accident or infection, their expectation of life outside these risks is to a considerable extent in their own hands. It is true that we cannot return to the wild life, nor can we, as a rule, afford to pick and choose our work. Most of us must accept some conditions which are not altogether the best for health; but they may to a large extent be met and overcome by those who are willing to do so.

Danger of slight excesses.—Prolonged, though slight, excesses are a fruitful source of disease in later life. The slight daily excess, though not felt at the time, is more pernicious than the occasional gross excess. It is a daily source of irritation to some internal organ, or keeps some part constantly over-stimulated or overworked. Year by year the slight effect is continued, and it slowly begins to tell upon the part or organ which has to bear the strain. Perhaps at the end of twenty or thirty years the doctor is consulted about some symptom, and finds the liver, kidneys, or stomach diseased. The mischief has now been done; and however much help it may be possible to give the patient by medical treatment, the disabled organ will remain disabled; in most instances it will ultimately be the cause of death, and not rarely its hereditary influence will be felt in the offspring.

Excess in drink: in food: in tobacco: in work.—When we talk of excesses, drink is the thing which at once occurs to the mind of most people. Amongst the working classes it certainly takes a first place as the cause of disease and crime; but it is possible to exceed in many other ways equally certain to cause disease, though perhaps attracting no attention because not otherwise blamable. The well-to-do classes, who usually take but little muscular exercise, induce just as much disease by an over-stimulating diet as the working classes do by an over-stimulating drink. In each case there is a daily strain thrown upon some of the internal organs to get rid of a substance which is not required by the body. Excessive use of tobacco, especially chewing, is also an undoubted cause of disease, amongst others of that terrible affection, cancer of the mouth. But we may exceed in praiseworthy as well as in blameable ways. For instance, over-work will produce disease as certainly as over-eating. Even in muscular work, sudden strains, long spells of thirty or more hours of heavy work, or each day working a little beyond the strength, will end in doing mischief. But over brain-work, especially of an exciting character, is still more sure to cause a breakdown, and is at the present time apparently an increasing cause of disease of the nervous system.

It is not often that the circumstances of life actually require us to exceed in any of these ways; and yet, if we could be temperate in drink, moderate in the use of food, prudent in work, and discreet in the enjoyment of pleasures and luxuries, we might banish, perhaps, more than half the diseases which have grown up with, and become a part of, civilised life.

CHAPTER XCVIII

CAUSES AND PREVENTION OF CHRONIC DISEASES (*continued*)

Imperfect ventilation: insufficient sunlight.—Imperfect ventilation is another cause of chronic disease, though it is very difficult to estimate how much illness ought to be attributed to it. It acts chiefly by lowering the constitution, and so making us an easy prey to diseases of the blood, lungs, joints, spine, glands, skin, &c., which we should otherwise have escaped. Want of sunlight has a similar effect, and is often associated with insufficient ventilation. The people who suffer most from these causes are those who work in close, overcrowded rooms, like many tailors and dressmakers; shop hands, when they work long hours in dark, ill-ventilated shops; domestic servants, when they live in cellar-kitchens, sleep in small, unventilated attics, and rarely go out until after dark; poor families, living in one dark, overcrowded room; and other people placed in at all similar circumstances. In addition, there are very many people who have the means and the room, but, from ignorance or choice, sleep in bedrooms with an insufficient air space, and practically no ventilation, and who occupy during the day the darkest room in the house, thus, without knowing, or apparently caring, throwing away what is necessary for perfect health—namely, sunlight and pure air.

Dirt: dirt of trades.—Dirt, again, is a well-known cause of disease. The most striking examples are met with in certain trades. The chimney-sweep's cancer is caused by soot. In England it is not uncommon, but in many other countries is never met with, for the simple reason that the sweeps are cleaner. Knife-grinders' consumption is a disease of the lungs caused by inhaling steel dust. It is not true consumption, but is quite as fatal. Death is certain within a limited number of years to every man engaged in grinding steel, unless he takes the proper precautions to keep this form of dirt out of his lungs. The dirt of many other trades has the same harmful effect.

Want of personal cleanliness: dirt the home of germs.—Want of reasonable cleanliness in person or home, though not often giving rise to such striking examples of disease, interferes with the healthy action of the skin, producing diseases of the skin, and through it affecting the general health of the body. Moreover, dirt is the natural home of infectious germs, some of which rarely infect any but dirty people and those who have the misfortune to work amongst them.

Such are the common causes of chronic diseases—agencies working slowly for many years, until they undermine our constitution, rendering us not only subject to disease in our own bodies, but liable to transmit similar tendencies to our children.

Moderation in one may be excess in another.—We must bear in mind that what is moderation in one person is sometimes exces in another, and that what is quite good for one may be harmful for the other. Thus, a man working hard all day in the open air may eat hearty meat meals with benefit; whilst another, working equally hard with his brain in an office, would find the same quantity of meat food excessive, and suffer from it. Again, in a country cottage the windows often consist of a single pane of glass, and do not open. Notwithstanding the darkness and bad ventilation the people are ruddy and strong, the reason being that as they are all day long in the sunlight and fresh air, they can do with much less in the house. Town people, on the contrary, get so little sunlight and fresh air outside, that they require as much as possible indoors.

Diseases prevented by change of habits.—The prevention of chronic diseases is to be effected by removing the causes. This means nothing less than a great revolution in our social habits and customs, a revolution based upon the knowledge taught in such lessons as these—that is, a knowledge of physiology, or the nature and functions of the different parts of the body, of the uses of food and clothing, and of the laws of health. Those who know these things, and wisely regulate their lives by them, are doing their best to prevent disease, and encourage the growth of a strong, healthy, cleanly race of people.

CHAPTER XCIX

INFECTIOUS DISEASES—GERMS—ALCOHOLIC FERMENTATION—DECOMPOSITION—INFECTION

Infectious diseases: characters: typical forms: cause.—The infectious diseases form a large and important class, quite distinct from those chronic affections referred to in the last chapter. Their most important features are: (1) they are infectious and occur in epidemics; (2) they attack people suddenly, and when in good health; (3) they run a definite course, and if not fatal end in perfect recovery; (4) one attack protects against another.

The typical forms of infectious disease in man are the fevers: such as scarlet fever, small-pox, measles, and typhus; which are all of a highly infectious nature. The cause of these diseases can only be explained on the ground that there is at the time of an epidemic some harmful substance in the air, water, or food, which, entering into the body, infects it with the disease. This harmful substance is now definitely known to exist in the form of certain microscopic bodies usually called disease-germs, but to which many other names have also been given, such as micro-organisms, microbes, &c.

Germs.—Germs are low forms of life belonging to the fungus class. Considered as a natural order they occupy a position of great importance in the world; but individually they are so small, being invisible to the eye, that until recently they have escaped notice, notwithstanding the striking character of the results they effect.

The yeast plant.—The yeast plant is a fungus allied to disease germs, but much larger and growing much more profusely. It feeds on fluids containing sugar,

Fig. 144.

1, germs of milk fermentation (Klein); 2, various germs of decomposition from water contaminated with sewage (Crookshank); 3, the hay bacillus, the commonest germ of decomposition: its spores are always present in grass (Klein); 4, germs of alcoholic fermentation, yeast.

where it grows in the form of a frothy scum. Under the microscope this scum is seen to consist of myriads of small round or oval bodies like those in fig. 144. The yeast plant itself is very insignificant, but what a marvellous result it effects. It is the cause of fermentation. This insignificant fungus changes innocent sugar into powerful alcohol, and is responsible for the production of beer, wine, spirits, and all other alcoholic drinks.

Germs of decomposition.—The germs of decomposition (fig. 144) are still more closely allied to those of disease than the yeast fungus. If you put some broth, beef-tea, milk, or any other substance prone to decomposition into a flask, stuff the neck with cotton wool, as in fig. 145, and boil vigorously for twenty minutes, it will remain good for an indefinite length of time. If at the end, say, of a month, the cotton wool is removed, and the fluid examined under the microscope, nothing will be found in it but particles of the food substance; but, having removed the wool, it will now decompose in a day or two. A further microscopical examination will then show the fluid to be teeming with minute fungous bodies constantly on the move. These are the germs of decomposition, and the fluid is no longer harmless and nutritious, but poisonous.

FIG. 145.—A Flask of Sterilised Broth—that is, broth in which the germs have been killed by boiling, and fresh ones kept out by stuffing the neck with cotton wool.

The experiment shows that decomposition is caused by the action of these germs. The twenty minutes' boiling killed all that were present in the first instance. The cotton wool, whilst allowing the air to pass in and out, filtered off all the germs. Directly it was removed, germs, some of which are always present in the air, fell into the fluid, multiplied, and caused its decomposition.

Object of germ life: parasitic germs.—What happened in the experiment is constantly going on in the world on a large scale. It is by the agency of germs that dead and useless organic matter decomposes and is broken up, and its elements returned to the inorganic kingdom, so that they may be used again in the composition and structure of fresh plants and animals. This appears to be the great object of germ life: to feed on and destroy used-up organic matter. Under these circumstances it is surely not surprising that some germs should find their home and food in living instead of dead animals and plants. Larger individuals are frequently parasitic one upon the other. Why should not these microscopic fungi behave in the same way? And if parasitic, why should they not produce the same profound effect in the living body as they do in solutions of sugar and broth? The reply to these questions is that they do become parasitic; and that they do produce the most profound effect in the bodies of the men or animals they infest.

Disease germs.—These parasitic germs are the disease germs. They grow in us as the yeast plant grows in sugary solutions, and they change the nourishing fluids of the body as the yeast plant changes the nature of sugar. Each variety of infectious disease is due to a special kind of germ, which as it grows produces a special kind of poison in the blood, which in its turn sets up the special train of symptoms by which the disease is known.

Germs of anthrax.—If the blood of an animal suffering from splenic fever (anthrax) is examined with the microscope, it is found to be infested with germs of the peculiar shape shown in fig. 101. Some of them may be grown, or cultivated as it is called, on nutrient jelly in a glass tube, with such precautions that no other living thing is present in the tube. If the pure germs are now injected into the blood of a healthy animal, it will at once be attacked with the same fever.

The observation shows that splenic fever is caused by these peculiar germs, and that it is conveyed from one animal to another by means of the germs.

Fevers regarded as a phase of germ life.—These diseases are more easily understood if we study them as part of the natural history of germ life, rather than too exclusively from our own point of view. From our side an attack of small-pox is simply a disease, and is altogether bad; but looked at from the germ life point of view, we are merely a suitable soil for the propagation of a crop of small-pox germs. At the time of an epidemic the seeds are floating about in the air, ready to grow if only they can find a suitable soil to grow in. A man breathes some into his lungs, and at once that suitable soil is found.. As germs they grow and flourish, passing through their phases of life, and seeding again. But the man suffers a serious illness whilst they are living in his blood, and when their short life is over and he recovers, he very often passes some of the seeds on to his neighbours, in whom the same conditions are repeated.

CHAPTER C

CONDITIONS OF GERM LIFE—EFFECT OF ISOLATION AND CLEANLINESS—GERMS CARRIED IN AIR, WATER, AND FOOD—CONDITIONS INFLUENCING INFECTION

Conditions of germ life: effect of isolation: of dirt.—The cause of infectious diseases will now be understood. They are due to germs whose natural home is in the living body. They evidently exist under two conditions: (1) an active condition when inhabiting and flourishing in the living body, that is, when causing an attack of fever; (2) a more or less passive state during their existence outside the body. As regards this latter state, it is very important to know where they live, and how long they can survive. Many kinds of disease germs or their seeds are certainly carried in the air, but they do not appear to be carried far in this way. Typhus fever, for instance, is terribly infectious in the dirty dens in which it thrives, but cases have frequently been put in the well-ventilated wards of a general hospital without showing any indication of spreading from bed to bed. Near contact with the patient is always dangerous to those who have not had the disease, but typhus germs seem rarely to be carried through more than a few feet of pure air. In the case of the other fevers also, though they often spread from room to room in a house, and may be sent a thousand miles in a letter, a few yards of perfect isolation seems to prevent them from being carried from one place to another. But in the houses where the fever originates and thrives, infection always hangs about for a long time. Such places are in some way dirty, for perfect cleanliness and plentiful fresh air banish infection. There is something in close and dirty rooms, in badly kept ash-pits and middens, in foul drains, and all other filthy conditions which is especially congenial to germ life—not only to the germs of decomposition, which find their natural home in filth, but also to their close allies the disease germs, the seeds of which can apparently remain in an active condition for an indefinite length of time under such circumstances. These facts must be remembered when we come to study the prevention of infectious diseases.

Germs carried in water.—In some cases the germs are carried in water. This happens in typhoid fever, cholera, and dysentery. In a case of typhoid fever the doctor will tell you that you need not fear infection with reasonable care and cleanliness. This is because typhoid is a fever which attacks the bowels, and the germs are not exhaled into the air but pass off with the motions, and live in the drains. The germs of typhoid and cholera are just as infectious as those of typhus and small-pox, but the former are only infectious through the excretions of the bowels, and thus ought to be much more easily avoided than the latter, in which the germs pass into the air from the skin and lungs.

Infection in food and through wounds.—Infectious diseases are not often carried in food, because the heat employed for cooking destroys any germs which may be present in the raw substance. Epidemics have, however, several times been traced to milk, especially of typhoid fever, when the source has invariably been proved to be due to the addition of impure water to the milk before it was sold. Milk houses are now under special supervision, in order that the public may be safely guarded in respect to this most important food for the young.

Some infectious diseases enter the body through wounds. This is the case with blood-poisoning, erysipelas, and some other forms of wound fever.

Conditions influencing infection: exhaustion: a previous attack: vaccination.—In order to take a fever it is not only necessary that the germs should in some way find admission into the body, but also that the body should be in a condition favourable to their propagation. A person may be exposed to infection from measles, for instance, twenty times without taking it, and then succumb the twenty-first time. This usually cannot be explained, but we know that slight causes, such as exhaustion from want of food or over-work, at the time predispose the body to yield to the attack of infectious germs; and, no doubt, it is often a very little thing which determines whether germs succeed or fail in inoculating us. There is, however, one condition which definitely protects the body from infection, and that is a previous attack. Sometimes people have measles or scarlet fever twice, or are supposed to have them twice; but these are exceptions. The rule, which is almost invariable, is that one attack of any fever protects against a repetition of the same illness. This is believed to be due to the action of the germs upon the blood. The profound change they work in it not only makes us ill at the time, but makes our bodies more or less permanently unsuitable for the further propagation of the same class of germs. This is a most important fact, and has been taken advantage of in the attempts to prevent infectious disease, as in the case of vaccination for small-pox, and inoculation, or Pasteur's treatment for hydrophobia. In either case the object is to bring about the protective change without causing the disease, or at any rate only a very mild and modified form of the disease.

CHAPTER CI

THE DISEASES CAUSED BY GERMS

Germ diseases.—The list of germ diseases includes a number of illnesses in addition to the fevers. In the most acute kinds, the germs find their way into the blood and infect the whole system, as in the common fevers. In other cases, their action may be entirely local, as, for example, in a boil, which is due to a local crop of germs. These local germ diseases afford no protection against future attacks. One boil, for instance, instead of preventing others, usually produces them by inoculation.

The fevers.—The first group of germ diseases comprises the fevers called scarlet fever, measles, small-pox, chicken-pox, and typhus. These all run a definite course

FIG. 146.

1, the germs of cholera, from a stain on linen, magnified 700 times (Koch); 2, germs of consumption, × 1,500 (Crookshank); 3, germs of typhoid fever in a preparation of diseased bowel. × 1,000 (A. Barron); 4, germs of erysipelas in a preparation of skin, × 1,000 (A. Barron); 5, germs of inflammation in a preparation of pus, × 1,200 (A. Barron).

of so many days each, and are characterised by a typical rash on the skin and high fever. The infective germs are given off from the skin and lungs of affected persons, and are carried by the air and inhaled by those taking the disease. Infection is most virulent during the later stages of the fever, lasting longest in scarlet fever and small-pox, in which the diseased particles of skin take from three to six weeks to come away and be renewed by healthy tissue.

Bowel fevers.—Typhoid fever, cholera, and dysentery are closely allied to the foregoing, but in each the bowels are the parts chiefly attacked by the germs. These germs are passed in the discharges from the bowels, and through the sewers infect rivers and other sources of drinking-water, such as shallow wells. They are swallowed in water or uncooked food by those who become infected. These diseases are not infectious through the air like the other fevers, if the patients are kept very clean and all the bowel discharges are disinfected and entirely removed.

Diphtheria.—Diphtheria is a germ disease in which the throat is specially affected. Infective germs are given off in the breath and the discharges from the mouth. They also occur in foul drains, ash-pits, middens, &c., which are not known to have been contaminated with diphtheritic discharges. The disease may be conveyed by either inhaling or swallowing the germs.

Ague and malaria.—Ague and malaria are fevers which only originate in marshy districts. The infective germs are derived from the soil, and are not conveyed from person to person. One attack does not protect against another, as the germs apparently continue indefinitely in the system, but remain in an inactive condition between each fit.

Whooping-cough and influenza.—Whooping-cough and influenza are germ diseases which chiefly attack the respiratory system. The infective germs are carried in the air. They are derived from persons suffering from the diseases, and possibly from some other sources not yet understood.

Wound fevers.—Blood-poisoning and erysipelas are germ diseases which attack wounds, the former being very fatal. The infective germs inhabit various foul and decomposed substances, and may be carried by anything which is brought in contact with the wound; hence the extreme importance of cleanliness in dealing with wounds.

Fevers communicated by animals.—Hydrophobia is a germ disease attacking the spinal marrow. The infective germs are always derived from the bite of a rabid animal.

Glanders, anthrax, and foot-and-mouth disease are infectious diseases among animals, which are occasionally conveyed from them to man.

Consumption: leprosy.—Consumption is a germ disease of very wide distribution, to which all domesticated animals are subject as well as men. Some animals are very easily inoculated with the germs, but mankind, at any rate, cannot be infected unless the tissues have been predisposed to disease by inherited tendency or attacks of inflammation. The germs of consumption may attack any part of the body, but only when its vitality has been lowered by constitutional or local causes. The germs probably exist plentifully in the air, and it is only very rarely that anything like infection from person to person can be traced. Leprosy is an Eastern disease, due to a species of germ somewhat resembling the preceding, but more infectious.

Other affections.—Boils, abscesses, and various inflammations are also due to germs acting locally, and having no tendency to infect the entire system.

As knowledge advances, it is very probable that all acute affections will be proved to be due to germs. For instance, at the present time it is almost certain that inflammation of the lungs, rheumatic fever, lock-jaw, and various affections of the skin, &c., are due to them.

CHAPTER CII

THE PREVENTION OF INFECTIOUS DISEASES: PERSONAL PRECAUTIONS

Prevention of infectious diseases: necessity for combined action.—The cause of infectious diseases has been explained at some length, in order that the means by which they may be held in check or prevented may be intelligently grasped, and that the duty each one of us owes to the community in this matter may be understood.

In the case of other diseases, the risk usually concerns the individual only; but with infectious diseases, whilst an immense deal can be done by combined effort to protect an entire district or country, there are no means by which an individual can make certain of escape. For instance, if a man resolves to make no use of alcohol, he certainly cannot die from any of the diseases caused by it; and in other ways, by leading a perfectly healthy life, he may insure himself against a great many common causes of death. But no matter what precautions he may adopt against fever, they may easily be upset by the carelessness of some one else. A friend may send him a letter contaminated with scarlet-fever germs. He may ride in a carriage just previously used by a fever patient. He may drink milk which has been adulterated with impure water containing typhoid germs. His linen may be washed in the same tub with infected linen, or in a hundred ways he may receive infection through the negligence of others.

State regulations.—Of course the State steps in, and by law takes every possible precaution to prevent the spread of infection, but its efforts may at almost every point be rendered unavailing unless it receives the cordial assistance of the people. It is illegal for anyone suffering from an infectious complaint to occupy rooms at a hotel or lodging without stating the fact, or to use a public vehicle without first acquainting the driver, who, in his turn, is bound, if he accepts such a fare, to take his cab to be disinfected before using it again. It is also illegal to send infected clothing to the wash, or to sell them previous to disinfection, or to let an infected room, or otherwise to expose people to needless risk of infection. In case of an epidemic these regulations may at any time be added to by the Local Government Board; as, for example, in the recent threatened epidemic of cholera.

Personal precautions.—Every precaution taken against infection is for the public good, since each case is a source of public danger; but some are of a more personal nature than others, and these we will consider first.

Cleanliness.—It has already been pointed out that germs, when not conveyed directly from person to person, find their resting-place amongst dirt. Typhus rarely spreads beyond close and dirty houses, typhoid is derived from foul and imperfect drains, diphtheria from heaps of garbage, cholera from bad water, blood poisoning from overcrowded and dirty hospitals. Indeed, if it were possible for a whole nation to be perfectly and scientifically clean, infectious diseases would probably die out; in the meantime, a clean, airy, well-drained house may be regarded as one of the best safeguards against fever.

Personal cleanliness, especially amongst those brought in contact with fever cases, is also of the greatest importance. Think how easily the hands may be contaminated with germs from the skin of fever patients, or the discharges in diphtheria, typhoid, or cholera. The most minute soil may contain many germs, and if eating with unwashed hands, how easily some of them may be swallowed. When nursing fever cases the most scrupulous cleanliness should be employed in hands, clothing, utensils, and in everything connected with the sick-room and the persons entering it.

Exhaustion.—Exhaustion makes people more subject to infection; therefore it is not wise to be exhausted from want of food, want of sleep, or over-work when visiting or attending on fever cases.

Conditions of health.—Experience shows that infection is rendered more easy if the part liable to be specially attacked by the germs is weakened by previous illness. Consumption is generally preceded by colds on the chest; indeed, as far as is known, the germs of consumption cannot attack a perfectly healthy tissue. When cholera is prevalent, it has been noticed over and over again to attack people who had contracted simple diarrhœa from eating things which disagreed with them. The influenza germs, too, certainly attack people who catch an ordinary cold. We may accept it as a general rule that a lowered state of health, either of a part or of the whole body, encourages infective germs to establish themselves, and therefore that times of epidemics are times to be specially careful of general health. The people who more than all others should remember this point are those who are necessarily exposed to infection, like nurses and doctors, and those who inherit a tendency to a disease like consumption.

CHAPTER CIII

PREVENTION OF INFECTIOUS DISEASES (*continued*): INOCULATION—VACCINATION

Vaccination and inoculation.—The most certain way of infecting a person with a germ disease is to introduce some of the germs into his body through the skin, as is done in vaccination. If a little matter from a small-pox pimple is used, small-pox is inoculated; if from a diphtheritic throat, diphtheria would be produced, and so on. When inoculation is performed with proper precautions the disease is taken in a mild form. This was known as regards small-pox before vaccination was discovered; and as small-pox was as much feared then as cholera is now, people voluntarily submitted to inoculation, as they preferred the certainty of a mild attack to the chance of a severe one caught in the ordinary way.

Protection by inoculation: Pasteur's treatment for hydrophobia.—Pasteur has devoted a great deal of work to the subject of inoculation, and has met with some brilliant successes. First, he discovered that some of the most fatal epidemics of infectious disease in animals could be arrested by inoculating them with a mild form of the disease, from which they easily recovered. Then he discovered a way of curing hydrophobia—a disease which previously was invariably fatal. The method is an advance upon the older form of inoculation, as the germs of the disease are not used, only the fluid or poison made by them in the body of the diseased person or animal, and which protects it from a future attack, as was explained in Chapter C. Pasteur's treatment is employed as follows: Suppose a man to be bitten on the bare skin by a rabid (mad) dog. This almost certainly means that he is inoculated with the germs of hydrophobia, and will in time succumb to the disease. The germs take some weeks, or even months, to 'incubate' before they propagate and affect the entire system; when this happens, however, death results in all cases. Such a patient would now be immediately sent to Pasteur's Institute, where there is always a rabbit which has been inoculated with hydrophobia. Now the germs of hydrophobia, like those of other fevers, produce in the blood of the infected animal a substance capable of protecting it from a future attack. Pasteur takes this protective fluid from the rabbit, and injects it into the man before his germs have had time to propagate. Thus, when the time comes for them to propagate, the man's blood has been protected, they cannot flourish in it, and consequently the disease comes to nothing.

Hydrophobia is a disease specially suited to this form of treatment, on account of the unusually long period which elapses between the infection and the development of the symptoms—the period of incubation. This gives time to thoroughly saturate the system with the protective fluid before the germs begin to grow and multiply. In small-pox the period of incubation is only twelve days; still, it has been shown that vaccination during the first day or two after exposure to infection will prevent the disease from developing.

Koch's treatment for consumption.—Koch's treatment for consumption, which recently created so much excitement, was based upon a similar principle. The Koch's fluid is obtained from a consumptive guinea-pig, but is quite free from the germs of consumption. When injected into the body of a person suffering from any form of consumptive disease it produces a great disturbance in the affected part, but unfortunately up to the present this has very rarely ended in recovery. The germs of consumption behave in many ways unlike those of the acute fevers. Experience of the disease in the human being affords no evidence that they produce a protective substance, and, therefore, the failure of this kind of treatment in consumption is no argument against its employment in the more highly infective forms of germ disease.

Vaccination.—Vaccination is not quite the same thing as inoculation, unless cow-pox is the same disease as small-pox. This is said to be the case, and if so, it is easy to understand why vaccinating a person with the germs of cow-pox should protect him from having small-pox. It will be understood that inoculation consists in inoculating a person with the germs of a disease in order to give him a mild attack of that disease, which will protect him from ever having it again. This was constantly done with small-pox before vaccination was discovered. Pasteur's treatment of hydrophobia and Koch's treatment of consumption are, of course, not real inoculation, as the germs are not used and the disease is not produced; the protective fluid which is injected is more of the nature of a medicine, though it has to be taken from the body of an animal suffering from the same disease.

Vaccination was discovered and practised by Jenner nearly one hundred years ago, in 1796. Vaccinia, or cow-pox, is a mild febrile complaint to which cows are subject. It is allied to small-pox, and is perhaps due to accidental inoculation of cows with human small-pox. Jenner observed that milkmaids, who from handling the cows became accidentally inoculated with cow-pox, did not take small-pox. . This observation was much more easy to make in those days than it would be now, for small-pox was so rife that at times one out of about every ten deaths was due to it. Jenner having observed the fact that cow-pox apparently protected from small-pox, began to vaccinate people with the former disease. Then, as was the custom in those days, he inoculated them with small-pox, but entirely without effect. Every means was tried to ascertain if it was possible to give small-pox to people who had been thoroughly vaccinated from the cow, and the result was to prove beyond question that vaccination protected against small-pox. In the hundred years which have passed since Jenner's discovery, experience has confirmed his views, and now small-pox, instead of being the most feared of all diseases, attracts very little notice. It certainly sometimes attacks well-vaccinated people, but only in a modified form, when it has a very low death-rate.

The operation of vaccination: its course: the law.—The operation of vaccination is performed in different ways. The lymph containing the germs may be obtained directly from the calf, when the vaccination is generally very severe but effectual. Or it may be taken from the ripe vesicle in one child and directly introduced into the arm of another—the arm-to-arm method of vaccination. This is also effectual, and is less severe. Another method is to collect the lymph and seal it in glass tubes, or dry it upon ivory points, and use it at some subsequent date. This method is not quite so reliable and effectual.

However obtained, the lymph is gently pricked or scratched into the skin of the arm. In two or three days little pimples arise at the points of inoculation. These enlarge and have watery heads and a red base, when they are called vesicles. About the eighth day the fluid changes to thin matter, and the vesicles are now said to be ripe. The lymph used for vaccinating other children should not be taken later than this period. About the tenth day the places begin to dry up, and a scab soon forms, which falls off at the end of the third week, leaving behind the characteristic scars. When very severe the arm becomes red and tender, and the glands in the arm-pit are swollen and painful. In most cases also, as would be expected, the child seems out of sorts, and has a little general fever.

All children are required by law to be vaccinated before the age of three months, unless a medical certificate is submitted stating that the child is not in a fit condition of health for it. The object of this law is not to interfere with individual rights, but to protect the community from the greater danger of general infection, which would follow from the rashness of those who neglected to avail themselves of this means of protection. Vaccination is only effective against small-pox.

CHAPTER CIV

PUBLIC PRECAUTIONS AGAINST INFECTION—NOTIFICATION—ISOLATION

Public precautions against infection: notification of infectious diseases.—The special sanitary measures which are adopted by the health authorities to prevent the spread of infection are notification, isolation, and disinfection.

The immediate notification to the medical officer of health of the occurrence of every case of infectious disease has only been in practice of late years. It is a step in the right direction; for if this officer knows where and when every case of fever originates, he has the best possible chance of discovering the cause of the outbreak and at once checking it. It may be that the epidemic follows a certain distribution of water or milk—a fact that would pass unnoticed unless one man was supplied with information respecting all the cases in his district. People do not like it to be known that they have a case of fever in the house. Friends will not visit them; and if it is a shop or other business place customers keep away, and the loss may be serious. Under these circumstances there is a temptation to conceal the illness, and thus to greatly increase the risk of spreading infection. Fortunately now, the doctor attending, or whoever has charge of the patient, is required by law to at once notify the case to the medical officer of health, who has power to enforce whatever sanitary measures are necessary ; and thus selfish people have not often the chance of concealing their trouble at the expense of risk to others.

Isolation: fevers spread from person to person.—Isolation is one of the chief means of dealing with infection. It is almost certain that the germs of most of the infectious diseases can flourish only in the human body. If, therefore, the germs which are given off by a case of fever do not meet with some susceptible person in whose body they can propagate, they must, sooner or later, perish. So far as it is possible to trace diseases like small-pox or scarlet fever they seem invariably to spread from person to person, and it is not believed to be possible for anyone to get such an illness in any other way than by infection with the germs of a recent case. If this be so, common sense at once suggests isolation as the most important precaution that can be taken in the interest of the public health. Let the person infected be at once removed from all contact with his neighbours, excepting only those who are absolutely necessary for his welfare.

Special hospitals.—Satisfactory isolation can be obtained in all but very small private houses ; but in the crowded dwellings of the poor, in small shops—especially where food is sold—in schools, workrooms, and business premises generally, safe isolation is out of the question, and it is only right that the patient should be removed from his surroundings, where he is a source of danger, and treated in some other building more suitable for the purpose, such as a fever hospital. It seems hard to the ignorant that a child or a parent, whom the friends are anxious to nurse at home, should have to be removed; but it is much harder that unsuspecting people lodging in the same house, or coming to it, or buying food or clothes at it, should be allowed to run the risk of infection, and perhaps death. The medical officers of health frequently meet with cases which are very shocking to hear of; such as a milk shop with scarlet-fever children put to bed under the counter. Above them stand the uncovered bowls of milk with which other people's children are to be fed. In another case the mother is nursing fever, and making a suit of clothes for a tailor, in the same room. Clearly when infectious cases cannot be properly isolated at home, it is right for the health authorities to take the matter in hand and enforce their removal to hospital.

Isolation in a private house.—To isolate a case of fever in a private house, it is advisable that the room should, if possible, be on the top floor, and it is well that no other room should be occupied on the same floor. A sheet, which is to be kept wet with carbolic lotion, should be nailed along the top of the doorway, so that it hangs like a curtain over the door, and a tub of the same lotion should be placed just outside to receive all soiled linen from the sick room. Things brought to the room should be given to the nurse at the door, and no one should be allowed to enter except the doctor, The nurse should herself wash and disinfect the crockery and utensils used by the patient, and when she goes off duty she should never neglect to wash and change her dress.

The room.—The room should be well cleaned down, and all unnecessary furniture removed before the patient is placed in it. The carpet, curtains, bed-hangings, heavy furniture, and all ornaments not easily washed should always be taken away; in fact, nothing but what is absolutely necessary should be retained. It is most important that the room should be clean, airy, and well ventilated, and that there should be no places where germs can remain undisturbed, as they would in dark corners, beneath and behind heavy furniture, and on the tops of wardrobes, &c.

Duration of isolation.—Isolation must be commenced directly the case is suspected to be infectious, and continued until the doctor pronounces the patient safe to mix with others again. The period during which these diseases are communicable extends from the first day until some time after the symptoms have disappeared; but the later stages are usually the most infectious. Cases of mumps are isolated for about two weeks; measles, diphtheria, and typhus about a month; scarlet fever and small-pox six weeks, or until the last scale of infected skin has come away; whooping-cough two months or more; and typhoid and cholera until the movements of the bowels are quite healthy again.

CHAPTER CV

PREVENTION OF INFECTIOUS DISEASES BY DISINFECTION—DRAINS—TYPHOID, CHOLERAIC, AND OTHER DISCHARGES—THE SKIN AND MOUTH—WOUNDS AND SORES

Disinfectants: object of disinfection.—Many substances are used for disinfection, or the destruction of infective germs. It must be remembered that the object of disinfection is not to destroy, cover, or remove bad smells, but to *kill germs.* Bad smells are chiefly important as indicating the presence of germs, the chemical gases which cause them not being harmful in the small quantity in which they usually occur. The smell is easily covered by a strong-scented disinfectant like chlorinated lime; but the proper plan is to remove the cause of the smell. A drain which requires chlorinated lime is one which is out of order, and should be put right; for it does not follow that because the odour has been covered by the stronger one of a disinfectant that the germs are necessarily destroyed. The strongest disinfectants, as a rule, are entirely without smell, and when there is occasion to disinfect any putrid matter, the safest plan is to use an inodorous chemical, as the sense of smell will then guide us as to the effect produced.

Purposes for which disinfectants are required.—Disinfectants are required for many purposes, amongst which the following are the most important: For drains, typhoid and choleraic discharges, the sick room during the illness, the sick room after the illness, infected linen, infected bedding and clothing, the patient's skin, wounds and sores.

Disinfection of drains.—The foul emanations escaping from imperfect drains are not to be cured by any form of disinfectant. The only proper treatment is to see that they are correctly laid, trapped, ventilated, and flushed. As, however, people have sometimes for a time to put up with bad drains, the danger may certainly be lessened by the use of strong disinfectants. For this purpose the salts of iron and zinc are the best; the latter are the stronger, but the former are the cheaper, and so can be used in larger quantities. Neither of them have any odour, therefore the sense of smell will be a guide as to the amount of good they do. Carbolic acid and chlorinated lime are also powerful and good disinfectants for this purpose; but a little sprinkled about the surface gives off such a strong odour, that the drain-smell is quite covered, and a false sense of security is thereby encouraged.

Disinfection of typhoid and choleraic discharges.—In all our knowledge about infectious germs, there is nothing more certain than that the contagion in the case of these two diseases is carried in the discharges from the bowels. In this way they contaminate the sewers, cesspools, or other places where these discharges are deposited; and from them the germs escape into the air with the sewer gas, or get into drinking water through imperfect drains. Such discharges should, in *every case*, be disinfected. It is a clear duty that we owe to the public, the neglect of which is chiefly responsible for the spread of these diseases. The disinfectant used should be a strong one; Burnett's fluid, which consists of a strong solution of chloride of zinc, is one of the best. The discharge should be received into a vessel containing a pint of water mixed with two ounces of the fluid, or into a pint of a solution of sulphate of iron of the strength of one pound to the gallon of water. It should be allowed to remain in the fluid for a short time, and then mixed with a little more before being emptied away. In town, the vessels are, of course, emptied into the lavatory; but in the country the discharges should be buried in the ground, taking care that the place selected is some distance from the source of the drinking water. If the contagion of all such discharges were destroyed, there is good reason to believe that any epidemic of these diseases might be infallibly stamped out.

The discharges from the throat and nose in diseases like scarlet fever, small-pox, and diphtheria should also be disinfected in the same way, or received upon pieces of rag, which must be immediately burnt.

Disinfection of the skin and mouth..—In all fevers accompanied by a rash the skin is infested with germs, some of which escape into the air with the little particles of scarf skin which come away during convalescence. In scarlet fever and small-pox the scaling is more extensive than in the others, and the scales are loaded with germs; they appear to be the chief source of infection. The best method of disinfecting the skin is to gently rub it with camphorated oil, or eucalyptus and vaseline, and when the patient is well enough, to wash the skin with warm water and carbolic soap.

To disinfect the mouth, chlorine water, Condy's fluid, sanitas, weak carbolic, and strong boracic acid solutions are the best. The first should only be used by a doctor's advice.

Disinfection of wounds and sores.—Wounds and sores, if not kept clean, are liable to be occasionally infected with germs of a very bad nature, such as cause blood-poisoning, and, unless disinfectant lotions are used to them, they are always infected with simple germs which keep up a discharge of matter from the raw surface. Hence all lotions used by doctors for wounds contain some sort of disinfectant. The safest lotion for use by those who have no medical knowledge is made by dissolving as much boracic acid in cold water as it will take up. The wound may be washed with this, and dressed with lint dipped in it. It cannot do any harm, as it is unirritating, and it suits all kinds of sores. Should the sore be very foul, boracic acid is not strong enough by itself to make it sweet and healthy; therefore, each time it is dressed it should be washed with carbolic lotion, of the strength of 1 to 40, and the surface dusted with iodoform, a strong-smelling yellow powder. The wound should be dressed as often as is necessary to keep it pure and clean, for cleanliness and rest are the principles on which all wounds should be treated.

CHAPTER CVI

DISINFECTION OF THE SICK ROOM DURING AND AFTER INFECTION—OF INFECTED LINEN, BEDDING, AND CLOTHING

Disinfection of the sick room during the illness.—The air of the sick room may be partially purified, and the spread of infectious germs limited by the use of disinfectants, but air cannot be absolutely disinfected without making it unfit to breathe. Various plans are adopted. One is to use a non-volatile disinfectant and spray it at intervals through the air of the room. For this purpose Condy's fluid answers very well. In the form of a fine spray it mixes with the dust in the air, carrying it to the ground and destroying any germs it may contain. Condy's fluid is frequently placed about the room in small saucers; in this form it is very nearly useless, as it would only affect the few germs which accidentally happened to fall into the saucers.

Another method is to hang up towels or sheets wetted with carbolic acid lotion of the strength of 1 part of the acid to 20 parts of water. Carbolic acid is volatile, and slowly diffuses itself through the air of the room as it evaporates off the sheets. Moreover, the dust and germs suspended in the air when they come in contact with the wet sheets adhere to them. This is the chief use of the carbolic sheet hung outside the door of the sick room, and of the plan, common in hospital wards, of surrounding a suspicious case with a carbolic screen.

A third method is to volatilise the disinfectant by boiling it with water. This is usually done with a steam or bronchitis kettle, a kettle with a long spout projecting into the room. Carbolic acid may be used in this way, but eucalyptus is perhaps the best disinfectant to disseminate through the air of a room by means of steam. It is specially useful in infectious diseases of the throat and other parts of the respiratory system, such as diphtheria, influenza, and whooping-cough.

The dust obtained by sweeping the room should be at once burnt.

Disinfection of the sick room after the illness.—When the case is over, the room requires thorough disinfection. This is a point upon which medical officers of health always rigidly insist, and very properly, as in no other way can it be made safe for use again. This is how to do it: First remove the bedding, linen, and clothing, but leave all furniture which is not to be disinfected elsewhere. Next paste brown paper over all the openings leading out of the room, such as the fireplace, ventilators, and the chinks round the window sashes. Then set fire to some sulphur in the middle of the room, go out quickly, and paste up the crevices round the door. Burning sulphur gives off a powerful suffocating gas, destructive to all living things, germs included, but does little or no harm to the furniture. It is very penetrating, and is certainly the best disinfectant for this purpose.

Method of burning sulphur.—To burn sulphur put some live coals in an old iron pan, or anything of the kind that will serve as a brasier, and set it in the middle of the room on an old tray or other piece of metal, to avoid the possibility of the floor taking fire. Then sprinkle the broken-up sulphur on the top of the live coals and leave it to burn. One pound of sulphur should be used for each 1,000 cubic feet of space in the room. Sulphur fumigators, which burn by simply lighting a wick, have recently been manufactured. They are sold by the best chemists, and are very convenient and satisfactory.

The room should remain closed for twenty-four hours; then, to make the disinfection complete, it should be thoroughly cleaned down with carbolic soap, the paper stripped from the walls and burnt, the ceiling lime-washed, and the windows left wide open. With such precautions no trace of infection could remain about a room, no matter what it had been used for.

Disinfection of linen.—Every article of linen used in the sick room should be straightway deposited in a tub outside the door containing carbolic lotion of the strength of 1 part of the acid to 40 or 50 of water. After remaining in this for some hours they may be washed in the ordinary way. But any linen which has been soiled with the bowel discharges in typhoid and cholera, or handkerchiefs which have been used in diphtheria, scarlet fever, small-pox, or whooping-cough, should be first left to soak in the lotion, and subsequently at a convenient time be well boiled in the same before being washed.

Disinfection of bedding and clothing.—The only efficient way of disinfecting bedding and clothing which will not wash is to stove them in an oven specially constructed for the purpose, or to expose them to the action of steam super-heated under pressure. The latter is considered the better method. Steam heated in this way, when all air has been exhausted from the steam chamber, acts as a dry penetrating heat, not as a moist heat, and is consequently very effectual and not destructive to clothing. The temperature used is 240°, and the articles are exposed for half an hour. Dry heat in an oven cannot be used beyond 220° without risk of injuring the fabric, and in order that it may be thoroughly destructive to the germs, it is continued for six to eight hours. Of course these processes cannot be undertaken in a private house, but the health authorities are prepared to remove, disinfect, and return such things free of charge, the cost being paid out of the rates.

CHAPTER CVII

DISINFECTANTS: SULPHUROUS ACID GAS, CHLORINE, CARBOLIC ACID, CONDY'S FLUID, SANITAS, EUCALYPTUS OIL, CAMPHOR, THYMOL, BORACIC ACID, IODOFORM, AND SALTS OF ZINC, IRON, AND MERCURY

The following is a list of the principal disinfectants:

Sulphurous acid gas.—The gas given off by burning sulphur. It is used as has been described.

Chlorine.—The strong-smelling gas given off by chlorinated lime. When of full strength, it is an even more powerful disinfectant than the preceding. Pure chlorine, however, is not much used, as it is difficult to prepare, and bleaches and otherwise damages furniture more than the sulphurous gas. The amount ordinarily given off by chlorinated lime is not sufficient to make it a strong disinfectant, though the latter is largely used for drains, yards, cattle-pens, &c.

Carbolic acid.—This is one of the very best disinfectants. It is one of the numerous substances prepared from coal tar. When pure it is in white crystals, which have a slight and not unpleasant carbolic smell. The impure forms are dark coloured and liquid, and have a strong, disagreeable odour. The acid dissolves in water in the proportion of one part to twenty or more. It is very poisonous and corrosive when strong.

Carbolic acid may be used for any of the purposes for which disinfectants are required. It has the advantages of being powerful, volatile, and not destructive to flesh or clothes when properly diluted. The pure acid, dissolved in forty parts of water, has a well-deserved reputation for cleansing sores of all kinds, and still a little weaker it makes an excellent mouth-wash, being, indeed, the chief ingredient in the best dentifrice waters. The second quality, of the same strength, is sufficiently good for disinfecting the hands, linen, &c. For drains, bowel discharges, and foul matters generally, the coarse, crude kind will do ; it should be used double the strength, namely one to twenty, but is not quite so efficacious as the mineral disinfectants. The carbolic powder, consisting of a small percentage of crude, strong-smelling acid mixed with lime, is popular for dusting about where there is a bad smell ; but, as has been mentioned on p. 384, the smell is in this way covered without the danger being removed. Carbolic soap is disinfectant and purifying, but is not so safe as the one to forty lotion for the hands. The pure acid only should be used for the vapour, and not too much at a time. For disinfecting the air of the sick room it is safer to use the spray of Condy's fluid or the vapour of eucalyptus oil. Carbolic acid is also a very good insecticide.

Condy's fluid.—Condy's fluid is a solution of the permanganate of potash or soda. It has no smell, very little taste, and is not poisonous. It is not volatile, and therefore only acts upon matter which is brought into contact with it. If enough is used, it oxidises organic matter, at once destroying germs, foul odours, and all the products of decomposition. The solution is of a deep claret colour, which is changed to brown by the action of organic matter. The colour therefore enables us to judge how much is required. When brown, the action is over and the solution useless; so the rule is to keep on adding fresh fluid until a permanent red is established. A great drawback to the use of Condy's fluid is that it stains things brown, and is thus not suitable for linen, hands, &c. It may be used for all the ordinary purposes to which disinfectants are applied, bearing in mind its staining action, that it is not volatile, and hence does not rise into the air, and that a great deal has to be added to drains &c. to be of any use. Its value in purifying drinking water has been referred to at p. 311.

Sanitas.—Sanitas is a derivative of turpentine, but differing from the latter in that it has a much more pleasant taste and smell, and in mixing readily with water. It is artificially prepared from coal tar. Its chief recommendations are its pleasant pine-like odour, and that it is not poisonous. It is sold both as a liquid and a powder, and may be used for any disinfecting purpose, but is not nearly so powerful and reliable as carbolic acid.

Eucalyptus oil.—Eucalyptus oil is a volatile essential oil of characteristic fragrant odour. Its very volatile nature, and the fact that inhaling it often does good rather than harm, make it a very suitable disinfectant for the air of the sick room. It is a powerful deodoriser, and is therefore an excellent substance for use in the chamber utensils in cases other than typhoid or cholera; a few drops are sufficient. It is a good insecticide, and mixed with vaseline or olive oil makes a good dressing for burns &c. and for disinfecting the skin after fever.

Camphor: thymol.—Camphor, thymol (from oil of thyme), and many essential oils, like those of peppermint and cloves, are strong disinfectants, but are too costly to be extensively used.

Boric acid.—Boric or boracic acid occurs in small white crystals, which are only slightly soluble in cold water. It is one of the best disinfectants for wounds. The lotion is made by simply putting some crystals or powder in a bottle of water, shaking them up, and then using the clear solution after the undissolved crystals have had time to settle. It is not irritating and not poisonous, and therefore may be used to any kind of sore. Boracic acid is also used as a preservative for food; but though not poisonous when taken occasionally, its continued use is harmful.

Iodoform.—Iodoform is a strong-smelling yellow powder, a powerful deodorant and disinfectant. It is very largely used for dusting on the surface of sores of all kinds, particularly those that are foul. It is one of the most cleansing applications which can be applied to a wound. It is not irritating, but is of a more poisonous nature than boracic acid.

Zinc salts.—Burnett's fluid consists of a simple solution of chloride of zinc of the strength of about 220 grains to the ounce. It is a colourless, heavy liquid, without smell, and of a very caustic and poisonous nature. It is a powerful disinfectant, and particularly reliable for destroying the germs in typhoid and choleraic discharges. It is not so suitable as carbolic for hands, linen, &c. The sulphate of zinc is also an excellent disinfectant for drains and many other purposes. It is not quite so strong, but has the advantage of being very much less corrosive.

Sulphate of iron (green copperas).—This is much cheaper than the sulphate or chloride of zinc, is not corrosive, and not poisonous in small quantities. Of the strength of one pound to a gallon of water it is a valuable disinfectant for drains, but is not so thoroughly reliable in cases of typhoid and cholera as the zinc salts. It cannot be used for linen.

Mercury salts.—Corrosive sublimate (perchloride of mercury), and all the soluble salts of mercury, are very strong disinfectants; but they are so poisonous and corrosive that they are scarcely fit to be used by any but medical men. The perchloride lotion is a very popular wash for wounds at the present time. It is used of the strength of one part to from one to four thousand parts of water. Commercially, the disinfectant qualities of the mercurial salts are utilised for the preservation of hides.

CHAPTER CVIII

HOME NURSING—THE DUTIES OF A NURSE—THE SICK ROOM—OBSERVATION OF THE PATIENT

Sick nursing.—Sick nursing is now recognised as one of the most important aids in the treatment of disease. Indeed, a patient's life often depends more upon good nursing than upon strictly medical treatment.

Training.—To be efficiently trained for the profession of sick nursing, it is necessary to spend three years in practical work, of which not less than one must be taken at a hospital where proper courses of instruction are delivered. The object of the following chapters is not to fit anyone for such a position, but merely to enable them to bring some knowledge as well as kindness to help them in their endeavours to nurse sick friends at home.

Home nursing.—The devotion of a near relation is one of the pleasantest features of home nursing; but the doctor has come to look for more than this. He is accustomed in the present day to be associated with an intelligent nurse in the care of sick people, and as the methods of investigating and treating disease have increased, many extra duties have devolved upon the nurse, which would be beyond the skill of the best of mothers or daughters without some special instruction.

Duties of a nurse.—Amongst the duties which constantly fall to the share of a nurse are the following:

(1) The preparation and management of the sick room.

(2) An intelligent observation of the course of the illness during the doctor's absence.

(3) A skilful attendance on the patient, including the administration of remedies.

(4) The preparation of suitable foods for sick people.

The sick room.—The doctor will generally advise as to which is the best room in the house to select for a case of illness. The points of importance are that it should be large, well ventilated, quiet, sunny, warm, and clean. The room having been selected, it should, if possible, have a thorough turn out the day before putting the patient in. This is particularly advisable in the case of surgical operations, serious injuries, and lying-in cases. To thoroughly turn out a room, everything should be taken out of it, a large fire made, and the windows thrown widely open. The ceiling and walls should be swept and cleaned; the woodwork and floor should be well scrubbed with carbolic soap; and lastly, only such furniture should be brought back as is really necessary after having been well cleaned elsewhere.

Observation of the patient.—A sick person is not usually visited more than once a day by the doctor. In the meantime, it is one of the chief duties of a nurse to carefully observe and record all that has been done for the patient, and all the changes that have taken place in his symptoms. In this part of her duty a nurse should not trust to memory, but should write down everything as it occurs on a sheet of paper. The notes so taken should include an accurate record of the amount of food and medicine given, of the sleep, the excretions,

Fig. 147.—A Clinical Thermometer.

and the symptoms of the illness, including, if she have the necessary skill, the morning and evening temperature of the body and the rate of the pulse.

The pulse and temperature.—The pulse is generally not difficult to count by the second hand of a watch. The artery for the pulse is felt beating on the front of the wrist, about one inch above the root of the thumb. The temperature of the body is taken with what is called a clinical thermometer (fig. 147). This is a plain glass thermometer, ranging from 95° to 110°, with an index which remains at the highest point reached by the mercury during the observation. The temperature is taken by placing the bulb of the thermometer under the tongue or in the armpit for five minutes. In the former case the lips must be kept closed, and in the latter the arm must be held to the side in such a manner as to grip the thermometer tightly.

The record of the temperature and pulse is often kept upon a special chart. Should the doctor wish it kept in this way, he will explain the method of doing it.

CHAPTER CIX

ATTENDANCE ON THE PATIENT—WASHING—BED-SORES—ADMINISTRATION OF FOOD

Attendance on the patient.—This is, of course, the nurse's chief duty, and occupies the greater part of her time and attention. A strong man, when on a bed of sickness, is often as helpless as a little child, and may be as dependent upon his nurse as a baby upon its mother. Her work under these circumstances is certainly hard and often disagreeable, but the very necessity of the patient makes it a labour of love. Of the many things which a nurse has to do for her patient the most important only will be referred to, and a short explanation of each will be given under a separate heading.

Attention to the skin.—It will be remembered that amongst the duties which the skin has to perform are two which have an important relation to acute illnesses: to regulate the temperature of the body and to excrete certain harmful things from the blood. These functions of the skin render it particularly active in sickness, and, therefore, cleanliness is even more necessary then than when in health. Another point requiring special care and attention during prolonged and exhausting diseases is the skin over the lower part of the back, which is very liable to suffer from pressure and breakdown to form a bed-sore.

Washing.—The face and hands should be gently washed with soap and water every morning, and again sponged with tepid water in the evening. In most cases the entire body may be sponged at least once a week, even in the worst if it is quickly and skilfully managed. Only a part of the body, as, for example, an arm or a leg, should be exposed at one time, and should be washed, dried, and made comfortable again before proceeding to another part. The more perspiration there is the more need for washing to keep the skin pure and healthy. In high fever tepid sponging is frequently used to reduce the temperature, in which case it is very refreshing and encourages sleep.

The hair and teeth, of course, also require daily care. When the person is too ill to use a tooth-brush the teeth should be cleaned with a little piece of lint or linen dipped in some antiseptic mouth-wash.

Bed-sores.—Bed-sores sometimes cannot be prevented, but generally they are the result of careless or unskilful nursing. If once the skin is allowed to break over the lower part of the spine, there is always a danger of its rapidly running into a bad sore; hence the greatest care must be taken to prevent the skin from being injured, as with the edge of a bed-pan, or irritated as with crumbs in the bed, or to become soft and sodden as from perspiration or urine. Every day in bad illnesses the nurse should gently turn the patient on his side, wash and carefully dry the lower part of the back, and dust it with violet powder. Whenever the skin is sodden, it should be gently rubbed with a little spirit or eau-de-cologne, before being powdered, in order to harden it. The most difficult cases to manage in this respect are paralysed patients.

Linen.—In rheumatic fever, acute consumption, and other cases in which the perspirations are copious, a frequent change of nightdress is imperative. Should the amount of linen be restricted, it is much better to change the wet nightdress for one that has only been dried and aired before the fire, than to leave it on the patient.

Administration of food.—Feeding the patient is often one of the most important parts of the treatment, and it is the very cases which are most difficult to feed that, as a rule, are the most dependent upon careful nourishment. A very little will cause a sick person to turn against food, and the same meal which would be refused if carelessly served will be happily disposed of if presented in a more attractive form.

Kind of food.—In very bad cases fluid foods and jellies are the only forms in which nourishment can be taken. Patients generally soon tire of beef-tea, chicken-broth, and meat-essences; but fortunately they take milk well, and tolerate it longer than anything else. As milk is in itself a complete food, it contains all that is necessary to sustain life, and is as suitable a food for sick people as it is for babies.

Quantity of food.—The doctor generally orders the food in the quantity required for twenty-four hours. For instance, he may tell the nurse to give two pints of milk, one pint of beef-tea, one ounce of meat-essence, and four ounces of brandy in small and frequent quantities. The nurse has then to calculate how she can get it all in without interfering with sleep, without worrying the patient, and without encroaching too closely on the hours when medicine is due. If she plans it out carefully she will succeed, the nourishment will be all taken and equally distributed; whilst when it is given in a haphazard way the patient probably gets less on the whole, and is exhausted from want of food at some times and from an overloaded stomach at others. Each time that food is taken the nurse should notice the amount, and write it down on her daily record.

Mode of feeding.—When the patient is too ill to sit up, the food is given in a feeding cup (fig. 148). The nurse first puts a napkin under the chin, then passes her left arm under the pillow and raises the patient's head, and feeds him with the cup. She then gently lowers him again, removes the napkin, and wipes his mouth with it.

Fig. 148.—Feeding Cup.

Sometimes during an illness there may be a time when the stomach is too weak to digest food of any kind. Under these circumstances food is given which has been peptonised—that is, partly digested by artificial digestive juices (see p. 406).

Sometimes food cannot be taken at all by the mouth for a time; it is then administered by the bowel. When this is necessary, the doctor will explain how it should be done if he is unable to come sufficiently frequently to do it himself.

CHAPTER CX

MEDICINE—THE BED—CHANGING SHEETS—HOT AND COLD APPLICATIONS

Medicine.—Medicine should always be given strictly in accordance with the directions, and should be accurately measured. Spoons vary too much in size for this purpose, but cheap measure-glasses may be obtained at any druggist's shop. Generally, medicine is given between meals, as it is more rapidly absorbed and its effect is more marked when taken on an empty stomach. But some, like cod-liver oil and arsenic, are best tolerated when the stomach is full, and so are given directly after a meal; as also are substances like pepsine and maltine, which help to digest the food.

Dangerous mistakes.—Lotion and medicine bottles should never be kept side by side, as the mistake of giving lotion for medicine has been fatal on several occasions. Poisonous lotions should always be dispensed in dark blue, fluted bottles, so that their dangerous character may be apparent to both sight and touch.

Nauseous drugs.—The unpleasant taste of many drugs constitutes one of the minor difficulties of the sick room. If the breath is held whilst swallowing the medicine, and not drawn until the mouth has been rinsed out, the taste will often be scarcely perceived. The persistent after-taste of nauseous drugs is best removed by eating a crust of bread. By recent improvements in the pharmaceutical art most medicines may be obtained in a tasteless form, as compressed tablets, or in gelatine or other coatings, but they are not quite so popular with doctors as the old-fashioned remedies, and are of course more expensive.

Management of the bed: the bed: bed cradle.—The best bed for health is also the best for sickness—namely, a plain iron frame with spring and hair mattresses. For fractures a harder bed is preferred, and for very exhausting illnesses a water bed or pillow is sometimes needed. If the room is kept at the right temperature (60°), two blankets will always be sufficient; more than two would be oppressive owing to their weight. Sometimes the patient cannot bear the weight of the bedclothes at all, when they are kept from the body or some part of the body by a cradle (fig. 149). A cradle, for instance, is always used for fractures, so that nothing but the splints need touch the injured limb.

Draw-sheet.—The linen under the patient is kept clean when necessary by the use of a draw-sheet. This is simply an extra folded sheet covering the middle third of the bed, and tucked in on each side to prevent it from rucking. A piece of mackintosh is generally placed beneath the draw-sheet; that is, between it and the under sheet.

To change the sheets.—To change the sheets whilst the patient is in bed the following plan is adopted.

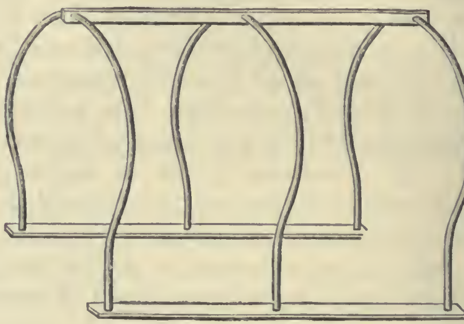


FIG. 149.—A Bed Cradle.

(1) Remove the upper clothing down to the last blanket; then without removing this draw out the top sheet from beneath it. (2) Take away the pillow and turn the patient on his side. Roll up the under sheet on the unoccupied side of the bed, and tuck it against his back. Half roll a clean sheet; lay the rolled part against the rolled part of the soiled sheet, and smoothly spread out the other half, and tuck it in. (3) Turn the patient gently on to his other side so that he rests on the clean sheet; then remove the soiled sheet, which is now free,

and unroll and tuck in the other half of the clean sheet. (4) Restore the pillow; then spread the clean upper sheet over the blanket, and, whilst holding it in position with one hand, remove the blanket with the other. Finally, replace the blankets and coverlet.

Draw-sheets may be changed in the same way as the under sheet if the patient is too ill to raise himself, or if he is too heavy to be easily raised whilst the change is being rapidly made.

Local applications: cold.—Cold is used to prevent or check inflammation, and to restrain hæmorrhage. For the latter purpose its use will be explained in another chapter. In the treatment of injured or inflamed parts, cold may be applied either in the form of ice or an evaporating lotion. The ice is broken up and put in a bladder or india-rubber ice-bag, which is suspended over the part so as only to rest lightly on it, a piece of lint or linen being interposed between the skin and the ice-bag.

The cooling effect of lotions depends chiefly upon evaporation; therefore, they generally contain spirit, and are never covered with mackintosh. The common evaporating lotion is made by adding two or three ounces of spirit to a pint of water. Lead lotion or Goulard water is also popular; it combines an astringent action with its cooling effect.

Hot applications: poultices: linseed poultice.—Poultices are made of linseed or bread. The former is the best material for the purpose, and is always used for large poultices. To make a linseed poultice the following things are required: two basins, a kettle of boiling water, a spatula or a flexible knife, linseed, linen, and olive oil. Into one basin pour some boiling water, and put the knife in it. Then, having first warmed the other with a little hot water, pour in sufficient for the poultice. Into the latter sprinkle the linseed meal while constantly stirring with the knife, until the mixture is of the thickness of porridge. Now turn it out on to the piece of linen, and spread it in an even layer of about half an inch thick to within one inch of the margin of the linen, frequently dipping the knife into hot water to prevent the poultice from sticking to it. Fold back the margin of the linen on to the poultice to make a neat border, and finally sprinkle a few drops of olive oil on the surface when the poultice is completed.

A poultice should be applied as hot as the patient can bear it, the heat being first tested by the back of the nurse's hand. It should be covered with mackintosh or wadding to keep the nightdress dry, and should generally be changed about every four hours.

Bread poultice.—A bread poultice is commonly made by pouring boiling water on bread crumbs in a teacup, which is then placed covered in a pan of boiling water until the bread is thoroughly swollen. The other details are the same as for a linseed poultice.

Charcoal poultice.—Charcoal and other disinfectant poultices are made by adding the charcoal or disinfectant to linseed or bread. A popular surgical poultice or fomentation is made by pouring boiling water on to bran contained in a muslin bag, and mixed with a small proportion of boracic acid or borax.

Mustard poultice.—A mustard poultice is made by stirring in mustard after mixing the linseed with boiling water. It may be made of any strength up to equal parts. Instead of olive oil, muslin is spread over the surface. A mustard plaster is made of mustard and water, with or without flour, spread on brown paper; but the mustard leaves now sold by chemists are frequently used instead. The strength of a mustard plaster must be regulated by the age, sex, and part. Children and women feel the effect much more than men, and thin skin like that of the throat much more than the thick skin of the back. Mustard should redden but not blister the skin. When the latter is desired, a blister is ordered.

Fomentations.—To make a hot fomentation pour boiling water on a folded piece of flannel, wring it in a towel by twisting the ends in opposite directions; then take it to the patient, give it a light shake out, and at once apply to the part. Cover with mackintosh. A fomentation is not so heavy as a poultice, but does not retain the heat nearly so long. Fomentations are frequently medicated. A boiling decoction of poppy heads may be used instead of water, or laudanum may be sprinkled on the surface of the flannel after wringing. The turpentine stupe is made by sprinkling from one to four teaspoonfuls of turpentine on the flannel. It acts like mustard.

CHAPTER CXI

FOOD FOR INVALIDS

Milk.—In many acute illnesses, and in some chronic cases, the diet is absolutely restricted to milk. In fevers from two to five pints are given daily, generally two to three pints diluted with an equal quantity of water, soda-water, barley-water, or lime-water. In chronic cases like kidney disease, from five to seven pints are given daily in small and frequent quantities without dilution. In wasting diseases it is given in addition to other diet. If not easily tolerated, to a small glassful add two ounces of hot water containing five grains each of soda and salt.

When milk is boiled or diluted, and especially when diluted with water containing soda or lime, it is more easily digested, because the curds formed in the stomach are smaller.

Whey.—Heat half a pint of milk to 140° (as hot as it can be sipped), add one teaspoonful of Fairchild's or Benger's essence of pepsin, and stand in a warm place till the curd forms. Break it with a fork, and strain off the whey.

Lemon whey.—Boil one pint of milk with two teaspoonfuls of lemon-juice, and strain off the curds. Whey is a useful form of light nourishment in fevers, &c.

White wine whey.—To half a pint of boiling milk add a wineglass of sherry; strain, and add a little sugar.

Koumiss.—One quart of new milk, one dessertspoonful of honey, and one teaspoonful of yeast. Warm the milk, and add the honey and yeast. Pour from one jug to another two or three times to mix, and bottle in pint bottles. Cork tightly, and stand in a warm place for twenty-four hours; it is then ready to drink. Koumiss should be made fresh every two or three days.

Peptonised milk.—To one pint of milk add a quarter of a pint of water. Heat to 140°. This is conveniently done by boiling one half and mixing it with the cold half; the whole will then be heated to 140°. Now add two teaspoonfuls of Benger's Liquor Pancreaticus and half a level teaspoonful of soda (bicarbonate). Mix in a covered jug, and stand in a warm place for twenty minutes. Then bring just to the boiling point to prevent further peptonising, which would make it bitter, and serve like ordinary milk.

Gruel.—If made from fine English meal, make two dessertspoonfuls into a thin batter with water, and gradually add it to a pint of boiling water in a stewpan, with stirring. Boil for ten minutes, and sweeten. If made from coarse Scotch meal, make the gruel like thin porridge, sprinkling the meal into the boiling water, and boil from half an hour to an hour. Gruel may be made with milk instead of water.

Peptonised gruel.—Allow the gruel to cool to 140°, and add two teaspoonfuls Liquor Pancreaticus and half a level teaspoonful of soda to the pint. Mix and stand in a warm place for two hours; boil and serve. Milk gruel may be treated in the same way. The sweetness of the artificially digested starch covers the bitterness of the prolonged peptonising of the milk.

Arrowroot.—Make a dessertspoonful of arrowroot into a thin paste with milk, and add a little castor sugar. Pour half a pint of *boiling* milk on to the paste, with stirring, and serve. The arrowroot is improved by returning it to the pan and boiling carefully for ten minutes.

Revalenta Arabica.—Make a teaspoonful of Revalenta into a thin paste with milk. Add it gradually, with stirring, to half a pint of boiling milk, and continue the boiling, with stirring, for an hour. Revalenta requires thorough cooking; a water pan is therefore a great help, as it removes the risk of burning the milk. It is very nourishing and digestible if properly cooked.

Rusks.—German rusks (tops and bottoms) made into a food with boiling milk are very digestible, and suitable for invalids and babies.

Baked flour.—Fill a basin with fine flour, lightly press it down, and bake in a moderate oven for four or five hours. Baking renders flour more digestible. A thin gruel made of it is used in dysentery and other affections of the bowels.

Egg-flip.—Beat together the yolk of an egg and a teaspoonful of castor sugar, and add gradually a wineglassful of brandy and one of cinnamon water, previously mixed. Wine may be used instead of brandy and water.

Beef-tea.—To one pound of lean, juicy beef, finely minced, add one pint of water. Put in a well-covered brown jar, and allow to cook in a moderate oven for three hours, or even longer; or the jar may stand in a pan of boiling water instead for the same length of time. The fluid may be strained off through a coarse wire strainer, but not through muslin, as a fine strainer removes a good deal of the nourishment. Salt and pepper may be used to taste.

Beef juice.—To a half-pound of finely minced lean beef add a quarter of a pint of water, and allow to stand in a cool place for two hours. Strain and squeeze through muslin. If four drops of strong hydrochloric acid are added to the water, more nourishment will be extracted. The acid itself acts as a digestive tonic, and is, therefore, not objectionable; but, if desired, it can be at once removed after straining by adding a pinch of soda, which converts it into common salt. Raw beef juice has no unpleasant taste, but should be given to the patient in a feeder, so as not to attract attention by its appearance. It may be flavoured with a slice of lemon, or a little claret, or Liebig's extract. It should be kept in a cool place, and not longer than from twelve to twenty-four hours.

Mutton-tea.—To two shanks of mutton add from one to two pints of water. Soak for several hours, then scrape well, and simmer for five hours with salt and a piece of well-toasted bread. Strain, and remove fat. It may be given cold as a jelly, or warm as a tea.

Veal-tea.—Cut up the meat and crush the bone of a knuckle of veal. Put in a pan and cover with cold water, using one pint and a half to the pound, add salt and a very little pepper. Simmer for five hours, strain, and serve.

Chicken-broth.—Skin and cut up a small fowl. Place in a stewpan with a quart of water, a crust of bread, salt, pepper, and a sprig of parsley. Simmer for four hours, strain, and skim when cool.

Mutton-tea, veal-tea, and chicken-broth are all somewhat less stimulating than a strong beef-tea, and all contain a good deal of gelatin. They are a suitable form of light nourishment in febrile complaints and during long illnesses, when a change from beef-tea is desirable. They are very much improved, not only in flavour, but in *wholesome* and nutritive qualities, by stewing with them a handful of fresh vegetables enclosed in a muslin bag, the expressed juices of which have a most beneficial action, when, as is so often the case, food of this class is otherwise entirely withheld.

Scraped beef.—This article is prepared by scraping the pulp from the best lean beef with a table knife; all the fibrous parts should be left behind. The raw pulp of beef is a valuable form of nourishment. It is best given in the form of sandwiches, or diffused in clear soup, the temperature of which does not exceed 140°. For convalescents, a pleasant and digestible dish is made by lightly cooking the scraped beef in a cup standing in boiling water, and serving it on toast.

Barley water.—Put two ounces of barley and three pints of water into a covered earthen jar. Cook in a moderate oven for three or four hours. Strain, and add a little sugar and lemon. Or the barley and water may be simmered in a pan.

Rice water.—Wash three ounces of Carolina rice and put it in a pan with two quarts of boiling water and a one-inch stick of cinnamon. Boil for one hour, and strain.

Lemonade.—Peel two lemons very thinly. Remove the white skin, cut the lemons into thin slices, and take out the pips. Put the lemons and half the thin skin, with sugar to taste, into a jug, and pour on a pint and a half of boiling water. When cool, strain into another jug.

CHAPTER CXII

THE ST. JOHN'S AMBULANCE ASSOCIATION—VALUE OF FIRST AID—BLEEDING: VARIETIES—TREATMENT OF INTERNAL AND EXTERNAL BLEEDING

St. John's Ambulance Association.—Sixteen years ago an association was founded, called the St. John's Ambulance Association, with the object of teaching all classes of people how to give immediate help to the injured, and to those suddenly seized with some illness, rendering them urgently in need of assistance.

Value of 'first aid.'—It very rarely happens that a doctor is present when the accident or other emergency occurs. Time, therefore, and very valuable time, must elapse before his assistance is obtained. Is this time to be lost? Some friend, neighbour, fellow-workman, or passing stranger, is generally upon the spot, and upon his or her power of rendering assistance life or death may depend. It is a terrible situation to stand by and see life ebbing away, not knowing what to do; and it is still more sad to learn subsequently that one did the wrong thing, and so perhaps destroyed the last chance. The majority of cases are of course not so serious as this; but in many the subsequent recovery will be very much influenced by the sort of treatment to which the patient was subjected in the first instance.

When a sudden emergency occurs, some one is sent with all speed for a doctor. Why? Because common sense tells people that something should be done *at once*. The object of the following chapters is to give some guidance as to what it is that can be done before the doctor arrives.

Bleeding (Hæmorrhage): varieties.—Everyone knows that bleeding is one of those emergencies which brook no delay. Help to be effectual must be rendered immediately. Bleeding may take place from arteries, veins, or capillaries. Blood spurts in jets from an injured artery, being forcibly driven out by the beats of the heart, and is of a bright red colour. It wells up in a continuous stream from a wounded vein, and is very dark in colour. Capillary bleeding occurs as an oozing of blood from the mucous membranes, from which it trickles off in drops, as in the familar example of bleeding from the nose. Bleeding may be either external or internal; that is, it may flow from the surface, or into some internal organ or cavity. In the latter instance no blood at all may be visible, or, as in the case of the lungs and stomach, it may be coughed or vomited up, and so ultimately come to the surface.

Treatment of internal bleeding.—Internal bleeding must be treated upon what are called general principles. As we cannot get at the vessel, we have to be satisfied with doing what is possible to help nature to close it. The natural process is that the vessel should contract and so partly close the open end; then that a clot of blood should form and completely seal it up. The contraction of blood vessels is best stimulated by cold in the form of ice. When there is bleeding from the lungs or stomach, the patient should be given a piece of ice to suck, and the cold in the mouth, if it does not actually reach the bleeding part, still reacts through the nerves and helps to bring about the desired effect. But the most important thing is to get the patient to lie quietly down and calm his fears and excitement, for anything which tends to quiet the circulation gives nature a chance of forming the life-saving clot, whilst anything which excites the heart causes it to be washed away as fast as it is produced. For this reason brandy and all stimulants are inadmissible whilst bleeding is going on; and fainting, though it seems so serious, is not always a bad thing, since by checking the blood stream, it often enables the clot to form and plug up the injured vessel at once.

Treatment of a case.—Thus, when a person begins to cough up or vomit blood, put him on a sofa or a bed, or, if necessary, the ground. Support the head enough for him to be able to get rid of the expectoration, but not too high, or a dangerous faint might be caused. Do everything you can to soothe his fears and excitement, and do not permit him to make any exertion that can be possibly avoided. Open the clothing at the neck and over the chest. Get ice as soon as you can, and of course send for the doctor at once. If he faints and does not come round, lower the head and raise the legs to send blood to the brain, and use smelling salts; but put the body flat again as soon as he begins to rally. Never allow more than one or two people to be present in the room.

Bleeding from the nose.—Bleeding from the nose is not uncommon in young people, and is rarely serious. When it occurs in older persons it is usually more difficult to stop, as it is probably not the result of simple congestion but a symptom of some disease.

Treatment.—Let the patient sit or stand with the head thrown back and the arms held up straight above it. The sudden raising of the arms above the head is usually enough to stop the bleeding. If it fails, try ice to the bridge of the nose and ice to suck; or ice to the back of the neck, or a bunch of cold keys slipped down the back. Bathing the face and nose in cold water is often sufficient; but to do this requires the head to be held forwards, which increase the congestion of the lining membrane of the nose.

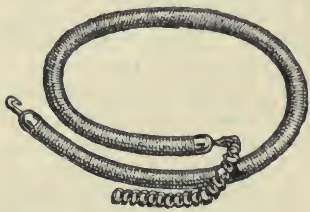


Fig. 150.—Esmarch's Elastic Tourniquet.

Treatment of external bleeding.—The plan which is at once suggested by common sense, and which is the correct one, is to compress the bleeding vessel until a surgeon can be found to tie it. To do this properly one should know the position of the main arteries and veins thoroughly; for to immediately find and compress a vessel requires more than a superficial knowledge of anatomy, and can practically only be accomplished by a trained surgeon. The methods of checking external bleeding which can be successfully carried out by an ambulance pupil are: (1) To apply the elastic tourniquet; (2) to bind a compress directly over the wound; (3) to raise the part.

Esmarch's elastic tourniquet.—The elastic tourniquet (fig.

150) is simply a piece of strong india-rubber tubing, with a hook at one end and a short chain at the other, or some other simple means of fastening it. It is used by surgeons throughout the world to control bleeding whilst operating on the limbs. The method of applying it is very simple : it is to wind it tightly round the limb three or four times in the same place (fig. 151), and fasten it by attaching the hook to the chain. It cuts off the entire circulation from the limb below, and ought not, therefore, to be kept on for more than one or two hours. It can of course only be applied to the arms and legs, and is, therefore, of no service in wounds of the head, neck, and body.

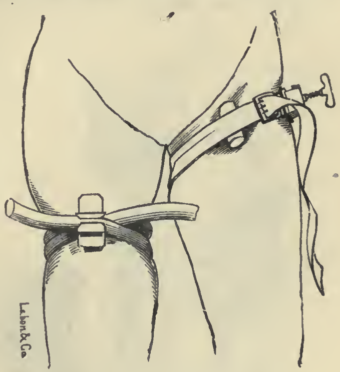


Fig. 151.— Tourniquets in Position—the old style on the left, and Esmarch's Elastic Tourniquet fastened with a clip on the right thigh.

The compress.—Pressure within or over the wound may be employed in all cases, and is often the only available method, since few except medical men have the skill to compress the artery above, and an elastic tourniquet is frequently not to be met with when it is suddenly wanted. A compress for the wound is made by folding up pieces of linen or handkerchiefs and placing them one on the top of the other. The piece next the wound is the smallest, and the others gradually increase in size, so that the entire compress is wedge-shaped. This is held firmly over the wound, and then bound on tightly with a bandage, scarf, or folded handkerchief. Should the linen compress not be successful, try a big sponge squeezed up like a ball, and bound firmly into or over the wound. The elastic expansion of the sponge is a great help, and will often succeed when the other fails.

Raising the limb.—If a limb is raised above the level of the trunk, the blood pressure in it is lessened. This should always be remembered in bleeding. By simply elevating the limb the flow is somewhat checked, and is more easily stopped by the compress. Always keep the wounded part well raised when bleeding is troublesome.

CHAPTER CXIII

BLEEDING FROM WOUNDS OF THE EXTREMITIES—FRACTURES: SYMPTOMS, VARIETIES, CAUSES, TREATMENT

Bleeding from wounds of the upper extremity.—Wounds of the palm of the hand sometimes bleed freely. The way to stop it is to place a firm ball like a rolled-up bandage in the

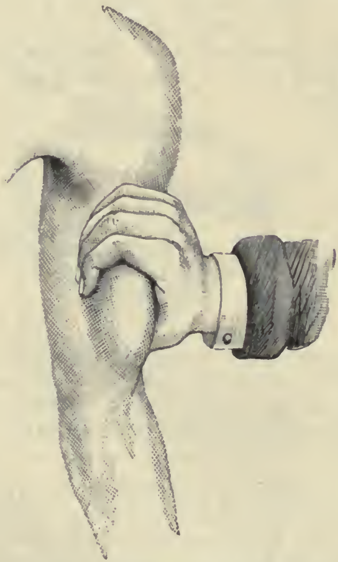


Fig. 152.—Compression of the Main Artery of the Arm with the Fingers.

Fig. 153.—Compression of the Femoral Artery in upper Part of the Thigh.

patient's hand, and bind his fingers tightly over it. Bleeding from other wounds of the arm may be stopped by a tight compress, or by the elastic or other tourniquet, or by compressing the main artery with the fingers against the inside of the bone near the top of the arm (fig. 152). The latter requires an exact knowledge of the position of the artery, and its relation to the bone behind it, both of which may be studied by anyone on their own body, as it can easily be felt beating beneath the skin.

Bleeding from wounds of the lower extremity.—Wounds of the lower extremity are most serious when they involve the

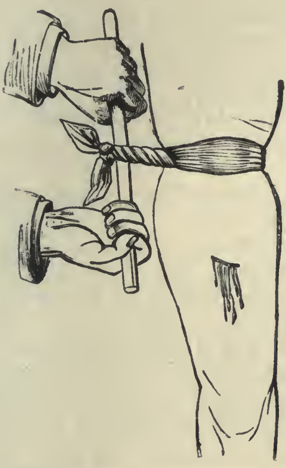


FIG. 154.—Application of an Improvised Tourniquet to the Thigh for Wound below (handkerchief and stick with a hard ball placed over the position of the main artery).

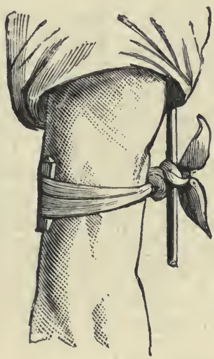


FIG. 155.—Improvised Tourniquet applied to the Upper Arm (a handkerchief and stick with something hard over the artery).

vessels of the thigh, which are very large. It requires a very tight compress to close the main artery of the thigh, and if one applied over the wound is not successful, and there is no elastic tourniquet at hand, an endeavour must be made to compress the artery against the bone at the top and front of the thigh either with the two thumbs, as in fig. 153, or with an improvised tourniquet, as in fig. 154. Here, again, the vessel may be felt beating, and its compression practised on one's own body. Bleeding from wounds lower down is not so severe, and is more easily stopped.

Bleeding from varicose veins.—Bleeding from a varicose vein in the leg is sometimes very serious, because in such dilated veins the valves do not act. The result of this is that as the weight of the column of blood above the wound is quite unsupported, the blood rushes out in the wrong direction, rapidly emptying the main veins of the body. It is just a case of tapping a column of fluid near its lowest point.

Treatment.—No kind of bleeding is so easy to stop. If you merely put the patient down and raise the leg it will almost or quite cease, and a compress lightly bound on will make it safe in any position of the body.

When a varicose vein gives way, it is generally due to an ulcer of the leg; but of course a wound may sometimes be the cause.

Bleeding from scalp wounds is stopped by a bandage firmly applied over a compress, as in fig. 175.

Broken bones: symptoms.—To learn how to treat an accident without knowing how to recognise it, is like learning to write shorthand without being able to read what you have written. When you have reason to suspect a broken bone, look for the following symptoms, and if none are present, you may dismiss the idea, and remember that the less pronounced the symptoms, the less urgently needed is a splint. (1) Loss of power in the part. If the bone which is broken is an important one, the limb will always be useless. (2) Pain. This is present in all injuries; but it is particularly severe when a broken bone is moved. (3) Deformity. The limb is usually but not always out of shape. (4) Unnatural mobility. A limb will bend at the seat of a fracture, whilst if the bone were sound it ought only to bend at the joints. (5) Crepitus. A sensation of grating produced by the fractured ends rubbing against each other when the limb is moved.

How to examine for fracture.—If the severity of the pain and the loss of power point to a fracture, too great care cannot be exercised in handling the limb. Further examination requires that the clothes should be removed, and this is best done by ripping up the seams. When the limb is handled it should be very firmly grasped, and held in its natural position. If you touch it gently the muscles will often contract and hurt the injured part much more than if you held it firmly. When a splint is to be applied there should if possible be two people, so that one can bind it on whilst the other holds the limb in a good position.

Simple fractures.—A fracture is called simple when there is no wound through the skin leading down to the bone. Such a fracture in the arm heals in three or four weeks, and is generally strong enough for the limb to be used again at the end of six weeks, or, at any rate, two months. In the leg the limb is usually kept in splints four weeks; in a stiff bandage four more weeks, and then may perhaps require a little longer rest before it is fit for use. A fractured thigh is rarely fit for work under three months.

Compound fractures.—When the ends of the bone communicate with the air through a wound, the fracture is said to be compound. The wound may be a part of the original injury, or it may have been caused by careless handling subsequently, which has allowed the sharp fragments to push through the skin. A compound fracture requires from twice to four times as long to repair as a simple fracture; thus, in a compound fracture of the leg, it is generally twelve months before the patient is able to undertake hard work again. Moreover, the risk of losing the limb or even life is very greatly increased by permitting a simple fracture to become compound. Indeed, one of the reasons for holding ambulance classes was this very fact that by the ignorant handling and moving of broken limbs simple fractures were frequently made into compound.

Causes of fracture.—Fractures may be caused by direct violence, as in kicks, blows, run-over, &c., when the bone gives way at the part where it was struck; or by indirect violence, when it gives way at the weakest point. Examples of the latter are a fracture of the collar bone by a fall on the outstretched hand, and a fracture of the kneecap by the muscles of the thigh in trying to avoid a fall.

Splints and bandages.—To set a fracture splints and bandages are required. The former may be extemporised out of almost any material which is sufficiently unyielding, such as sticks, umbrellas, piece of paling, newspapers rolled up flat, cardboard, &c. For the latter folded handkerchiefs, scarfs, or strips of linen answer very well. The object of the splint is to give the limb some of that support which it has lost by the fracture of the bone, and to keep the sharp fragments quiet. To do this the splint should be bound to the limb above and below the fracture, and should if possible be long enough to fix the joint above and the joint below the injury. Thus, in a fracture of the bones of the leg, not only should the leg itself be bound to the splint, but also the lower part of the thigh and the foot, so that both ankle and knee are fixed as in fig. 157.

CHAPTER CXIV

SPECIAL FRACTURES OF THE ARM, LEG, RIBS, SPINE, SKULL, AND FACE

Wrist and forearm.—Fractures of the wrist and forearm belong to the less serious class. Two newspapers folded flat make very good temporary splints. With the thumb pointing upwards one is placed on the back and the other on the front of the forearm, where they are firmly bound in position. The arm with the elbow bent is then put in a broad sling (fig. 171).

Fig. 156.—Splints for a Broken Arm.

The elbow.—Fractures of the elbow are more serious. If the joint is stiff and will not bend, the injury is probably a dislocation, in which case there is no occasion to put on a splint, but the patient should be taken to a doctor as soon as possible, that it may be reduced. If it appears to be a fracture, the best thing to do is to carefully bend the arm, and put it in a broad sling. Such a fracture cannot be satisfactorily set in makeshift splints, and is not likely to take any harm if properly slung.

The arm bone.—Fractures of the bone of the upper arm should be put up by binding three or four small and short splints round the broken bone with handkerchiefs (fig. 156). Then sling the arm from the wrist with a narrow sling (fig. 172).

In cases of injury of the upper extremity, always remove the clothing from the sound arm first; then pass it over the head, and gently draw it off the injured limb. When the fracture is at the elbow or the upper arm, the seams of the clothing on that side should be undone.

Collar bone.—Fractures of the collar bone are very common. This bone is so near the skin that the broken part can usually be seen and felt quite easily. All that is necessary is to put the arm in a sling.

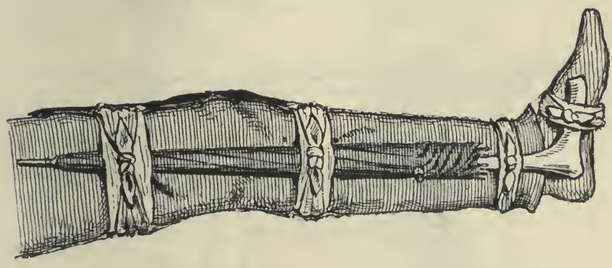


Fig. 157.—Temporary Splint applied for Fracture of the Bones of the Leg.

Ankle and leg.—Fractures of the ankle and leg bones are in much more urgent need of first aid than those previously mentioned. The bones here are very near the skin, the fragments are usually sharp, and a little carelessness converts a simple into a compound fracture. If the patient has not been drinking he will not try to stand, knowing from his own feelings that the leg will not support him, but with help he will hop along on the sound leg, or manage to get into a cart. To allow this, however, is very bad treatment, as the bone may be pushed through the skin, the very thing which ought to be prevented. He should, if possible, not be moved at all until some firm temporary splint has been bound on the leg, and then he should be carried lying flat. If lifted into a cab a board should be placed from seat to seat for the leg to rest on. An umbrella bound as in fig. 157 makes a suitable splint for a fractured leg.

Thigh.—Fracture of the thigh bone is the most serious of all fractures of the limbs. The patient is rendered so helpless by it that he never makes any attempt to stand. A splint to be of service should be strong, well bound on, and

Fig. 158.—Temporary Splint applied for Fracture of the Thigh Bone.

Fig. 159.—Stretcher formed by four Poles.

Fig. 160.—Rope-stretcher formed of Rope and two Poles.

should reach from the armpit to the foot. A flat wooden splint shaped like a piece of paling is the best, but a long-handled broom, which is more likely to be at hand, will do very well (fig. 158). If applied next the skin it will require padding with some soft substance like wadding, but in a fracture of the thigh bone the pain, the complete helplessness of the limb, and the patient's knowledge that the bone has snapped, are sufficient to indicate the nature of the injury without removing the clothing. It is better not to do so, but to apply the splint outside the clothes. Cases of fractured thigh should always be moved lying flat on a stretcher,

FIG. 161.—Carriage of the Injured by two Bearers.

shutter, gate, hurdle, or similar contrivance. Improvised stretchers are shown in figs. 159 and 160. When an injured or insensible person has to be carried by bearers, the method shown in fig. 161 is the best.

To remove the clothing from the lower limb, the boot should be first carefully taken off, the trousers ripped up on the injured side, and then drawn off the sound side.

Ribs.—Fractures of the ribs are caused by blows, kicks, run-over, &c. The chief symptom is a sharp catching pain when a breath is drawn. The patient should be taken to a house, the clothing removed, and a flannel bandage bound several times firmly round the chest; it supports the broken bones and limits the chest movements in breathing.

Spine.—Fractures of the spine are very sad injuries, not because of the bones—they heal very well—but because the spinal marrow is nearly always torn through at the same time. This causes complete paralysis of all parts below the injury, from which the patient very rarely recovers. Anyone can recognise the nature of this injury by the paralysis of the legs. There is not much pain. No splints are required, but the patient should only be moved lying flat on a stretcher of some kind.

Fig. 162. Chin Bandage of Handkerchiefs for Fractured Jaw.

Skull.—Fractures of the skull are serious in proportion to the injury sustained by the brain. If the brain is not at all hurt the case does very well, and it is hard to get the patient to submit to the proper period of rest. But frequently the brain is very much damaged, when the patient will be more or less unconscious. He must be taken carefully home, put to bed, and cold applied to the head. No splints are required. In such cases it is the injured brain much more than the injured bone that needs attention. Unfortunately, the symptoms vary very much, so that it is often difficult to say what is the matter. Sometimes the patient is deeply unconscious, sometimes only stupid; sometimes he is noisy as if in drink; sometimes has fits, and so on; and there is often no mark whatever to be seen on the head. If there is any reason to think that a person has had a blow or fall on the head, and is in any way peculiar, the safest plan is to regard the case as one of injury to the brain, as it is much better to have taken perhaps unnecessary care of a drunken man, than to have harshly neglected a case of concussion of the brain.

Jaw.—Of fractures of the bones of the face there is only one that is usually of importance. This is fracture of the lower jaw. Immediate treatment is not very urgent; but it is as well to keep the jaw closed by passing a bandage or handkerchief under it, and tying the ends on the top of the head (fig. 162). Fractures of the nose or cheek do not require first aid unless it may be that the bleeding in the former case requires treatment.

CHAPTER CXV

SPRAINS, STRAINS, AND BRUISES—BURNS AND SCALDS

Sprains, strains, and bruises.—A sprain is a violent wrench of the leaders and ligaments which surround a joint. A strain is a similar condition applied to other parts, particularly the muscles. Thus, a man is said to sprain his ankle or wrist, but to strain his back or thigh. In either case some of the tissues are overstretched or actually torn; more or less blood is effused and shows under the skin in bruise-like patches, and some inflammation is set up. In a sprain the inflammation affects the joint and the neighbouring leaders, causing swelling and stiffness. With rest the former generally subsides soon, but the latter is often slow to go.

Treatment.—The best treatment is first to bathe the part in water as hot as it can be borne for half an hour or more, and then to put on hot flannel or bran fomentations. The hot applications should be continued for about twelve hours, during which time the sprain may be bathed as often as the patient likes. Then for a few days, whilst the limb is kept perfectly at rest, the joint should be wrapped in cold water bandages, or lead and opium lotion (Goulard water one pint, laudanum one ounce). When the swelling has gone down, which may happen in from a few days to two or three weeks, the wet applications should be given up, and the part well rubbed with some simple liniment, such as the soap liniment, and the joint worked about.

Nearly all the stiffness and pain which is so frequently left after a sprain is due to the glueing together of the leaders by the inflammation, a condition which is generally removed by freely moving them. When the joint has been much swollen, a bandage, or some similar support, should be worn for a few weeks after beginning to use it again.

Bruises.—Bruises which are unaccompanied by fracture or internal injury are not serious. Cold water or lead and opium lotion applied on lint, and kept in position with a bandage, is all that is necessary.

Burns and scalds : causes.—These injuries are, unfortunately, of very common occurrence. They are most frequent in women and children, owing to the inflammable nature of their clothing. Men generally meet with such accidents at their work, or as the result of drink. In the former a common cause is that light cotton articles of clothing, such as night-dresses, aprons, and pinafores, are drawn against the bars of the fire by the draught up the chimney. Other causes are various forms of carelessness with lighted matches, candles, and paraffin lamps, upsetting pots and kettles of boiling water, &c. In men, besides fire and hot water, molten metal, boiling oil, and gunpowder are met with as causes, and very severe burns they produce. In some places mothers are foolish enough to allow the children to take a drink out of the kettle-spout when it is full of cold water. It is easy to see how this may occasionally lead to a terrible accident when the mother's back is turned and the water happens to be boiling; an accident which is well known in the London hospitals.

Degree of injury.—Burns are met with in every degree, from simple reddening of the skin to destruction of a limb; but the severity of the injury depends not only upon the depth of a burn, but its extent. The greater the damage to the nerves of the skin, the more intense will be the shock, even although the skin itself is only partially destroyed. Scalding water is not so severe as burning clothing, but hot metal and oil are both very destructive.

To put out burning clothes.—Burning accidents might very frequently be prevented by the exercise of a little presence of mind. Some one is generally near when a child's or a woman's clothing takes fire. The first flame is a small one; and if, instead of standing aghast, the burning spot were seized and crumpled up in the hands, the catastrophe would be averted. The person whose clothing is on fire should be laid flat immediately, as flames spread upwards with great rapidity. In a minute more the clothing is all in flames, when the only thing that can be done is to cover the person up with woollen things and roll her about, and so smother and press out the flames. The woollen articles most likely to be at hand are coats and shawls, hearthrug, carpet, and blankets, any of which will do. Flames can be more quickly smothered in this way than put out with water, unless it happens to be possible to jump bodily into water. When a woman is endeavouring to put out fire, she must take the utmost precaution to prevent the flames touching her own dress.

To go into a burning room.—When a house is on fire, the people in it may be killed in two ways : by burning, and by suffocation with the fumes of combustion. If it is necessary to go into a burning room, take the following precautions : If possible, wear only woollen clothing. If none is to hand, wrap the head and as much of the body as you can in a blanket, preferably wet ; crawl quickly into the room, keeping the head near the floor, as, if there is any fresh air, it is always near the floor. If, at the last moment, you take several rapid and deep inspirations, you may be able to hold your breath long enough ; but if you must breathe in the room, draw the breath through a corner of the wet blanket held over the mouth and nose, which will filter off the choking particles in the smoke, or through a wet handkerchief stuffed into the mouth. Wool, silk, and leather being animal substances burn with difficulty, and therefore protect the body against fire ; and a wet woollen material is the best respirator that can be extemporised at a moment's notice.

Treatment of burns and scalds.—These cases call for immediate help, both on account of the painful nature of the injury and the severity of the shock. Get the patient into a house as soon as possible, cut off the clothing, and dress the burns at once. The object is to apply something soft and soothing which will keep the air out and keep the part warm ; for though the injury was caused by heat, the subsequent shock is accompanied by the usual coldness of the surface. Strips of cotton wadding, oiled on the side next the skin, make an excellent dressing ; or, in the absence of wadding, oiled linen will do. If these are not to hand, boiled starch is very soothing and healing ; or even a simple dusting with flour helps greatly to relieve the pain. The oil generally used is called carron oil ; it consists of a mixture of equal parts of linseed oil and lime-water. In the absence of this, linseed oil alone, or olive oil, or vaseline will do. In hospitals some disinfectant is generally used in the dressing, as parts of the burnt skin die and become offensive. The best is eucalyptus oil, which is used mixed with vaseline; and when starch is applied, boracic acid is added to it.

Course and results of burns.—In addition to the dressings, warm drinks and stimulants will be required to overcome the shock in bad cases, and a few drops of laudanum are often urgently needed to relieve the pain. Following the shock is a stage of reaction, accompanied by fever, which lasts till all the dead skin has separated and the sore become clean. Then there is a prolonged period, during which healing is slowly progressing, but in which an exhausting discharge is taking place. Ultimately, if the case does well, the sores heal; but, unfortunately, this is rarely the end of the trouble; for all large scars gradually shrink and contract, and this contraction of the scars of burns is often the cause of distressing deformities.

CHAPTER CXVI

FAINTING—APOPLEXY—EPILEPSY

Shock.—Shock is a condition of nervous prostration which accompanies all severe injuries. Any circumstance which sufficiently depresses the power of the nervous centres is felt throughout the whole body. When they fail, energy is withdrawn from the vital organs; their functions are reduced to the lowest ebb, and life is almost suspended.

Symptoms.—When suffering from severe shock, the patient is partly or altogether insensible. He looks dull, languid, and lifeless. The skin is very white, and feels cold and clammy. The pulse is hardly or not at all perceptible. The breathing is shallow and irregular. The muscular system is almost paralysed. Indeed, every part of the body is in a condition of complete prostration.

Reaction.—Should the shock not be fatal, the vital organs continue to struggle hard to maintain life, and as the brain power gradually returns and energy is restored to them, they begin to err on the side of doing too much. The patient now rouses; the stomach often vomits its contents; the pulse becomes full and bounding; the skin hot, dry, and flushed; the mind excited and perhaps delirious. This is the stage of reaction. In weak, irritable, and excitable constitutions it may be so excessive as to be fatal; but in most cases reaction is succeeded by sleep when danger, so far as shock is concerned, is over.

Treatment of shock.—In the first place, if bleeding is going on, that should be stopped as quickly as possible. Then the indications are to restore warmth and stimulate the vital powers. With this object, give the patient a small dose of brandy and water, and wrap him up with warm clothing. Let him be removed and put to bed without delay, and when there, put hot-water bottles or hot bricks wrapped in flannel to his feet and sides, and cover him with a well-warmed blanket. Do not give more than a wineglassful of brandy in any case, and generally not so much; for, whilst a little does good, much does harm. If the patient swallows pretty well, a small cup of some hot meat-essence, such as Liebig or Bovril, is better than continuing alcoholic stimulants. If he cannot swallow, you may try to restore him with smelling-salts. When reaction sets in, the opposite conditions have to be guarded against. The hot bottles should be removed, the stimulants replaced by cooling drinks and sedatives, and sleep in every way encouraged.

Fainting: symptoms and treatment.—Fainting is recognised by the ghastly pallor which precedes and accompanies the attack of unconsciousness. There are no convulsions, as in epilepsy, and no snoring breathing as in apoplexy, brain injuries, drink, or poison. Life seems for the time to be almost arrested.

A person about to faint is well aware of the fact, as the period of unconsciousness is preceded by sensations of giddiness, sinking, singing noises, flashing light, and other evidence of disturbed circulation in the brain. The attack may at this point generally be cut short if the person will at once lie down flat on the back with the head *low*, which causes the blood to return to the brain. If this cannot be done, stoop the head as low as possible, use smelling-salts, and drink a little cold water or some stimulant. Get away from the cause of the upset as soon as you can, as fresh air is usually sufficient to restore a person at once; and remember that a mental effort will often enable anyone subject to fainting to avoid the actual attack.

A person in a dead faint is perfectly unconscious and entirely dependent upon the assistance of others. In such a case carry the patient with the head low into a cool room or the fresh air. Open the clothing at the neck, and dash a little cold water over the face. Use smelling-salts, and give a little cold water or stimulant as consciousness returns. Particularly remember that in a dead faint the head should never be raised, but that, if necessary, the head should be lowered and the feet raised.

Apoplexy, or stroke.—Apoplexy is a form of internal bleeding. It is due to a diseased blood vessel in the head giving way and bleeding into the brain. The symptoms are not caused by loss of blood, for there is not room in the head for much blood to escape, but to the injury of the brain, due to pressure and tearing of the delicate tissue by the effused blood.

Symptoms.—People who are attacked with such an illness are generally upwards of fifty years of age, and more often than not have partaken too freely of either drink or animal food. The attack resembles a fit in suddenly rendering a patient unconscious, but it is not accompanied with convulsions, and recovery is at the best slow and imperfect. It may come on either during sleep, or when the person is walking about. If, under the latter circumstances, he falls and is unconscious, with deep snoring breathing and a congested face. When you come to examine him you find that one side of the body is paralysed and motionless, and this more than anything else guides you as to the nature of the complaint.

People sometimes die from a stroke within an hour or two, but this is not often the case; even very bad cases usually last longer. In the majority, after a few hours the patient is sick, and then begins slowly to recover consciousness, when it is more plainly seen that he is paralysed on one side. In course of time he may be able to get about again, but rarely recovers full use in the paralysed limbs.

Treatment.—Having made up your mind that a person is suffering from a stroke, remember that the cause is bleeding into the brain, and that the sooner it is stopped the less mischief will result. At once loosen the clothing about the throat, and put the head into a position in which the breathing seems easy. Then let him be carried home flat on some kind of stretcher, and put to bed with the head a little raised. Apply cold to the head and keep the room cool, dark, and quiet. Avoid everything which might excite him, and especially *give no stimulants*, nor is it necessary to give nourishment for at least some hours.

Fits or epilepsy.—Epilepsy is the cause of true fits. In such cases there is no diseased structure to be found in the nervous system or elsewhere; but, for some subtle reason, an otherwise healthy brain is suddenly upset and the person falls in a state of complete unconsciousness.

Nature of the attack.—Fits occur in two forms: a minor and a major. In the minor attacks there is only a momentary unconsciousness, without convulsions. In the major the patient after falling becomes stiff and rigid throughout the body; the colour of the face changes to be almost black, and within half a minute the muscles are violently convulsed. A fit lasts from three to five minutes, when the convulsions cease and consciousness is regained. Shortly afterwards the patient usually falls into a deep but natural sleep.

Accidents accompanying fits.—The chief dangers of epilepsy are lest the patient should sustain a serious injury owing to the suddenness of the attack causing him to fall too near a fire, or into water, or on to some hard substance. A lesser danger is to bite the tongue severely. This is common, and is shown by bloodstained froth issuing from the mouth. Another accident is for false teeth to get dislodged and choke the patient; but, on the whole, it is marvellous how constantly the subjects of epilepsy pass through life without any such untoward accidents.

Cause of fits.—The actual cause of epilepsy is unknown, but the tendency to it is certainly frequently inherited. The fits may be brought out by some comparatively trivial circumstance, such as a fright, excitement, worry, the irritation of worms, &c., or they may follow an illness, or a blow on the head. But a careful inquiry will often show that there has been either brain disease or dipsomania in the family.

Treatment.—The immediate treatment consists in watching the patient through the attack, and preventing him during his unconscious state from suffering any harm. The fit will soon be over, so unless he is in a dangerous position you need not move him. Loosen the clothing so that it may not impede breathing, and try to put something like a cork or a piece of firewood between his teeth to prevent him from biting his tongue. Beyond this there is no occasion to do anything, as there is no way of checking the duration or altering the character of the attack. When a patient recovers from a major attack, it is better that he should rest until he feels restored; but after a minor attack there is no exhaustion, and neither the desire nor occasion to sleep.

CHAPTER CXVII

DROWNING—SUFFOCATION—CHOKING

Drowning: cause of death.—When anyone who is unable to swim falls into deep water, he is very soon choked by the water getting into his windpipe and lungs. Death from drowning is brought about by suffocation, owing to the water entering the lungs instead of air. The greater the struggle for life made by a drowning person, the more water he draws into his lungs, and the more difficult it is to restore him when he is rescued. Experience has taught us that in the case of those who faint and make little or no respiratory effort after falling into the water, resuscitation is possible after upwards of fifteen minutes' complete submersion; whilst with those who struggle hard, the chance is but a poor one when the submersion has not reached half that time. Thus, success or failure in treatment will always depend a good deal upon the amount of water which has been drawn into the lungs.

Treatment.—Let no time be lost. Even seconds are valuable. The treatment must be undertaken with coolness and precision, and, unless the details are carried out carefully and intelligently, no benefit is likely to be experienced.

Drain the water out of the body.—(1) Drain the water out of the body. Pull the coat off and roll it up. Turn the body on its face, and put the coat under the chest and pit of the stomach. Now press hard on the lower and back part of the chest, so as to squeeze the water out of the lungs and stomach. To do this, it is best alternately to squeeze hard and to relax; when you squeeze, some of the water is forced out; and when you relax, a little air is probably drawn in by the elastic recoil of the ribs. Having occupied one or two minutes with this, clear the mouth out with your finger, and turn the body on its back.

Restore breathing.—(2) Perform artificial respiration. Artificial respiration consists in producing movements in the chest of an inanimate or dead body such as shall resemble breathing; that is, such as shall actually cause inspiration and expiration. Natural inspiration is effected in two ways:

Fig. 163.—Artificial Respiration Movement of Inspiration.

by the descent of the diaphragm, and by the ascent of the ribs. Over the former we have no control, but we can make the ribs rise by pulling on the muscles attached to them. Natural expiration is effected by the elastic recoil of the ribs and lungs. This is not a vital act, and will take place just as well after death as during life. Artificial respiration, therefore, consists in pulling up the ribs, and letting, or helping them, to fall back again. Now the muscles of the chest are attached to the ribs below and the arms above; consequently, if you pull up the arms as high above the head as you can get them, you pull up the ribs at the same time, and when you let the arms down, you let the ribs down also.

Process of artificial respiration.—To perform artificial respiration, stand behind the patient's head, as in fig. 163. Grasp the arms above the elbows, and steadily and firmly pull them up above the head, having it in your mind that you are trying to pull up the ribs, expand the chest, and get the air into the lungs. Take time over it, as you would in taking in a good breath yourself. Then quickly lower the arms, as in fig. 164, and squeeze them against the chest to

Fig. 164.—Artificial Respiration—Movement of Expiration.

help the expiration as much as possible. Repeat these movements not more than sixteen times in a minute. If you make the movements properly, air should be heard to enter and leave through the mouth or nose. If none enters on pulling the arms up, it is probably because the tongue has fallen back and blocked the throat. Under these circumstances, an assistant should grasp the tongue with the help of a pocket handkerchief and hold it forwards. Unless you hear the air enter, you have no evidence that you are doing any good; if you do hear it, you may rest assured that you are doing all that can be done at the time.

Should you not have succeeded in restoring natural breathing within an hour, the case is hopeless, for the person is certainly dead. But if you are more fortunate, you will find that after a time a gasp is made, and then another, and later on natural breathing is resumed. As soon as you are satisfied on this point, turn your attention to the next.

Warmth and stimulants.—(3) Restore warmth, help the circulation, and maintain the strength. Get off the remainder of the wet things, and wrap the patient in warm clothes or blankets, and use hot-water bottles or hot bricks if you can get them. To restore warmth is of vital importance. It is a matter of life and death; so, in the absence of any other source of heat, that which may be derived from a warm and healthy human body should be utilised.

Rub the limbs and body with warm flannel to improve the circulation, and give a little stimulant as soon as the patient can swallow. Later on, follow this up with some hot broth, and keep the patient in bed warmly wrapped up and well watched lest there should be a relapse.

Inflammation of the lungs.—When all the immediate danger has been overcome, there is, unfortunately, a probability that the chill will be followed by some internal inflammation, especially of the lungs, owing to the fact that cold water has been in actual contact with their delicate tissue. In all cases of partial drowning there is cause for great care and anxiety for at least two days after the accident.

Suffocation.—There are many ways of getting suffocated besides that just described, but the treatment in all is on the same general lines. First remove the cause; then perform artificial respiration; and when natural breathing is established, restore warmth, circulation, and strength.

Choking.—When any foreign substances, such as food, buttons, coins, &c., get into or across the top of the windpipe, the person is choked. This accident is more common in children than in adults. It is due to a sudden inspiration whilst the foreign body is loosely held in the mouth.

Treatment for bodies in the windpipe and throat.—When the body passes between the vocal cords into the windpipe, it is practically shut up there, for the vocal cords generally prevent it from getting out again. The accident is recognised by the suddenness of the attack of fearful spasmodic coughing, in which the child is nearly choked. Occasionally the body may be expelled in this way, especially with the help of a few smart pats on the back. If so, all is well; but usually, when thoroughly exhausted, the coughing subsides, and there is an interval before another paroxysm comes on. Unless the danger is *very* pressing, it is better only to try and soothe the child until a doctor can be obtained with the necessary instruments to give it relief; but if the choking seems likely to be fatal, it should be suspended by the heels, when the body may drop out. The only reason why this should not always be done at once is that it is pretty sure to cause a spasm which, in the absence of the instruments, may be fatal.

When the foreign body sticks at the top of the windpipe, it may block it altogether or only partially block it. In this position you can do no harm by trying your utmost to dislodge it; therefore, in large foreign bodies, or in any which act by impeding the breathing without causing paroxysms of coughing, at once put your finger down the throat. If you cannot touch it you may excite vomiting, and the act of vomiting will often dislodge a foreign body. Failing this, invert the person—that is, hold him head downwards—and give him some smart pats on the back.

When the body is large enough to be arrested at the back of the throat, it can be reached with a finger, and with pluck and perseverance may generally be either hooked out or pushed aside.

In such cases as these never give in. You may fail up to the moment of death, and then, owing to the stillness and relaxation of the parts, you may be able to get it out. If you get it out within one or two minutes after apparent death, you ought to succeed in resuscitating the patient by artificial respiration.

CHAPTER CXVIII

FOREIGN BODIES IN THE ALIMENTARY CANAL—IN THE NOSE, EAR, AND EYE—BITES AND STINGS—POISONS

Foreign bodies in the alimentary canal.—These are, fortunately, much less urgent and dangerous than cases of foreign bodies in the windpipe. One of the chief marvels in the mechanism of the human body is the extraordinary way in which the folds and turns of the alimentary canal accommodate themselves to the passage of foreign bodies. Coins, stones, pins, and various small articles are frequently swallowed and passed again with safety. Even things like large plates of artificial teeth, clasp knives, long iron nails, shawl-pins, &c. (fig. 165), have been naturally passed a few days after being swallowed; but if they catch and stick anywhere, the case is almost certainly fatal without a successful operation is performed.

Treatment.—Never give an emetic or purge to get rid of a foreign body in the stomach or bowels. The proper treatment is based on quite opposite lines. Put the person to bed and give a full diet of solid farinaceous food, like suet pudding, boiled bread, &c. This makes large motions, in which the body may be safely passed without injuring the tissues of the bowels.

Fig. 165.

1, a tooth-plate removed from the gullet by operation; 2, a shawl-pin passed by the bowels three days after it was swallowed; 3, a sovereign eleven years in the alimentary canal.

Foreign bodies in the nose, ear, and eye: treatment.—Children will sometimes slip round smooth things into the ear or nose. The articles are usually pebbles, glass beads, peas, or pips. The foreign bodies themselves never do any immediate harm, but rough and unskilful attempts at removing them has often done very serious harm. Never poke at them with a hairpin or any similar instrument, especially in the ear. This is dangerous, and will only succeed in pushing them further in. The only plan which ought to be attempted by untrained hands is to try and wash the body out by syringing with warm water.

Particles of grit frequently get into the eye and cause considerable pain. In most instances they are naturally washed out by a flow of tears, and the winking movements of the eyelids. When this is not the case, the body should be looked for, and if seen, gently removed with the softest suitable thing at hand. The corner of a pocket handkerchief is generally used, but a small camel-hair brush is much better. If you cannot see it bathe the eye in warm water, and then, if the pain continues severe, drop in a little pure olive oil to shield and soothe it until the doctor comes.

When anything of a caustic nature, like lime, gets into the eye, adopt the same treatment, namely, bathing and olive oil.

Bites and stings: treatment.—The worst injury of this kind that we meet with in England is the bite of a mad dog, except in the rare case of a bite from an imported poisonous snake. In all bites of a poisonous nature the general treatment is the same. Tie something tightly round the limb above the wound to stop the circulation, and then try and suck the poison out of it. The risk in doing this appears to be very slight, as what is sucked out of the wound is of course expectorated; and, even if a little went into the stomach, it would probably be destroyed by the gastric juice. Poisons of this class are only powerful when they are directly introduced into the blood through a wound. Having sucked out as much poison as possible, what may be left behind should be destroyed by cauterising the wound; but as this can only be safely done by a doctor, the best substitute is to thoroughly rub strong Condy's fluid into every scratch. In bites of poisonous snakes in India, the injection of Condy's fluid into the tissues about the wound with a needle-pointed syringe has been found the most efficacious treatment.

In all cases of bite by a mad dog the patient should be subsequently submitted to Pasteur's treatment for hydrophobia.

The English viper has a very venomous bite, which, if treated as recommended above, will generally not be dangerous.

The pain caused by the acrid stings and bites of insects is best relieved by the immediate application of sal-volatile to the part.

Poisons.—Poisons are of many different kinds, and give rise to a variety of symptoms which are often like those caused by disease. Still the circumstances surrounding cases of poisoning are such as do not often leave us in doubt as to the cause of the malady. In suicide, the previous condition of the patient, some strangeness of manner, accompanied with a smell or appearance of poison about him, or a suspicious cup or bottle, tell the tale. And in accident or homicide, the previous good health, the suddenness of the attack after taking something, a peculiar flavour in the poisoned substance, the fact that others who partook of the same thing are also ill, and other similar points create suspicion, and generally lead on to inquiries which clear up the case.

Suicidal poisons.—The most common suicidal poisons are: carbolic acid, because it is often at hand; laudanum, on account of its narcotic properties; prussic acid, for its rapidity; and various substances, such as mineral acids, alkalies, oxalic acid, and various mineral salts, because they happen to be used by the individual in his work and are constantly before him.

Accidental and homicidal poisoning.—Accidental poisoning may be due to the careless habit of leaving poisons like carbolic acid about in cups, when they may be drunk in mistake, especially by people who are partly intoxicated. Or food may be poisonous, as is sometimes the case with mushrooms, bad meat, &c. Other forms of accidental poisoning are copper from dirty copper cooking-vessels; arsenic from wall-papers; lead from water or lead paint; poisonous berries, seeds and roots; over-doses of medicines; or giving lotion instead of medicine, &c.

The favourite homicidal poison is arsenic.

Treatment of poisoning.—First aid is very valuable in cases of poisoning, as without help the patient might be dead or hopeless before the doctor could arrive; but, unfortunately, the first-aid pupil cannot make use of two of the most important details of treatment—the stomach-pump and medicinal antidotes—and therefore medical help should always be obtained with all speed.

The first indication in nearly all cases is to induce rapid vomiting, in order that the poison may be rejected before much of it has been absorbed. The exceptions are those cases in which the poison is of so corrosive a nature as to destroy the coats of the stomach, and render that organ unable to bear the strain of vomiting; that is, in the case of poisons like the mineral acids and alkalies. In all other cases it is a general rule to make the patient vomit at once, as the success or failure of treatment depends upon *early* vomiting. The best emetic is twenty grains of sulphate of zinc dissolved in water; but as this is not usually at hand, a teaspoonful or more of mustard in a tumbler of tepid water is what is generally used, and answers very well. In the absence of this also, a finger must be thrust down the patient's throat and kept there till he vomits. Having emptied the stomach once, give plenty of tepid water to drink and cause it to be vomited again.

When you are satisfied that the poison has been pretty well cleared out, you must treat the symptoms which have been caused by it. In the case of an irritant, the stomach and bowels will be raw and irritable, so you must shield and soothe them by causing the patient to swallow some olive oil, white of egg, or flour and water. In the case of a narcotic, you should give some strong coffee, to rouse the patient; and in the case of a corrosive, you should treat him as one of shock from internal injury.

Alcoholic poisoning.—Alcohol sometimes acts as a dangerous poison in those who are unaccustomed to it, or in those who have taken an excessive quantity. Whenever a person who is, or is supposed to be, under the influence of alcohol cannot be roused, he should be treated as a serious case. It may be that the symptoms are all due to drink, or they may be partly due to a stroke or an injury, the result of drink previously taken. Serious mistakes which have resulted in loss of life have been made by doctors as well as others under such circumstances; so act on the safe side, and treat carefully every person apparently drunk and smelling of drink if he is unconscious. If drink is the cause, nature's treatment, vomiting, is the best. See that the breathing is not impeded, and that the body does not become chilled.

CHAPTER CXIX

BANDAGING—APPLICATION OF THE TRIANGULAR AND ROLLER BANDAGES

Bandaging: triangular and roller bandages.—It is not at all necessary for ambulance pupils to go through an elaborate course of bandaging. What they require is to know how to fix on a splint or a dressing with a reasonable degree of security and comfort to the patient.

Calico, flannelette, and flannel are amongst the best materials for bandages; but, on emergencies, they must be made from any material which is at hand. The shape is of more importance: it must be either triangular or long and narrow. The triangular bandage of Esmarch is shaped as in fig. 166. The lower border *bc* measures about 4 feet, and the sides about 2 feet 10 inches. This is large enough for

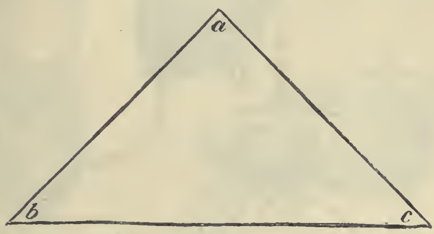


Fig. 166.—The Esmarch Triangular Bandage.

any part of the body, and may be divided through the centre to make two smaller bandages, which would be suitable for parts like the hand or foot. The St. John's Ambulance Association sell for sixpence a triangular bandage illustrated with figures to show the mode of applying it in various parts of the body. The long and narrow bandage is torn from calico and rolled up as tightly as possible for convenience of application. It is called the roller bandage, and measures three or four inches broad and six feet long.

The triangular bandage is the more useful for first-aid purposes, as it can be more rapidly applied, and requires less skill and training in its use.

Fig. 167.—Esmarch Bandage applied to the Head.

Fig. 168.—Bandage for the Chest.

To bind on splints.—For this purpose the bandage is folded, and then passed twice round the limb and splints, and knotted as in figs. 157 and 158. The bandage should not be fastened directly over the fracture, but above and below it, and the knots should be tied over the splint so as not to press upon the skin. The splints when fastened on should feel quite firm and secure.

Head bandage.—To retain a dressing on the head, lay the bandage on the head with the point hanging down the back of the neck, and the middle of the lower border placed over the forehead. Carry the two ends round the back of the head, cross them, bring them forward again, and tie them on

Fig. 169.—Bandage for Hand.

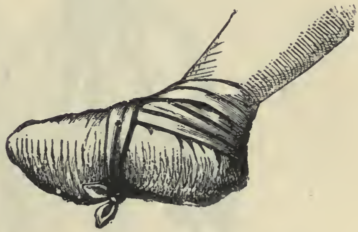


Fig. 170.—Bandage for Foot.

the forehead. Lastly, turn the point up, and pin it on the top of the head (fig. 167).

The chest.—Lay the bandage on the chest with the point over the shoulder on the bad side; pass the ends round the waist and tie them behind, and then draw the point down and tie or pin it to one of the loose ends (fig. 168).

The shoulder or hip.—The bandage is applied on exactly the same principles, the ends being crossed and tied round the limb, and the point pinned under a sling or a waistband as the case may be (fig. 172).

The hand.—Place the hand palm downwards on the open bandage with the fingers towards the point; turn the point over the back of the hand; cross the ends over it, and tie them round the wrist (fig. 169).

The foot.—Apply the bandage in the same way, except that instead of tying the ends round the ankle, cross them over the instep and tie under the sole (fig. 170).

The arm sling.—When a sling is required for injuries of the hand, forearm, wrist, or elbow, the broad sling is used, in

Fig. 171.—Esmarch Bandage forming Sling for the Arm.

order that the entire forearm and hand may be supported as in a kind of cradle (fig. 171). It is applied as follows: One end is laid over the shoulder on the uninjured side; then the arm is bent, the other end brought up in front of it, and carried over the shoulder on the injured side, and the two are knotted. The first end should be taken further over the shoulder than the second for two reasons. One is that the knot will come on the sise of the neck, where it is less likely to hurt than at the back; and the other is that the point will be above the elbow, and can be brought forward and pinned in such a way as to support the elbow all round.

The narrow sling is used for fractures of the arm bone and collar bone, in neither of which it is at all desirable to raise or support the elbow. The bandage is folded and applied as in fig. 172.

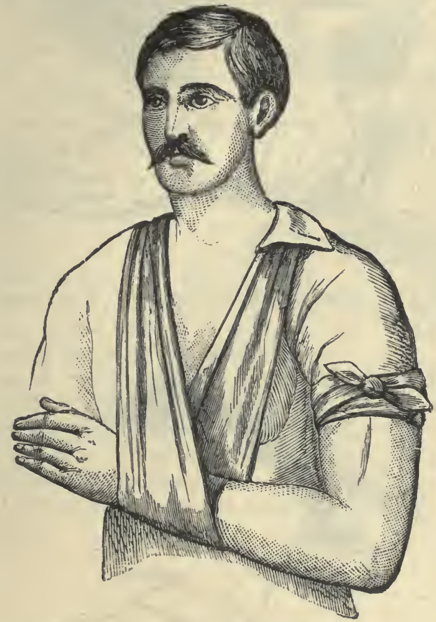


FIG. 172.—Bandage for Injuries of Shoulder.

The roller bandage.—When the fracture comes to be permanently set, or daily dressings have to be applied, or a gentle and even support is required for a limb, the roller bandage is to be preferred before the triangular; but more skill and practice is needed for its application, and for first-aid purposes it is not only unnecessary but not equal to the latter.

When using the roller bandage, the chief point to observe is that it must always be allowed to lie evenly on the skin, and never be twisted or forced into the desired position. If the part being bandaged is all about the same diameter, like

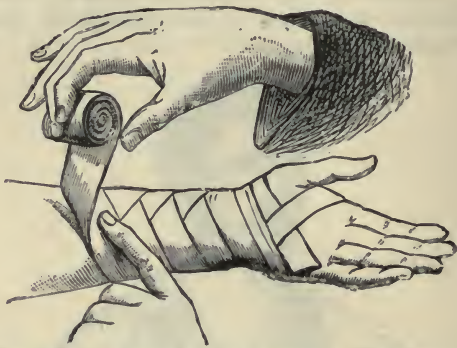


FIG. 173.—Bandage for the Forearm. The reverse.

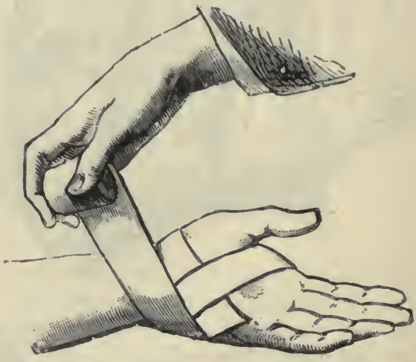


FIG. 174.—Bandaging Hand and Wrist. Figure-of-8.

the arm from the elbow to the shoulder, the roller is applied in simple spiral turns. When, however, there are inequalities to be got over, the bandage will not lie even and smooth unless special turns are adopted. Of these there are two kinds, the reverse and the figure-of-8. The reverse is used when the size of the part is gradually increasing, as in the case of the forearm or calf. The mode of making it is shown in fig. 173, where each spiral turn as it comes to the front is reversed, and then carried on round the limb. The figure-of-8 is employed when the inequality is too great to be evenly covered by reverses; as, for example, in carrying the bandage above and below the wrist, ankle, hip, and shoulder joints. Under these circumstances, the spiral turns are wound alternately round the part above and the part below the joint in a figure-of 8 pattern, as in fig. 174.

Fig. 175.—Bandage for Head.

Roller bandages are always applied from below upwards. The leg bandage is commenced as a figure-of-8 round the ankle, is continued in plain spiral turns from the ankle to the calf, and the calf is covered by reverses. The arm is bandaged in the same way, and if it is continued up to the shoulder, the elbow must be passed by figure-of-8 turns. When applied to the head, the roller bandage should generally be put on in two directions and pinned where they cross (fig. 175); this prevents slipping. In a case of bleeding from a scalp wound, this form of bandage makes more effectual pressure than the triangular; but on the limbs the triangular is quite as good.

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