HOME HYGIENE

THE ST JOHN AMBULANCE ASSOCIATION

As a companion to this Book—

A Catechism of Home Hygiene,

BY

J. M. Carvell, M.R.C.S. & L.S.A.

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HOME HYGIENE,

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Syllabus for Elementary Home Hygiene Certificate.

I. *Introductory.*—Explanatory—Historical progress—Heredity.

II. *The functions of the human body.*—The organs and systems—Work of the systems—Waste and repair—Nutrition, gaseous, liquid, and solid.

III. *Personal habits.*—Work—Exercise—Recreation—Rest—Sleep—Cleanliness—Bathing—Meals—Digestion.

IV. *Surroundings.*—Light — Warmth — Moisture — Air — Water—Soil—Plants—Animals—Man—Parasites—and their effects upon the human body.

V. *Air.*—Composition of air under various conditions—Deleterious impurities and their sources—Change of air—Ventilation.

VI. *Water.* — Uses — Kinds — Sources — Contamination — Wells—Cisterns—Filters.

VII. *Food.*—Mineral, vegetable, and animal foods—Diet—Liquid and solid foods and beverages—Cooking and preparation—Unfit and adulterated foods.

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PREFACE.

As in other subjects so in Hygiene, the St. John Ambulance Association desires to have its own text book.

In compiling this small volume the subject matter has been centred round the home, hence the title Home Hygiene.

My thanks are due to Dr. William Collingridge for a number of valuable suggestions, and to a number of Authors, Editors, Publishers, and others, for the loan of illustrations from various works.

J. F. J. S.

November, *1897*.

CHAPTER I.

Historical Introduction.

The terms *hygiene*, from the original Greek, meaning health, and *sanitary science*, from the Latin, meaning the science of maintaining the soundness of body, or the preservation of health, embraces also the prevention of disease. Protection from all possible injuries, from without and from within, that may affect the human body requires vigilance over a very large field. Consequently hygiene is extensive in its scope, and, like other sciences, has been elaborated and specialised into various branches. So that there is personal hygiene, and public hygiene, or public health; the hygiene of infancy and childhood, occupational and industrial hygiene; hygiene applied to buildings (constructive hygiene), as the sanitation of schools, offices, factories, and workshops, mines, dwellings, hospitals, and public buildings; rural, municipal, and state hygiene, or civil hygiene, military and naval hygiene.

The history of hygiene is largely that of civilization and of the progress of knowledge. A brief sketch of the stages passed through will enable the present position to be better appreciated, and afford a fitting introduction to a more detailed consideration of the subject.

Prehistoric times are regarded as having left us no record of measures taken to prevent disease, yet some most important facts have been handed down to us; facts which show that even at the period when man's habits most resembled those of wild animals with which he contended for survival, he realised the value of certain artificial protective measures. At a period when like animals he dwelt in natural caves he learnt to make and use *fire* to procure warmth, to protect himself against climatic vicissitudes, but above all he learnt to cook his food. Man is defined by Huxley as a "*cooking*" animal, and must have learned by experience in early days the value of hot food and drink, and probably observed that those who cooked their food and so killed parasites and other organisms (or as we regard it sterilized them) remained longer in good health.

Life and health further benefited by the advent of agriculture, including both the cultivation of the soil and the rearing of live stock, and known under the generic term of *husbandry*, for the purpose of supplying food in addition to that precariously obtained by hunting and fishing. The use of pottery, glass and metals, and the arts of making clothing and weaving, and of *housewifery* generally, also conduced to the comfort and health of humanity emerging from savagery.

The Approach to Historic Times furnishes us with outlines of the growth of civilization. The Chaldean, or Babylonian, empire over 3,000 and more years B.C. reached a considerable degree of civilization, and similarly the Assyrian, or Ninevehan, kingdom was highly organized. Although probably men then knew little of the manner of the spread of disease and the means of averting epidemics—for it would appear that plague, pestilence and famine, that always go hand in hand, swept many of their cities out of existence—recent excavations show that they displayed considerable skill in the construction of buildings, some of which are believed to have been erected six or seven thousand years before the Christian era.

The Egyptian and Israelitic Period.—The Levitical ordinances of Moses, derived mainly from the Egyptians, show that even at that period the influence of clothing, food, baths, washing, and cleanliness generally upon health was understood. Still the Israelites regarded plagues and pestilences as the manifestation of Divine wrath, and knew not infection in the form that we understand it. The general mortality was no doubt high, for epidemics were common, frequent and devastating.

The Grecian Period.—In Greece, amongst the Spartans, the partly religious, partly political system of laws of Lycurgus regulated the control of the public health. The names of Æsculapius and

Hippocrates are familiar to us as the founders of medicine and hygiene. The works of Hippocrates on epidemics, diet, air, water and localities have been handed down to us as the results of the observations of those days. Health was symbolised amongst the ancient Greeks by the goddess Hygeia, the source of the modern term hygiene.

The Roman Period.—Although we have records of

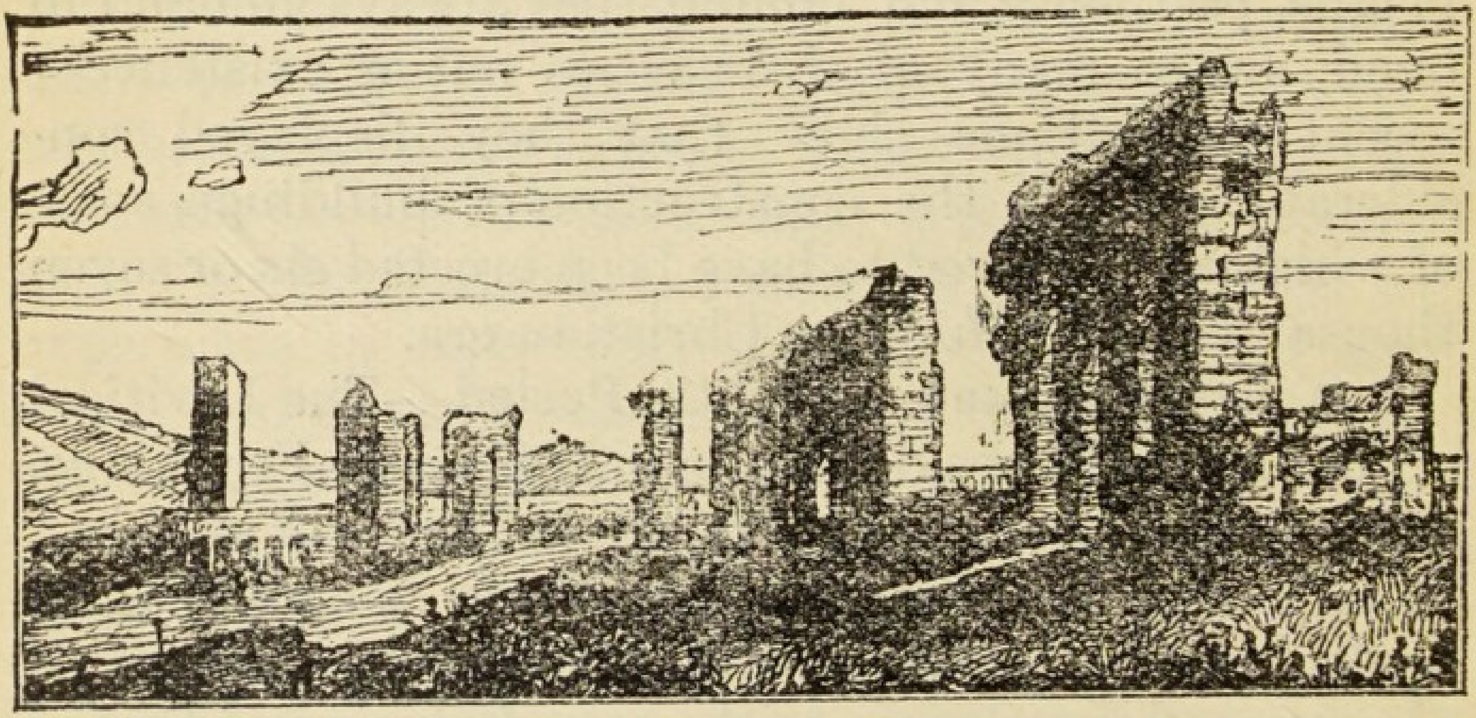


Fig. 1.—RUINS OF ROMAN AQUEDUCT.

epidemics in the Roman empire occurring again and again, the most deadly of which was the Plague of Justinian in the sixth century, still the remains of aqueducts and cloacæ, or sewers, in their cities testify to the public measures taken for the protection of health, and the works of many writers still bear witness of the knowledge of hygienic measures, personal and public, put into practice in those days.

The Middle Ages.—After the fall of the Roman empire the dark ages were entered. The feudal system was slowly evolved, and the feudal castle embraced within its walls all that remained of sanitation. During this period mortality was high, especially within walled towns, and devastating epidemics constantly recurred, culminating in England in the Black Death of 1348-9. The discovery at the end of the fourteenth century that Oriental plague was communicable from person to person, and the quarantine measures adopted by the Venetians marked a new era, but the measures that were taken did not advance with the growth of population and inter-communication, and consequently plagues, pestilences and famines continued their devastation.

The Early Modern Days furnished the numerous epidemics of plague of the Tudor period during the sixteenth century including the Black Assizes, and continued at intervals through the seventeenth century, culminating in the Great Plague of London in 1665, the last of the plagues in England.

Up to this period, the walled in towns were small and crowded; the streets narrow, tortuous, and unpaved; the water supply haphazard and of doubtful quality, and drainage absent or of a promiscuous kind; the houses badly constructed, the earth, covered with rushes rarely renewed, forming the foul floor of most dwellings; windows few and small, and panes absent or consisting of pieces of horn; and the food of the people rough, coarse and often scarce. During this century and the next advances were made in sanitary measures that ameliorated the conditions described. Not the least of these were improvements in public scavenging and the cleanliness of dwellings. The increase in the use of windows and in their size, materially conduced to the admission of light and air into dwelling-rooms. Wages, food, houses and streets improved and increased, and with these the health and vitality of the population of this country.

In the eighteenth century considerable advances were made in the prevention of disease. In 1721, Lady Mary Wortley Montague introduced into England the practice of inoculation against small-pox. In 1767, Sir George Baker made the discovery that the cause of Devonshire colic was lead poisoning by cyder prepared in vessels coated with lead glaze. In 1772, Captain Cook made his celebrated voyage, proving that scurvy could be abolished among ships' crews by the use of fresh vegetable food. About 1774, Howard so aroused public opinion with regard to the overcrowding of prisons, as to lead to the abolition of "jail fever," a form of typhus fever. In 1796, Jenner introduced vaccination, which not only prevented small-pox in individuals, but also avoided the spread of infection to others that inoculation had tended to foster.

The Victorian Era.—The progress during the present century is mainly embraced in the Victorian Era, and during this period the advances have been rapid and extensive. The year 1837, in which Her Majesty ascended the throne, saw the commencement of the registration of births, deaths, and marriages, the foundation of vital statistics, a science which is at the same time both a guide to and a record of the improvement of public health. In 1840, the first Act for gratuitous vaccination was passed. From 1843 to 1845 the Health of Towns Commission enquired into the sanitary condition of the people, and drew serious attention to the causes of the large amount of preventible mortality and sickness. In 1848, the General Board of Health was established. In 1851 the window tax was abolished. In 1855, the Metropolis Local Management Act and the Nuisances Removal Act were passed. In 1866, the Sanitary Act, and in 1875, the general and consolidating Public Health Act came into force. The year 1889 produced the Infectious Disease Notification Act, 1890 the Infectious Disease Prevention Act, and 1891 the Public Health (London) Act.

Many of these and other administrative advances have only been rendered possible by the extraordinary progress in the discovery of the causes of diseases.

In 1840, following upon the researches of his predecessors, Henle came to the conclusion and announced that he was convinced that the infectious diseases were caused by minute living organisms. About 1857, Pasteur commenced those researches into fermentations that subsequently produced such brilliant results in tracing the causes of diseases. In the meantime Snow had been collecting evidence which established the fact that cholera was spread by the intestinal discharges, and others working upon similar lines proved this to apply also to typhoid, or enteric, fever. Tyndall's experiment upon dust and the floating matter of the air traced the dependence of fermentation and putrefaction upon external living organisms, and Lister proved the truth of this by his brilliant work in antiseptic surgery. In 1880, Koch disclosed to the world his method of isolating and cultivating microbes, or microscopic germs, and since then the discovery and isolation of the germs of fermentation, putrefaction, nitrification, and disease have proceeded apace under many workers.

Perhaps the crowning triumph of the Victorian Era is the total abolition of maritime quarantine in the United Kingdom, and the substitution of medical inspection and isolation, the acceptance of this in principle by other nations promising vast improvement of an international system that has lasted nearly 500 years.

Some idea of the reduction of mortality at different periods may be obtained from the recent Reports of the Royal Commission on Vaccination where the following death-rates in London are quoted :—they are only approximate, but it is known that in epidemic years the death rates were often higher, for Sir William Petty said "the plagues of London do commonly kill one-fifth part of its inhabitants," which meant in the seventeenth century epidemics a mortality of 200 deaths per 1000 of population living :—

1629—35	...	50	per 1000	per annum.
1660—72	...	80	,,	,,
1728—57	...	52	,,	,,
1771—80	...	50	,,	,,
1801—10	...	29	,,	,,
1831—35	...	32	,,	,,
1861—70	...	22·5	,,	,,
1881—90	...	19·1	,,	,,

The mortality of the last two periods we know is absolutely correct.

The reduction of mortality from 50 to 20 per 1,000 living means the saving of 30 lives in every 1000 of population, or in a city of four millions of inhabitants, such as London, the saving of 120,000 lives annually.

Diminished mortality, however, is only one aspect of the benefits of the cultivation of health ; increased physical and mental vitality is another, and to both the extraordinary development of the British race throughout the world is to a great extent due.

Heredity.

To withstand the attacks and inroads of disease a sound constitution is necessary, and to start their offspring in life with sound constitutions must be the first care of all parents. A prospective parent, and every human being is one, therefore owes a first moral duty to posterity to maintain a sound and healthy body and mind. If we trace back the origin of individuals we find that the bodily and mental characteristics, taken as a whole, are in the main those of the immediate progenitors, and that as we go back in the pedigree many peculiarities are not to be found, so that in a remote ancestry they become a vanishing quantity. This is largely due to the influences of the intermixture of the male and female sides of the house. If these influences are deteriorating impressions, the progeny will suffer. Bodily structure, organic functions, mental and moral characteristics are all affected by heredity. Thus, it is of extreme importance to the health, happiness and prosperity of a family that the contemplation of marriage should carry with it the serious consideration of its results, not so much from a pecuniary or social, as from a physiological point of view.

In a race, under the same constant external conditions, an average tends to be maintained, and deviations from the normal do not pass beyond certain extreme limits without a tendency to injure the race.

This is true of all extremes, whether regarded as extreme amelioration or extreme deterioration, since they are both alike deviations from the normal, and are therefore either potential or actual disease, or abnormal tendencies.

A characteristic of a more distant progenitor that seems to have disappeared from a family will sometimes unexpectedly re-appear. This reversion is more likely to take place in a family than in a race. It is, however, the influences of the immediate parents that are greatest upon the offspring. In some cases those of the mother predominate, in others those of the father. Any characteristic that is common to both parents is intensified in the offspring, and if the characteristic be vicious or morbid the effect is usually serious. Therefore marriage between persons with like functional weaknesses, whether physical, mental or moral, and especially where there is also blood-relationship, is strongly to be deprecated.

It is by proper selection in the pairing of animals that breeds are maintained and improved, and the same law applies to man. So that in contemplating marriage, the solid advantages of physical fitness, physiological durability, mental soundness, moral firmness, and good family history, are to be considered before the ephemeral attractions of pecuniary worth or social standing. The more consideration is paid to these the greater will be the health and happiness of family life, and family life is the basis of national welfare.

Physical and Chemical Preliminaries.

Personal hygiene, or the science of health, cannot be properly understood unless the construction and functions of the body and its parts are known, and hence great stress must be laid upon the fact that all those who desire to understand hygiene must first be familiar with physiology. For this reason it is absolutely necessary to expound somewhat fully the various physiological functions, and in order to understand these a few elementary physical and chemical preliminaries must be briefly defined.

The study of physics is founded on the science of *force* or forces. Forces of *attraction* and *repulsion* when equally balanced or counteracted are in *equilibrium*, when not so, they are set in *motion*. Due to the force of attraction of the earth, known as *gravity*, objects attracted (such as falling objects), have *weight*, meet with *resistance*, produce *pressure*, and in passing contact with other substances cause *friction*. According to the nature of the material upon which forces are acting, that is, whether gaseous, liquid, or solid, so the results vary. *Magnetism* is a form of motion which, by means of a magnet, best illustrates the forces of attraction and repulsion ; in *combustion* the forces of attraction of particles are displayed, the carbon and hydrogen in fuel being set free are attracted by and combine with the oxygen of the air; *heat* is also a mode of motion, which, by *conduction*, passes to things in actual contact, for instance to a heating iron upon a stove, and by *radiation* passes through space, for instance, to a person in front of an open fire; fluids, as water and air, have their individual particles heated by conduction, and as the heated particles are constantly rising from, and the cooler particles constantly falling towards the heated surface, so the mass becomes heated by what is known as *convection*. *Light* again is a form of motion of a subtle medium. In a similar manner the human body possesses *energy*, that is to say, potential force, and when this is called into action it produces *work* and brings about recognised changes.

All things are continuously changing. Changes of form and properties of things are *physical* changes, and those of composition and properties are *chemical* changes, and when these two kinds take place simultaneously or consecutively they are known as *physico-chemical* changes.

All things, whether gases, as air, liquids, as water, or solids, as sulphur, are known for physical or chemical purposes as *substances* or bodies. All substances are either *compound* or *simple*; all compounds can be split up into simple bodies, and the simplest bodies to which substances can be reduced are known as *elements*.

When elements *combine* by chemical force so as to convert two or more substances into a single and different substance they form a *chemical compound*, as in the case of water which is a chemical compound consisting of the two elemental gases, oxygen and hydrogen; but when two or more elements are merely *mixed* together without any chemical change they form a *mechanical mixture*, as in the case of air, which is merely a mixture of the elemental gases oxygen and nitrogen. A third example will illustrate both conditions; if powdered sulphur and copper filings be mixed together they form a greenish mechanical mixture, but if this mixture be gently heated it glows and combines into a blackish chemical compound, a sulphate of copper.

The *principal elements* of the seventy or more known to chemists are briefly describable as follows :—

Oxygen is a light, invisible gas, supporting combustion, and necessary for the support of life. It constitutes one-fifth of the volume of air, and eight-ninths of the weight of water. It is found in the blood and many tissues of the body, and is everywhere abundant in nature.

Hydrogen is a very light, invisible, combustible gas. If burnt in air it combines with the oxygen and forms water, of which it constitutes one-ninth in weight. It is found in combination in all animal and vegetable substances.

Nitrogen is a light, invisible gas, neither supporting nor undergoing combustion. It constitutes four-fifths of the volume of air, and is found in combination in many animal and vegetable substances.

Carbon is a solid occurring in nature as charcoal, graphite, and diamond. It is found in all animal and vegetable substances, and is widely distributed in natural combinations.

Sulphur is a solid, easily melted by warmth, found in a natural state near volcanoes and volcanic springs. It exists in many animal and vegetable substances and elsewhere in combination.

Phosphorus when isolated is a solid, easily inflamed by heat, but in nature only found in combination. It occurs principally in bones in combination with lime.

Chlorine when isolated is a visible, rather heavy gas, having a greenish yellow colour, but in nature is only found in combination. Its most common combination is with sodium as ordinary salt, of which there is a quantity in the tissues of the body.

Sodium, potassium, calcium, and magnesium are elemental metals, and when combined with oxygen form **soda, potash, lime, and magnesia.** They are found in various combinations in the body.

Iron is also found in the body in combination, especially in the blood.

Compound Substances may be divided into inorganic and organic. The *inorganic compounds* are those in which carbon and hydrogen are not found combined, and the *organic compounds* are those in which carbon and hydrogen are found combined, either alone or together with other elements, most commonly with oxygen and nitrogen.

A few of the *principal inorganic compounds* must be mentioned :—

Water is a compound of two volumes of hydrogen and one of oxygen. It occurs everywhere, and constitutes two-thirds of the weight of the human body.

Carbonic Acid Gas is a compound of one volume of carbon and two of oxygen. It is produced by combustion, or oxidation, of any substance containing carbon, as coal, wood, paraffin and the tissues and fluids of the body, and consequently is found in the blood and tissues and in the atmosphere.

Carbonic Oxide Gas is a compound of one volume of carbon with only one of oxygen, due to incomplete combustion. It is not found in the body, and is very poisonous.

Ammonia Gas is composed of three volumes of hydrogen and one of nitrogen. It is found in most animal and vegetable tissues, or is formed by them when decaying, and in combination with sulphur and other substances gives rise to pungent and disagreeable odours.

Acids are sour tasting substances, the commonest forms of which are hydrochloric, sulphuric, nitric and phosphoric acids.

Alkalies, on the other hand, are soapy tasting substances, the principal of which are lime, soda, potash, and ammonia.

Salts are formed by the combination of acids or acid gases with alkalies or metals. Such are, common salt (sodiumandchlorine),common soda(sodiumandcarbonic acid), phosphate of lime (calcium and phosphoric acid), carbonate of lime (calcium and carbonic acid), all of which, together with others, are found in the body.

Some of the *principal organic compounds*, which are complex compounds of carbon with hydrogen and oxygen, and in some cases also with nitrogen, must also be mentioned :—

Organic Acids are best known in the form of acetic, citric, malic, and tartaric acids, that occur mostly in fruits.

Nitrogenous Bodies contain all four of the elementary substances, carbon, hydrogen, oxygen, and nitrogen. Animal and vegetable substances, containing these are known as *proteids* ; for example, albumen, casein, gelatine, etc.

Carbo-hydrates are bodies that consist of carbon combined with hydrogen and oxygen in hydrate (or water) form, that is, twice the volume of the hydrogen to one of oxygen. **Sugars** and **starches** fall into this category.

Fats, or hydro-carbon bodies consist of the same substances as the last mentioned, but with a larger proportion of hydrogen to oxygen.

Soaps, appropriately mentioned here because they form in the body, consist of alkalies in combination with the complex acids of fats, a combination resembling that of salts.

In addition to the substances already mentioned, various *animal products* of extreme complexity of composition are met with in the body, some of which will be dealt with later. *Chyme*, the digested food in a semi-liquid state in the intestine before absorption ; *chyle*, the fatty matter flowing in special vessels from the organs of digestion, and mixing with the liquid *lymph* from between the tissues, to be discharged into the blood for nutritive purposes : the *secretions* and *juices*, as the saliva, bile, mucus, gastric and pancreatic juices ; the *lubricating fluids*, known as the serous and synovial fluids, that lubricate the interior of joints and closed sacs of membrane ; the *tissues* that form the body itself, cartilage, bone, muscle, nerve, etc. ; the *blood*, and waste materials, as *urea* and *uric acid* excreted by the kidneys.

Ferments are of two kinds. Firstly, there are those consisting of living *microscopic organisms*, such as those which convert malt or grape sugar into alcohol, as in the fermentation of the juice of the grape into wine, or of the wort of malt into beer. Decomposition and putrefaction in various forms are brought about by similar organisms. The infectious diseases also are caused by micro-organisms entering the body and setting up fermentive processes which give rise to fever, and hence are known as zymotic diseases from the Greek *zume*, meaning yeast or ferment. Secondly, there are ferments that are *chemical substances* produced by living cells, but which, when separated from the cells, are capable of causing changes in the substances with which they are mixed. The most notable of these are the digestive ferments, as *ptyalin* in the saliva, *pepsin* in the gastric juice and *trypsin* in the pancreatic juice.

CHAPTER II.

The Functions of the Human Body.

The physiological processes or functions of the human body are best understood by regarding it as consisting of systems and organs; but, before describing these, an outline of its general construction will help to locate them.

The Human Body consists of head, neck, trunk, and limbs.

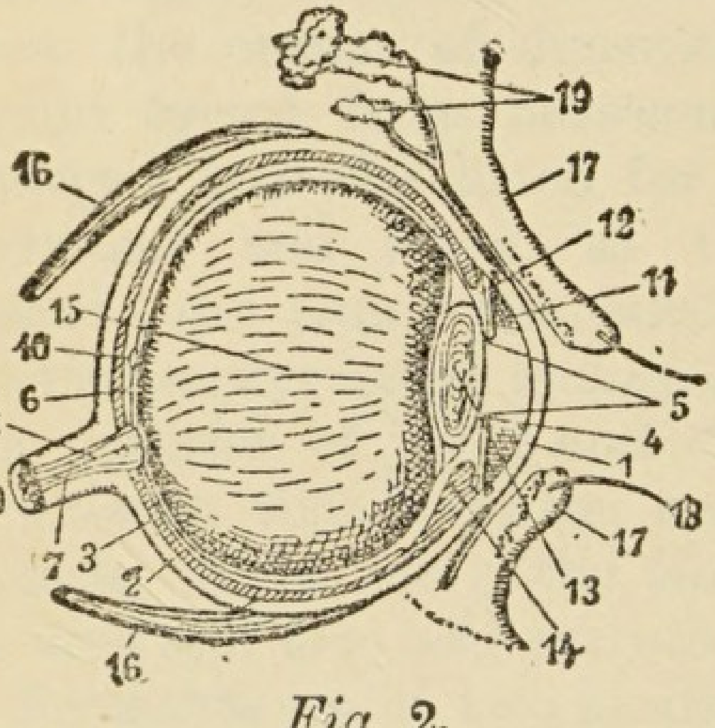
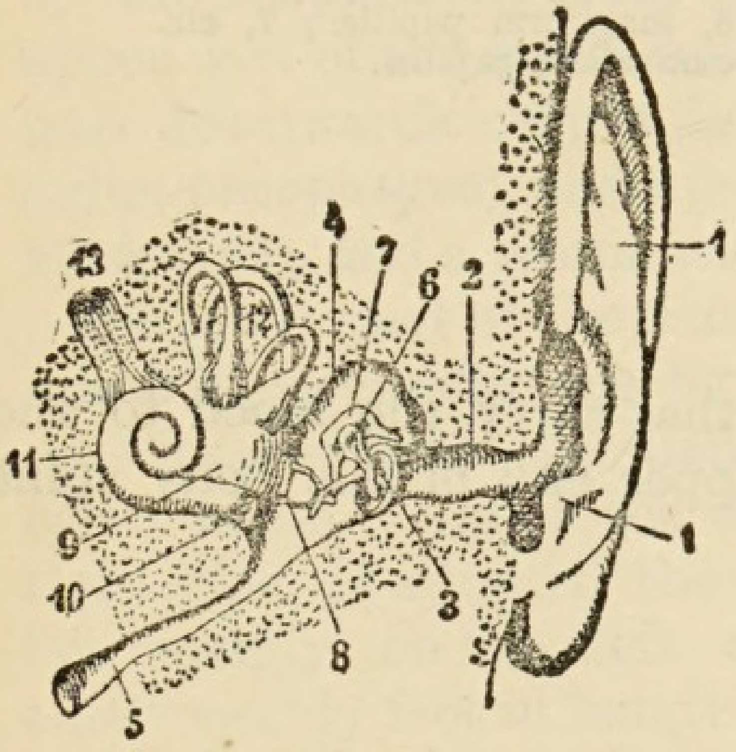


Fig. 2.

Section of eyeball. 1, cornea; 2, sclerotic coat; 3, choroid; 4, iris; 5, pupil; 6, retina; 7, optic nerve; 8, central artery of retina, at the retina end of which is the "blind spot"; 9, section of the optic nerve; 10, the yellow spot (macula lutea); 11, anterior chamber; 12, posterior chamber; 13, lens; 14, ciliary muscle; 15, cavity occupied by vitreous humour; 16, 16, muscle which moves the eye-ball (rectus); 17, 17, eye-lid; 18, eye-lash; 19, glands of the eye-lid (lachrymal gland).

The Head contains the brain, and the commencement of the spinal cord, the organs of sight, hearing, speech, taste, and smell; also the entrances to the respiratory and digestive systems, which open into the pharynx, or throat, a funnel-shaped cavity at the back of the nose and mouth.



Section of side wall of skull showing ear. 1, 1, the external ear; 2, external auditory meatus; 3, drum of the ear (tympanum); 4. auditory passage: 5, eustachian tube; 6, malleus; 7, incus; 8, stapes; 9, vestibule; 10, opening of cochlea; 11, cochlea; 12, anterior, posterior and external semi-circular canals (membraneous labyrinth), 13, auditory nerves.

Fig. 3.

The Neck contains the larynx, or voice box, the commencement of the trachea or tube that leads the air from the pharynx to the lungs, and the commencement of the œsophagus, or gullet that leads the food from the pharynx to the stomach (the food gliding into the œsophagus, over the epiglottis, a valve that protects the glottis, as the opening of the larynx is

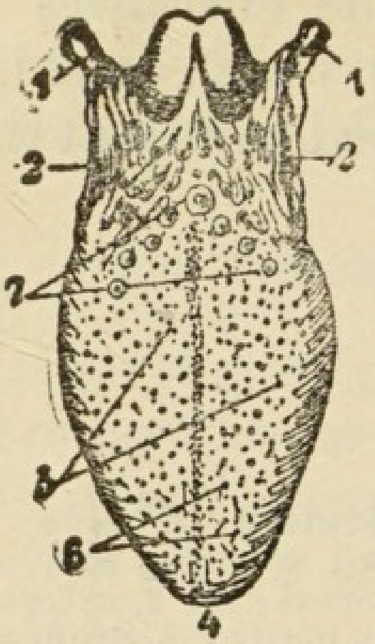


Fig. 4.

The Tongue. 1, 1, roots of tongue, short tendons attached to muscle at root of tongue; 2, 2, the tonsils; 3, the epiglottis; 4, apex; 5, filiform papillæ; 6, fungiform papillæ; 7, circumvallate papillæ.

called), the blood vessels that carry the blood to and from the head, and the upper end of the bony spine and spinal cord.

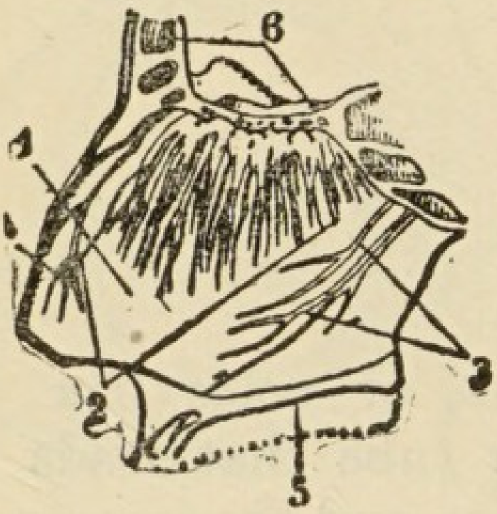


Fig. 5.

The nasal cavity. 1, the nasal cavity; 2, filaments from olfactorynerve; 3, naso-palatine nerve; 4, nasal nerve; 5, hard palate; 6, bones and bone-cells of the roof of the nasal fossa.

The Trunk consists of an upper and lower part. The upper part, or thorax, is a cone-shaped cavity, enclosed by the spine, the ribs, and the sternum, the latter a flat bone in front of the chest, to which the ribs pass from the spine at the back. The thorax contains the heart, a little to the left of the middle line, the great arteries and large veins, and on either side the lungs. The cavity of the thorax is closed below by the diaphragm, a curved muscle separating the upper part of the trunk from the lower, through which pass downwards only a large artery (aorta) and the gullet (œsophagus), and upwards a large vein (inferior vena cava), and a lymphatic vessel (thoracic duct).

The lower part of the trunk, the abdomen, is enclosed round its circumference by the spine and abdominal muscles, above by the diaphragm, and below by the pelvic bones. Under the diaphragm, mainly on the right side, is situated the liver, whilst the stomach lies mainly on the left side. The small intestine about twenty feet in length, occupies the front of the abdomen, the large intestine, about six feet in length, commencing in the right groin, runs up the right side, across beneath the liver and stomach, down the left side and through the pelvis, terminating in the rectum. The pancreas crosses transversely behind the stomach. The spleen lies on the left side, close to the tail of the pancreas. The kidneys are placed in the loins, one on each side of the spine, the right close under the liver, and the left close under the spleen. The bladder is situated in front of the middle of the lowest part of the abdomen, in front of the rectum.

Diagrammatic section of the human body showing organs in their relative positions. 1, bones of the skull; 2, bones of the face, with teeth; 3, spinal column (cervical, dorsal, and lumbar vertebræ), 4, breast bone (sternum); 5. section of the brain (cerebrum); 6, section of the brain (cerebellum); 7, connection of the brain and upper part of spinal cord (pons varollii and medulla oblongata); 8, spinal cord; 9, the alimentary canal (gullet or œsophagus); 10 the stomach; 11, the intestines; 12, the liver; 13, the epiglottis, open to admit air to the lungs; 14. 14 the wind-pipe upper part. the larynx; lower part the trachea; 15, the lungs; 16, the heart; 17, the cavity of the nose; 18, cavity of the mouth; 19, the tongue; 20, the diaphragm.

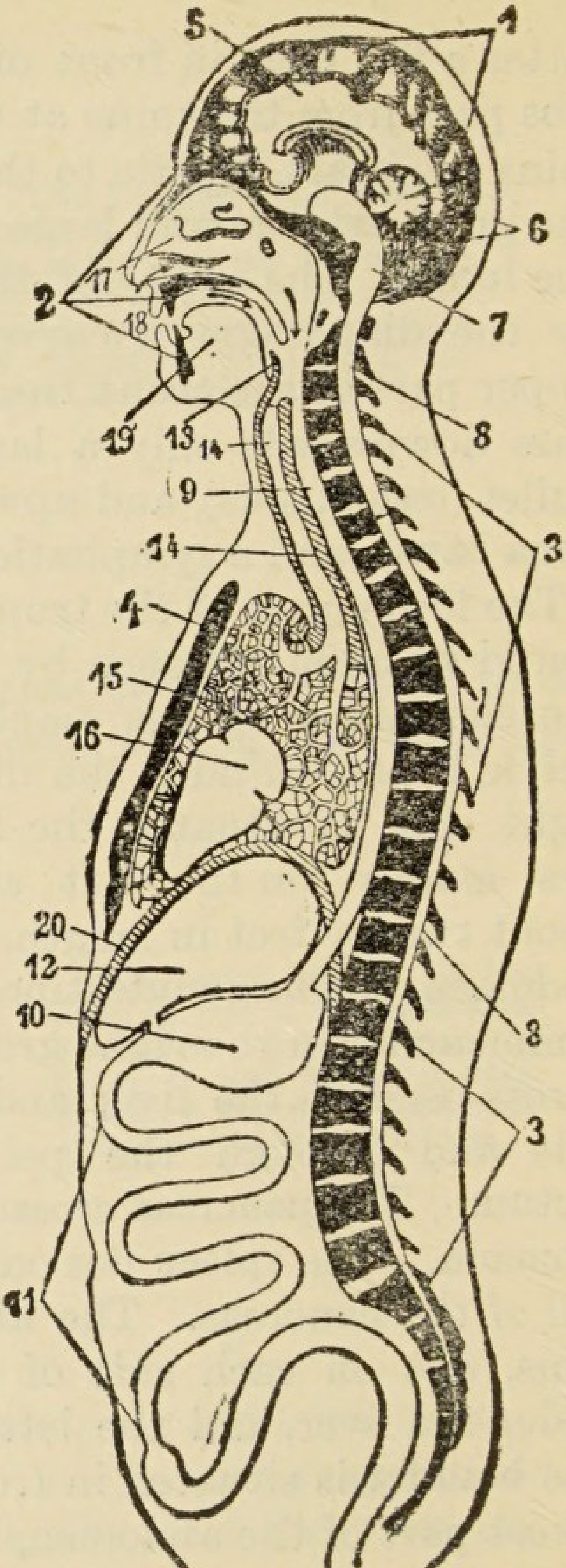


Fig. 6.

The Limbs are the mobile extremities appended to the trunk, the legs to the lowest part, or pelvis, and the arms to the thorax by means of the scapulæ, or blade-bones and attached muscles.

The Work of the Body is carried on by the systems, and displays itself as motion, circulation of the blood, respiration, digestion of food, secretion, excretion, mental effort, exercise of the senses, regulation of the temperature, and in many other ways.

Motion.—The feature that distinguishes the living from the dead is movement. Whether the movement be of an individual as a whole, or of a part, as a limb, or of one of the organs of which the individual is composed, as the heart or the lungs, work is being done, material is being used, burned up or oxidised ; that is converted into water and into carbonic acid.

Waste and Repair.—In the production of motion and of changes of various kinds in the body, the compound substances that form the cells of organs and parts are reduced to simpler compounds by oxidation. It is this disintegrating process that sets free heat and energy to carry on the vital functions. This process however will terminate in wasting and death unless additional compound substances are supplied to repair the waste. These are provided by food, gaseous, liquid, and solid, and are carried by the blood to the cells of the various organs and parts of the body.

Nutrition.—The cells of the tissues derive from the blood the materials for their growth and repair, and the oxygen for their vitality, and return to it the waste substances and carbonic acid they produce in the course of their changes, and *metabolism.* The blood derives its nutritive materials from the oxygen supplied by the lungs from inspiration, and from the oxygen, carbon, nitrogen, and hydrogen supplied by the alimentary canal from the digested food, and the nutriment in various forms of combination is carried to the remotest parts of the body. Some is immediately consumed, some is stored for a short period as glycogen in the liver, and some again is stored for a longer period as fat under the skin and between the muscles.

Secretion.—There are certain surfaces, as those of opposed synovial and serous membranes, that are continuously moist with fluid for purposes of *lubrication.* The *synovial membranes* are those that line the joints, the movable pads or cushions in parts exposed to pressure, and the sheaths of tendons and muscles. The *serous membranes* are those that surround the heart, the lungs, and the abdominal organs, including the intestines, and their opposed surfaces glide over each other to facilitate the movements of these organs.

The true secreting organs are the secretory glands, which vary in size from the liver to the almost invisible simple tubular gland. But the structure of most glands may be regarded as consisting essentially of a fine membrane carrying capillary blood vessels on the one side and covered with cells closely packed together on the other. When straight it is a simple tubular gland, as those that secrete the gastric and intestinal juices. When sub-divided it may form a sacculated, or, when branched, racemose gland, as salivary glands and the pancreas. The various secretions are poured out to be utilized in furthering the functions of the body.

Excretion.—The waste products of the tissues are injurious to them and have to be got rid of; also undigested food materials, surplus secretions and water have to be discharged from the body. These substances are excreted from the intestines, the kidneys, the skin and the lungs, from the last three, after passing through the blood, and hence these are regarded as the true *excretory organs.*

The daily Income and Outgo of the body may be so set out as to give an approximate idea of the amount of nutrition and waste; approximate only, because they vary within wide limits, and there are losses from other minor sources than those here mentioned :—

	Taken in.	Thrown off.
Digestive system (alimentary canal)	Solid food about 1½ lbs., water about 50 oz.	Solid fœces, about 4 oz.
Pulmonary system (lungs)	Oxygen about 28 cubic feet.	Water, about ½lb. Carbonic acid. about 14 cub. ft.

	Taken in	Thrown off.
Urinary system (kidneys) & Cutaneous system (skin)	— —	Urea abt. 500 grs. Water about 2lbs. Sebaceous matter, etc.

The principal Systems of the body are :—

1. The Locomotive, embracing the bones, joints, voluntary muscles, tendons, etc.

2. The Circulatory, consisting of the heart, arteries, capillaries and veins.

3. The Respiratory, formed by the larynx, trachea, bronchi, and lungs.

4. The Digestive, including the mouth, teeth, salivary glands, pharynx, œsophagus, stomach, pancreas, liver and intestines.

5. The Lymphatic, consisting of the lymphatics, lacteal vessels, spleen, and certain glands.

6. The Urinary, embracing the kidneys, ureters, bladder and urethra.

7. The Cutaneous, including the sweat and sebaceous glands, the hair, nails and the layers of the skin.

8. The Nervous, consisting of the brain and spinal cord, the nerves (motor, sensory, and sympathetic), and of the special senses.

The Locomotive System.

The framework upon which the human body is built is the *skeleton*, the bones of which are articulated together by movable *joints*, and are moved at the joints by *muscles* attached to them.

Skeleton in profile with diagrammatic attachments of some of the most important muscles. 1, bone of skull (parietal bone); 2. bones of face– nasal bone, malar bone, upper jaw, lower jaw; 3, 3, bones of spine (vertebræ); 4 breast bone (sternum); 5, bone of spine, first vertibra (dorsal); 6, shoulder blade (scapula); 7, bone of upper arm (humerus); 8, bone of forearm (radius); 9 bone of forearm (ulna); 10, bones of wrist (carpus); 11, bones of palm (metacarpus); 12, 12, bones of fingers (digits); 13, haunch bone (pelvis); 14, thigh bone (femur); 17, knee-cap (patella); 18, bones of ankle (tarsus); 19, bones of foot (metatarsus); 20, bones of toes (digits).

Muscles.—21, muscles of the spine; 22, muscles of front of the abdomen; 23, muscles of front of the neck; 24, 24, muscles of upper; arm 25. 25, muscles of forearm; 26, muscles of front of the thigh; 27, muscles of back of the thigh; 28, muscles of calf of the leg; 29, muscles of front of the leg.

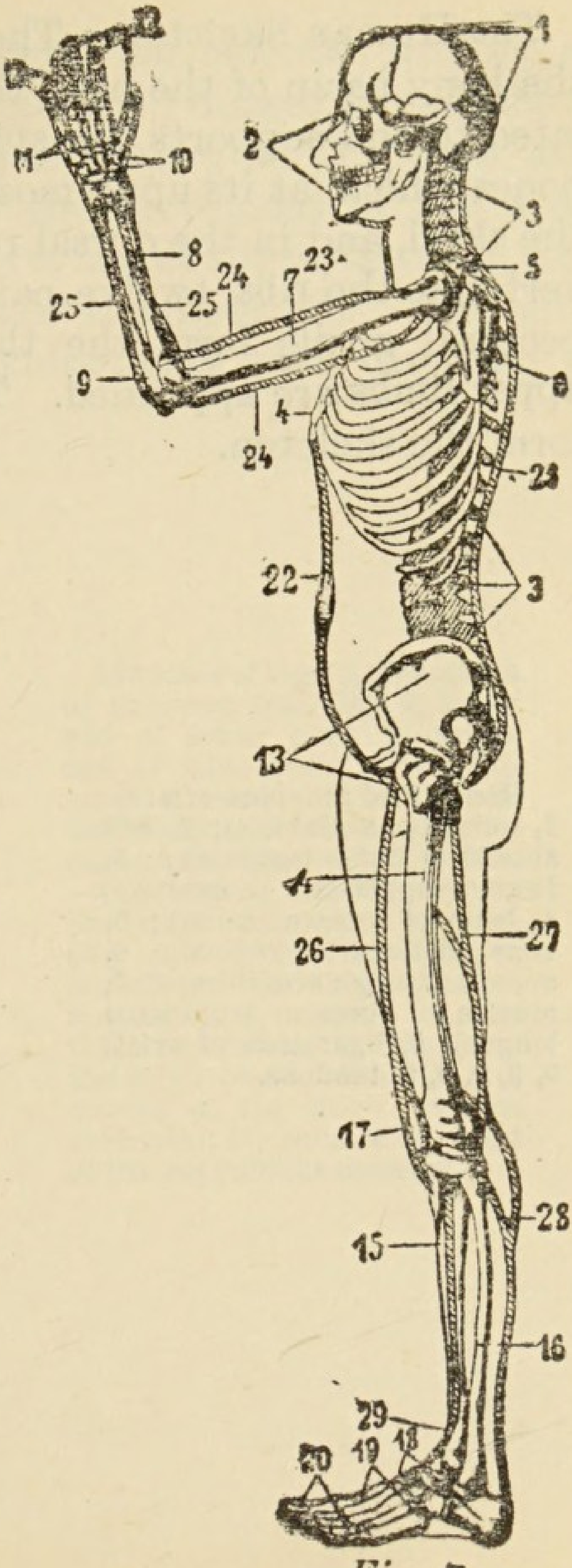


Fig. 7.

The Human Skeleton.—The two *lower limbs* support the bony basin of the hips, the **pelvis**, which is articulated to and supports the **spine** or column of vertebral bones which, at its uppermost end in its turn supports the **skull**, and in the dorsal region has attached to its vertebræ the **ribs**, twelve pairs, that together in the pectoral girdle form the **thorax** to which the two **upper limbs** are appended. The bones of these parts form the skeleton.

Bones and muscles of arm. 1, collar bone (clavicle); 2, left shoulder-blade (scapula); 3, bone of upper-arm (humerus); 4, bone of forearm (ulna); 5, bone of forearm (radius); 6, muscle of upper arm (biceps); 7, muscle of forearm (supinator longus); 8, ligaments of wrist; 9, 9, 9, 9, 9, tendons.

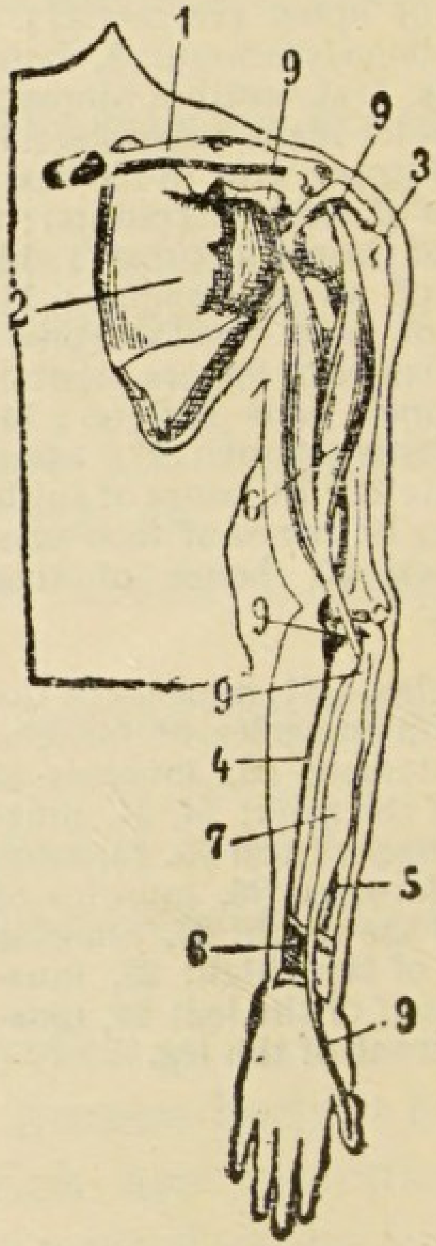


Fig. 8.

The Joints allow of various movements; gliding, as the joints between the vertebræ; hinged, as the elbow, knee and ankle; ball and socket, as the hips and shoulder; and pivot, as the movement of the atlas (the vertebra that supports the skull) on the axis, (the vertebra by which the atlas is supported). The joints are covered on their articular ends with cartilage or

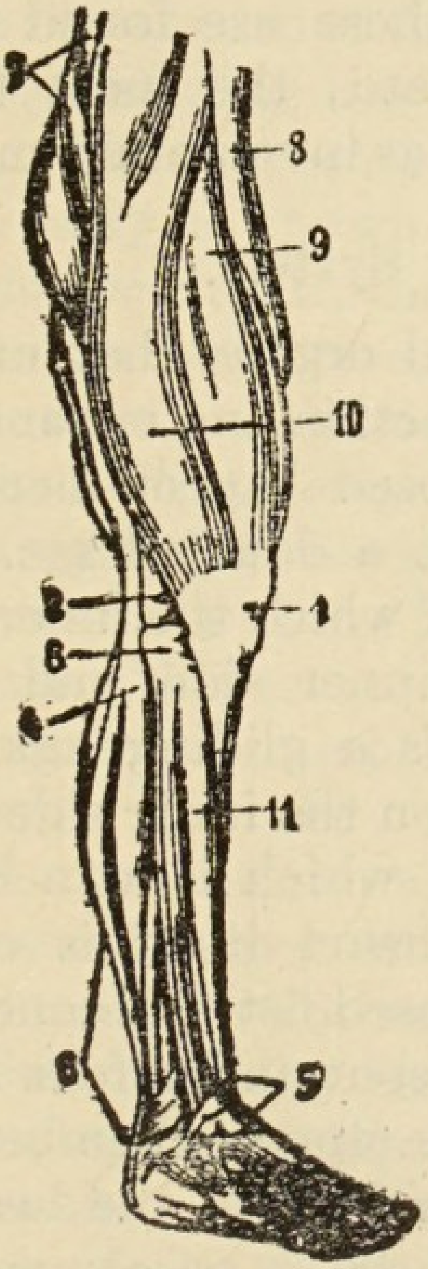


Fig. 9.

Muscles of leg. 1, ligaments of knee-cap (patella); 2, lower end of femur bone; 3, upper end of tibia bone; 4, attachment of muscle of calf (peroneus longus) to fibula; 5, anterior annular ligament; 6, tendon —the thickest and strongest in the body—attached to the heel and calf (tendo Achilles); 7, muscle of the hip (gluteus maximus); 8, muscle of the thigh (sartorius); 9, muscle of the thigh (rectus femoris); 10, muscle of the thigh (vastus externus); 11, muscle of front of the leg (tibialis anticus).

gristle, and also with secreting or lubricating surfaces known as the synovial membrane, which forms a closed bag between the opposed articular ends.

The Muscles of locomotion may be voluntarily contracted and relaxed. They are attached at either end to bones which they move, producing rotation, flexion, extension or other movements. Apart from locomotion, there are muscles that cannot be voluntarily contracted or relaxed, these are found in the stomach, intestines, arteries, etc., the most typical being the heart, and are known as involuntary muscles.

The Circulatory System.

The Heart, like other internal organs that undergo movement or rhythmical contraction and expansion, is enveloped in a completely closed bag of membrane folded upon itself, so as to form a doubled sac. This is known as the *pericardium*, of which the inner layer is attached to the heart on its inner side, and on its outer side is a lubricated surface gliding against a similarly lubricated surface upon the inner side of the outer layer, the outer side of which is attached to surrounding structures. The heart itself is conical shaped, about the size of the closed fist, and consists of a hollowed *involuntary muscle*, containing four chambers, two on each side. The upper chambers are known as the *right* and *left auricles*, and the lower as the *right* and *left ventricles*. There is no communication within the heart, between the chambers of the right and those of the left side, as they are separated by a *septum*, or muscular partition. The ventricles are supplied with *valves* at their inlet and outlet openings, each inlet thus allowing the blood to flow from the auricle into the ventricle below it, but not back again, and each outlet allowing it to flow on into an outlet artery, but permitting no reflux.

The Circulation of the Blood.—In the complete course of its circulation, the blood passes twice through the heart. The longer circuit, through the general system of the body, is known as the *systemic circulation*, and the shorter circuit, through the lungs, is known as the *pulmonary circulation*. Starting from the *left ventricle*, the blood is propelled into the main systemic artery known as the *aorta*, which divides into two, the one carrying the blood to the upper, and the other to the lower part of the body, including the organs of the abdomen, thence it flows into the *capillaries*, or smallest vessels, and is collected into the veins that discharge into the two main veins; known as the superior and inferior *vena cava*, or hollow veins, because they remain open like arteries and do not collapse when empty like other veins, and these discharge into the *right auricle*. Here the systemic passes into the pulmonary circulation.

From the *right auricle* the blood passes into the *right ventricle*, from which it is propelled into the *pul-*

monary artery, and so reaches the *pulmonary capillaries* in the lungs; from these it is collected into the *pul-*

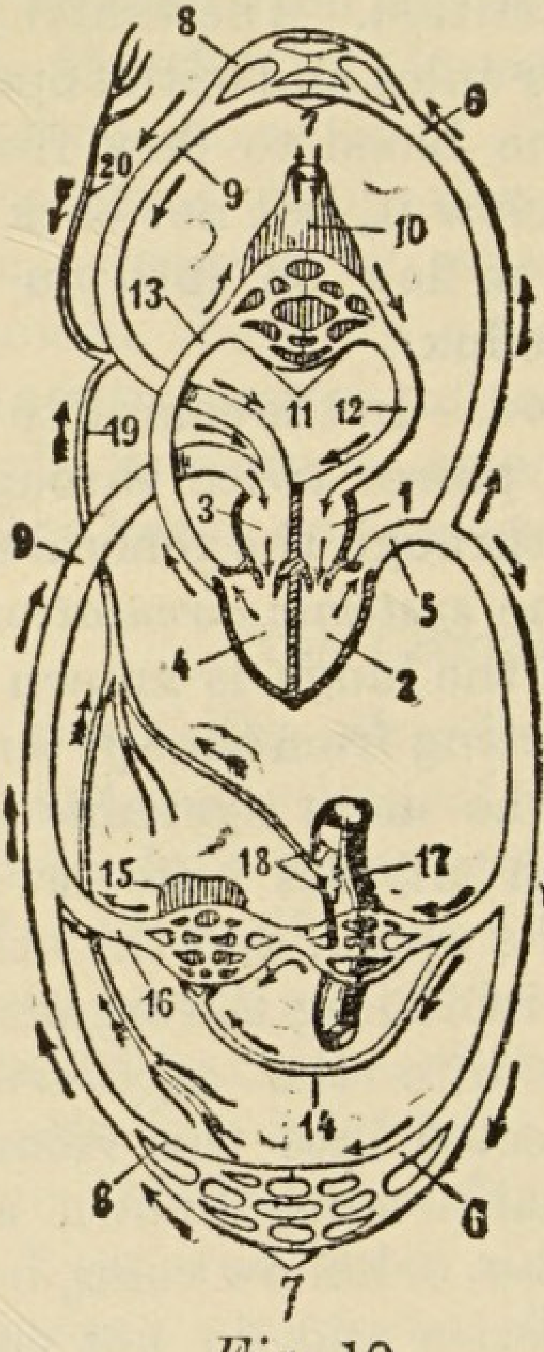


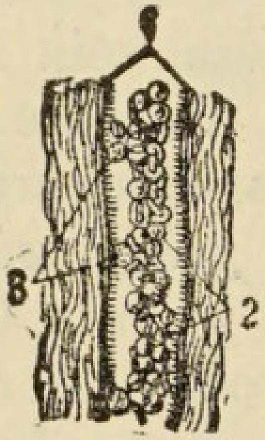
Fig. 10.

Diagram of the heart and vessels, with the course of the circulation. 1, left auricle of the heart; 2, left ventricle of the heart; 3, right auricle of the heart; 4, right ventricle of the heart; 5, aorta; 6, 6, branches from artery; 7, 7, capillaries; 8, 8, branches joining vein; 9, 9, vein; 10, the lungs; 11, capillaries of the lungs; 12, pulmonary vein; 13, pulmonary artery; 14, hepatic artery, which supplies the liver with part of its blood; 15, the liver; 16, hepatic vein; 17, alimentary canal; 18, thoracic duct (receptacle or cistern of the chyle); 19, thoracic duct; 20, lymphatics.

monary vein that discharges into the *left auricle.* Here it reaches the left side of the heart again, and passes into the *left ventricle*, the point from which we started.

There is also an important subdivision of the systemic circulation to be mentioned, known as the *portal system.* The main artery to the lower part of the body, *the abdominal aorta*, gives off branches as it passes through the abdomen, to all the abdominal organs, but the veins taking the blood from the capillaries of certain of these organs, do not pass directly into the *inferior vena cava*, the main vein from the lower part of the body. The veins from the stomach, large and small intestines, spleen and pancreas unite to form a large vein known as the *portal vein*, which runs to the liver and again breaks up into the capillaries traversing it. The blood from this source as well as from the liver tissue, reaches the inferior vena cava by the single large *hepatic vein*, the liver tissue itself having been supplied with blood by the *hepatic artery*.

The Blood.—Fresh blood is a red fluid, consisting of a pale yellow *plasma*, or liquid, in which float numerous minute solid bodies or *corpuscles*, that are of two kinds, red and white. The *red corpuscles* may be counted by millions, and are five hundred times more numerous than the white. They are extremely minute, shaped like discs, thicker at the circumference than in the centre, are very flexible and elastic, and outside the blood vessels tend to form *rouleaux* like piles of coins. Their spongy structure contains the red colouring matter, *oxyhæmoglobin*, that carries oxygen to the tissues. The *white corpuscles* are mostly larger than the red, and unlike them are constantly changing their shape; they are derived from the lymphatic system and ductless glands. Outside the body, *coagulation* of the blood takes place, the fibrinous material sets and

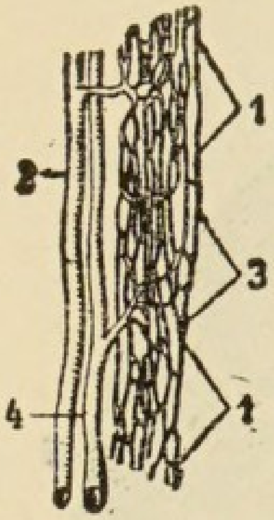


Blood corpuscles (white and red) in artery. 1, walls of artery; 2, red blood corpuscles; 3, white blood corpuscles.

Fig. 11.

entangles in its meshes the corpuscles, forming the *clot*, and this contracting presses out a yellowish fluid called the *serum*.

The Blood Vessels.—The tubes that carry the blood are of three kinds, arteries, capillaries, and veins. The *arteries* are very elastic, and when the heart propels the arterial blood through them they yield and expand, allowing it to flow forward, and contract upon it so as to assist in propelling it onward, and this gives rise to the pulsation of the arteries—the *pulse*. From the larger arteries, the blood is propelled into the smaller, until it reaches the *capillaries* of the various organs and tissues, where the interchange of the products of waste and repair takes place, and *arterial blood* becomes converted into *venous blood.* From the capillaries, the blood flows into the smaller veins that join



Arteries and veins, branching into capillary network (magnified). 1, 1, arterial blood capillaries (red); 2, small artery, branching into arterial capillaries (red); 3, venous blood capillaries (blue), joining into small vein (blue); 4, small vein.

Fig. 12.

to form larger veins which, not being elastic like the arteries, are supplied with valves or *pouches* to prevent reflux, and from them the blood passes onwards into the largest *veins*, and through them into the heart.

The Respiratory System.

The Respiratory Organs.—When inspired, the air passes through the *nose* or *mouth* backwards into the *pharynx*, through the *larynx* into the *trachea*, or windpipe, and *bronchi*, and so into the lungs, through the *bronchial tubes*, that become smaller by division, and finally reaches the *infundibula* or dilated sacular extremities of the tubes, with the *alveolar cavities* that cluster upon them like hollow grapes. It is in the capillary blood vessels of the walls of these

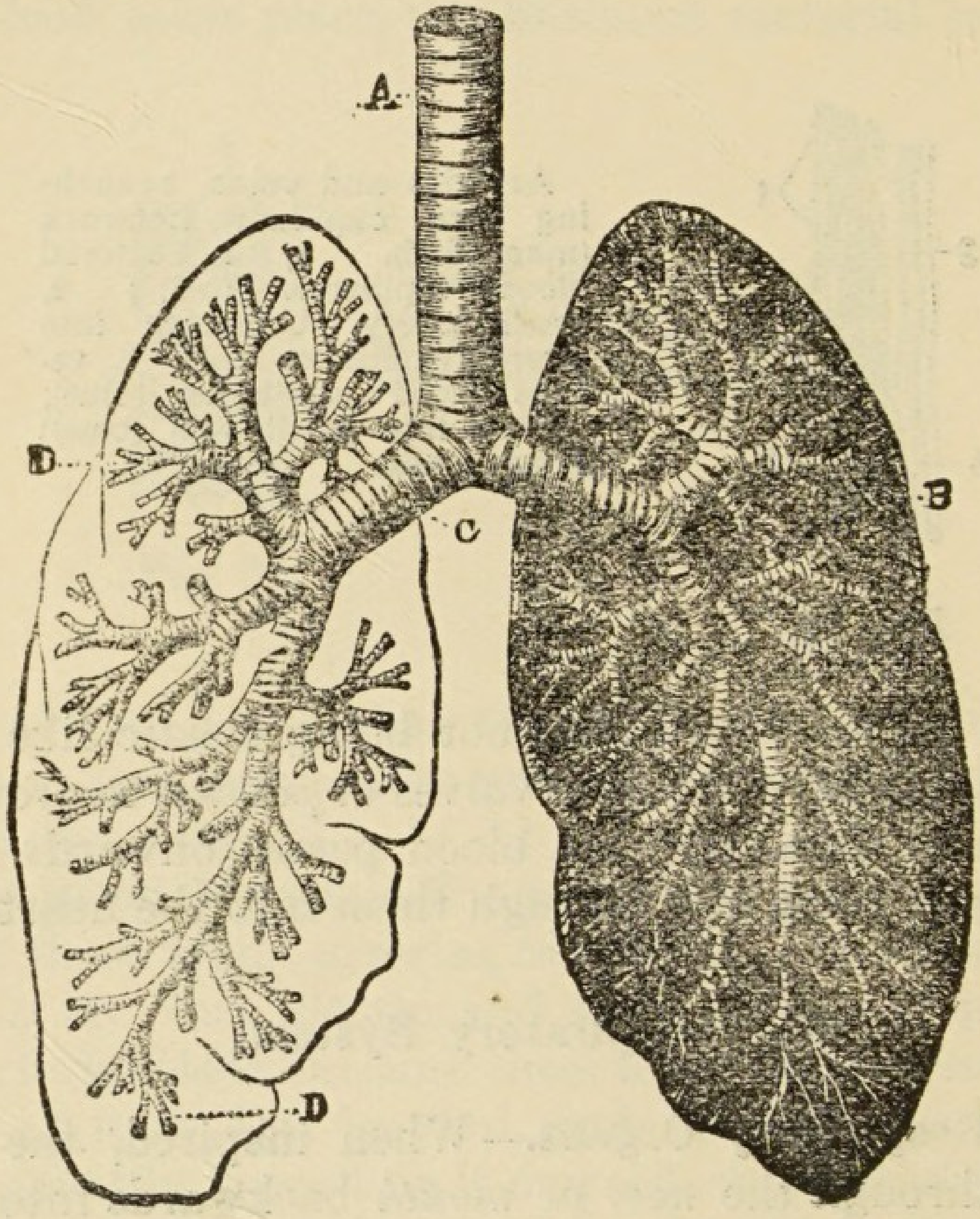


Fig. 13.

The Lungs and Bronchial Tubes. A, trachea, or wind-pipe. B, left bronchus. C, right bronchus. D, smaller bronchial tubes.

cavities that the exchange of gases in the blood takes place. The air is drawn into (inspiration) and forced out (expiration) of the lungs by the contraction and expansion of the boundaries of the thorax, and this is

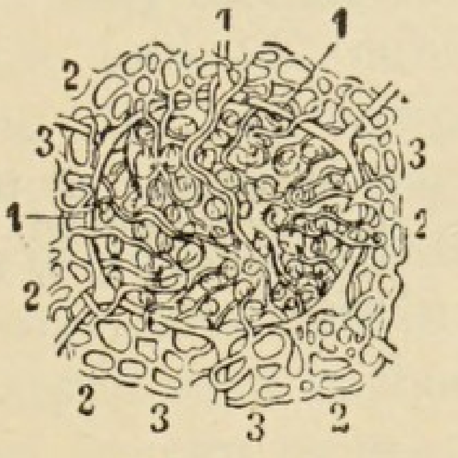


Fig. 14.

Air cells and capillaries (highly magnified). 1, 1, 1, walls of air cell; 2, 2, 2, 2, 2, arterial blood capillaries; 3, 3, 3, 3, venous blood capillaries.

effected from below by the muscular diaphragm, and laterally by the ribs, which are set in motion by the intercostal muscles.

The Mechanism of Respiration.—The larynx, trachea, and bronchi, with the exception of the very smallest bronchi, are all furnished with rings, or partial rings, or small pieces of a gristly substance, called cartilage, that prevent them from collapsing, so that they are always open and contain air. The infundibula, or dilated ends of the smallest tubes, and the alveoli, or clusters of air chambers upon them, on the other hand, are furnished with elastic tissue that causes them to expand and contract with the movements of inspiration and expiration produced by the action of the ribs and the diaphragm. The trachea and bronchi not contracting, have a constant capacity of 20 to 30 cubic inches, but the smaller bronchi and air cells being elastic, may vary in capacity from 100 to 300 cubic inches.

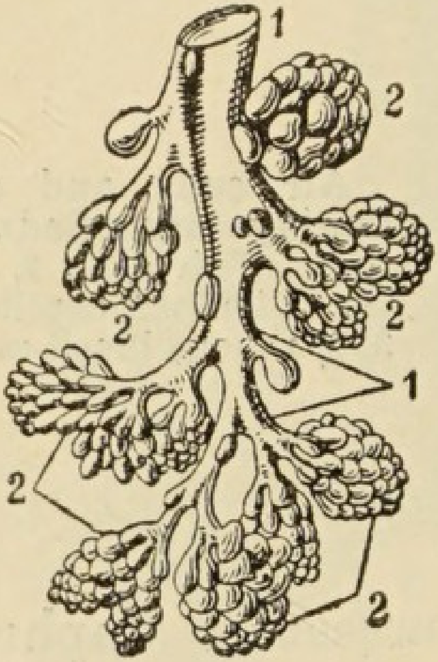


Fig. 15.

Structure of the lungs (highly magnified). 1, 1, bronchial tubes; 2, 2, 2, 2, 2, air cells.

In Ordinary Respiration from 20 to 30 cubic inches of air are inspired and expired, and this air is known as *tidal air*, and the quantity remaining in the smallest bronchi and air cells (about 200 cubic inches), is called *stationary air.* The fresh air at each inspiration not being drawn in beyond the smaller bronchi, it follows that the stationary air, which is used air, can only be renewed by diffusion. So that a double process of diffusion goes on in the lungs, firstly, the exchange of gases between the tidal and stationary air in the smaller bronchi, and secondly, the exchange between the gases of the stationary air and of the blood in the fine capillaries of the air cells.

In **Extraordinary Respiration**, as in exercise, 100 cubic inches, in addition to the 20 or 30 cubic inches of tidal air may be inspired, this is known as *complemental air*, and 100 cubic inches may be expired beyond the tidal and complemental air, this is termed *supplemental air*, but the remaining 100 cubic inches cannot be expired, and this is called the *residual air*.

The Changes produced in the Blood by Respiration.—Blood charged with carbonic acid, is dark purple in colour and known as *venous blood*, when it is charged with oxygen it is scarlet, and known as *arterial blood*. This is due to the fact that the purple *hœmoglobin* of the blood when charged with oxygen becomes scarlet *oxyhœmoglobin*. It is in the capillary vessels of the lungs that the blood exchanges its carbonic acid for oxygen, and in the capillaries of other parts of the body that it parts with its oxygen and takes up carbonic acid. This gaseous exchange takes place by what is known as *diffusion*, and the law of diffusion through membranes is, that gases diffuse into each other until the pressure on both sides of the membrane is the same, so that ultimately if sufficient time were allowed, the same amount of carbonic acid and of oxygen would be found on both sides. In the capillaries of the tissues the blood is exposed to an excess of carbonic acid—in the capillaries of the lungs to an excess of oxygen.

The blood in the left side of the heart, being derived from the lungs where it is oxygenated, is *arterial*, and flows through the arteries. In its passage through the capillaries it is deprived of oxygen, becomes venous blood and flows through the veins into the right side of the heart, which therefore contains *venous blood*. It is to be noticed that the pulmonary artery, unlike other arteries, contains venous blood from the right side of the heart, and that the pulmonary vein, unlike other veins, contains arterial blood from the lungs, delivering into the left side of the heart. In addition to this great change, the blood in the capillaries receives waste products, including carbonic acid ; in the inferior vena cava it receives through the hepatic vein nutritive material, derived from the liver and the portal system ; and in the superior vena cava receives nutritive material from the lymphatic and lacteal systems through the thoracic duct and lymphatic vessels that discharge into its branches.

Changes produced in the Air by Respiration.— Expired air contains from four to five per cent. less oxygen, over four per cent. more carbonic acid, and more watery and organic vapours than inspired air. That is to say the blood takes up a portion of the oxygen of the inspired air and yields to it in return a nearly similar amount of carbonic acid, and some watery vapour and organic matter. The nitrogen of the air remains practically unchanged.

In twenty-four hours about 24,000 cubic inches of carbonic acid are expired, representing some eight ounces of carbon derived from the disintegration of the tissues in carrying on their vital functions, and about half-a-pint of watery vapour also escapes by the lungs. The lungs supply oxygen only, and are the main source of its supply.

The Digestive System.

The Organs of Digestion.—These consist of the mouth, the teeth, the salivary glands, the pharynx, the œsophagus, the stomach, the liver, the pancreas (or stomach sweet-bread), the small intestine, into the commencement of which the ducts of the pancreas and liver discharge, and the large intestine, the terminal portion of which is known as the rectum. The whole length of the digestive canal is lined by a membrane that secretes mucus, and embedded beneath the membrane are numerous glands which vary in structure and function according to their situation.

Digestion.—Foods are supplied in various chemical combinations, and these are taken up by the digestive system. By the process of digestion the food materials are altered so as to render them capable of being absorbed from the alimentary canal, and of being ultimately assimilated by the tissues. They are for the most part absorbed by the capillary blood-vessels and directly enter the blood: the fats, however, are absorbed

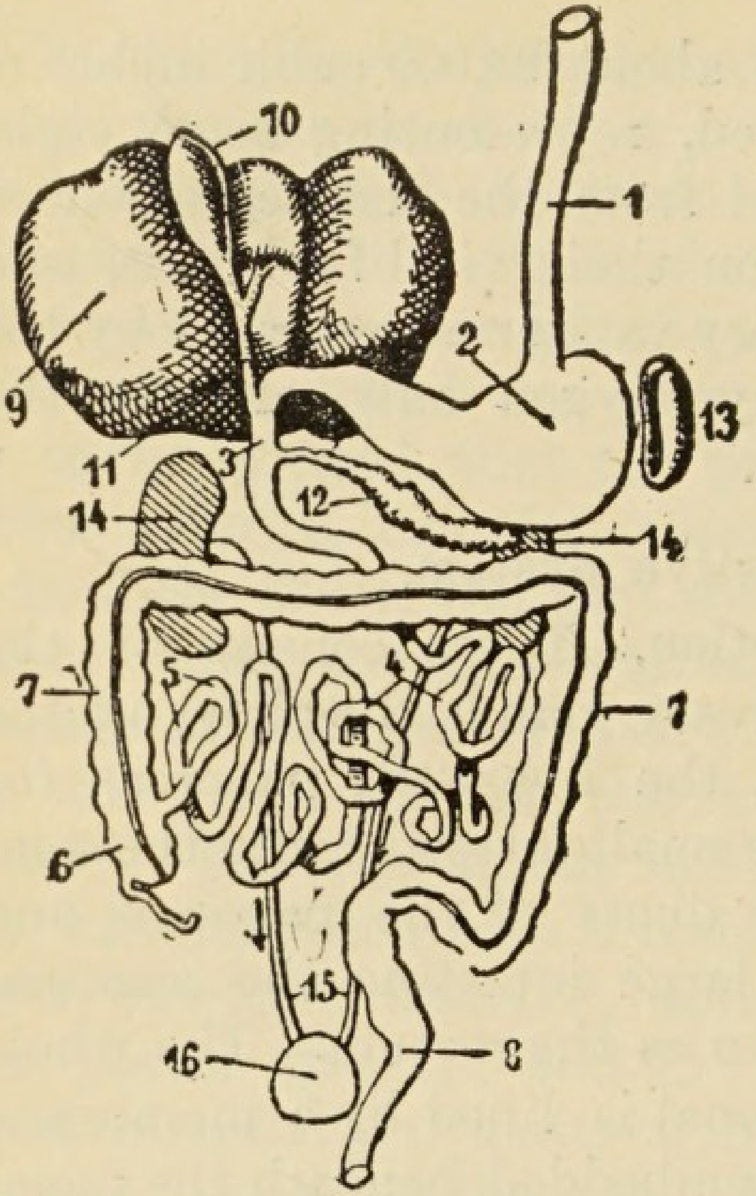


Fig. 16.

Diagrammatic view of the digestive organs. 1, alimentary canal or gullet; 2, the stomach; 3, duodenum; 4, bowels, or small intestines (jejunum); 5, bowels, or small intestines (ileum); 6 commencement of large intestine (cæcum); 7, 7, large intestine; 8, lower portion of large intestine (rectum); 9, the liver; 10, gall bladder; 11, bile duct; 12, pancreas; 13, spleen; 14, 14, kidney; 15, ureters; 16, bladder.

by the capillary lymphatic vessels, and pass into the thoracic duct, which discharges into the left subclavian vein. Before they are absorbed they are acted upon by one or more digestive secretions, of which the four principal are—the saliva, the gastric juice, the bile and the pancreatic juice. The process of digestion may be divided into three stages, *buccal*, *gastric* and *intestinal*.

The Buccal Stage.—When food enters the mouth it is first finely ground by the teeth and undergoes *mastication*. At the same time it is moistened by being mixed with the saliva, which is a clear, slightly viscid fluid containing *ptyalin*, which converts starches into an absorbable form of sugar known as grape or malt sugar. The broken and moistened food is forced by muscular contraction through the throat and gullet into the stomach.

The Gastric Stage.—*The stomach* is a dilation of the alimentary canal, the left, or *cardiac end*, being the larger, and the right end the smaller, curving and tapering to its circular outlet, known as the *pylorus*, where it becomes continuous with the first part of the small intestine. The walls consist of muscular tissue lined by mucous membrane, closely studded with simple *tubular glands* which secrete the gastric juice. The *gastric juice* is a colourless acid fluid, containing a little *hydrochloric acid* and a little of a ferment called *rennin*, which coagulates milk, but the principal constituent is a ferment known as *pepsin* that, in an acid medium, converts nitrogenous or proteid substances (lean meat, white of egg, etc.) into *peptone*, which is readily absorbed by the capillary blood-vessels.

Food from the gullet enters the stomach, part of the starches having been converted into grape-sugar by the saliva, the action of which is arrested by the gastric juice. The food is now churned and mixed thoroughly with the gastric juice until it becomes more or less fluid and the nitrogenous substances are converted into peptones, but the starches and the fats are not acted upon. Before leaving the stomach the water and salts of the sugar and the peptones are partly absorbed. The broken up starches and now melted fats, together with parts of the other constituents, pass as *chyme* through the now relaxed pylorus into the *duodenum*, the first part of the small intestine. Before describing the intestinal stage of digestion a diversion must be made in order to give some account of the pancreas and liver.

The Pancreas.—The Pancreas is a large long gland, lying behind the stomach. *The pancreatic juice* is a colourless viscid fluid, with an alkaline reaction, and contains three ferments, of which one converts starches into sugar, completing the unfinished action of the saliva, another converts proteids into peptones in an alkaline medium, supplementing the action of the gastric juice, and a third acts upon fats in such a way as to make them capable of absorption.

The Liver.—The liver is a large red-brown organ, weighing, in the adult, about fifty to sixty ounces, and lies with its convex surface immediately under the diaphragm, on the right side of the abdomen. The liver tissue consists of hepatic cells grouped into lobules, between and into which run the capillaries of the hepatic artery and vein, portal vein and bile duct. The hepatic artery supplies arterial blood to the liver tissue, the portal vein brings venous blood from the stomach, intestines, spleen and pancreas. This venous blood carries nutriment absorbed by the capillaries of the stomach and intestines, to be elaborated by the liver cells. The blood from both sources leaves the liver by the hepatic vein after yielding up sugar which is stored in the liver, and forming bile which travels along the bile duct to the gall-bladder and duodenum.

The functions of the liver are: (1) The continuous secretion of bile, a slimy yellow alkaline fluid, which is stored in the gall-bladder, and during digestion passes into the small intestine to act on the chyme, emulsifying fats in a similar manner to the pancreatic juice; (2) The separation of sugar from the blood, storing it as glycogen (a starch-like compound) and delivering it up as required by the system, so as to equalise the amount in the blood. Although the liver makes glycogen from sugar, it can also in the absence of sugar, elaborate it from proteids, but in less abundance.

Resuming the course of the gastric stage of digestion:—The food leaves the stomach and passes through the pylorus, as chyme, into the duodenum where it meets with the pancreatic juice and the bile. The chyme leaves the stomach in an acid condition, but mixing with these two fluids it becomes alkaline, and the further action of pepsin is arrested. The pancreatic juice converts into sugar those starches that have escaped the action of the saliva arrested by the acid gastric juice. It also converts the proteids or nitrogenous substances into peptone, but differs from gastric juice in that it effects this conversion in an alkaline instead of an acid medium. Further, in conjunction with the bile it acts on fats by emulsifying and partly saponifying them.

The Intestinal stage.—The functions of the *small intestine* are: (1) To continue the process of digestion; (2) To pass the chyme gradually onwards by slow wave-like contractions (*peristalsis*); and (3), most important of all, to absorb the digested and converted food substances. The peptones, sugar and salts pass directly into capillary blood vessels, and the emulsified fats into lacteals, whence they are carried to the lymphatics and the thoracic duct, and delivered (as *chyle*) into the veins near the base of the neck. The *large intestine* absorbs what is left of the digested food and the water, so that the remaining material becomes gradually more solid and is discharged by the rectum as *fœces*. The capillary blood vessels of the intestines, that have absorbed the water, peptones, sugar and salts, carry these by the portal vein to the liver, there to be further elaborated.

The Lymphatic System.

The colourless fluid that is derived from the blood, and that exudes through the walls of the capillary blood vessels to bathe the tissues, is known as *lymph*, and contains white blood corpuscles. This fluid flows in *lymph spaces*, which are drained by delicate *lymphatic vessels*, in the course of which are situated *lymphatic glands*, where the white corpuscles multiply by division and grow, thence the lymph passes into the *main lymphatics*, and so on to the *lymphatic duct*. The enlarged lower end of the lymphatic duct lying at the back of the abdomen is known as the *chyle receptacle*, because it receives the chyle from the *lacteal lymphatics* of the abdomen, which in turn receive it from the *lacteals* of the small intestine, where it is absorbed from the chyme.

The lymphatic duct extends upwards from the chyle receptacle along the front of the spine, and discharges into the veins at the base of the left side of the neck, where the mixed lymph and chyle enter the blood circulation, and when the blood again reaches the capillaries the process recommences, constituting a *lymphatic circulation*.

The Spleen.—Just below the left end of the stomach a dark red oval-shaped organ, measuring about five inches in its greatest length, is situated. It consists of a network of fibrous and elastic tissue, containing in its meshes the spleen pulp, composed of red blood corpuscles and colourless cells. The splenic artery supplies it with arterial blood, the effete red corpuscles of which remain behind in the spleen pulp and are broken up, the colouring matter passing on through the splenic veins and portal vein to the liver to assist in the formation of bile. The white corpuscles of the blood multiply and increase in the spleen and also pass on to the liver through the portal vein.

In addition to the spleen there are other ductless glands that still further modify the blood in a lesser degree to adapt it to the body's requirements.

The Urinary System.

The Kidneys.—These organs lie one on each side of the spine, in the region of the loins. A tube about fifteen inches long leaves each kidney, and the two tubes (ureters) pass to the bladder. The function of the kidneys is to secrete urine, which consists of water derived from the blood, and holding in solution certain waste products, *urea* and *uric acid.*

The Bladder.—The function of the bladder is to store the urine which drips into it from the kidneys through the ureters, and to discharge it at intervals through the urethra. The amount of urine passed averages forty to fifty ounces in twenty-four hours, but varies with the quantity of fluids imbibed, and the external temperature of the air. In cold weather the capillaries of the skin are contracted, less water being perspired, and more is excreted by the kidneys than in warm weather, the kidneys and the skin thus acting reciprocally.

The Cutaneous System.

The Skin.—Just as the internal surfaces of the passages into and through the body are lined with mucous membrane, so the external surface of the body is covered with skin. The skin consists of a superficial layer of cells or *cuticle*, and a deeper layer of true skin known as the *dermis*, and under this again lies the *sub-cutaneous tissue.* The colouring matter of the skin lies in the deepest part of the superficial layer, the surface cells of which are constantly being shed. The hair and nails are also formed from this

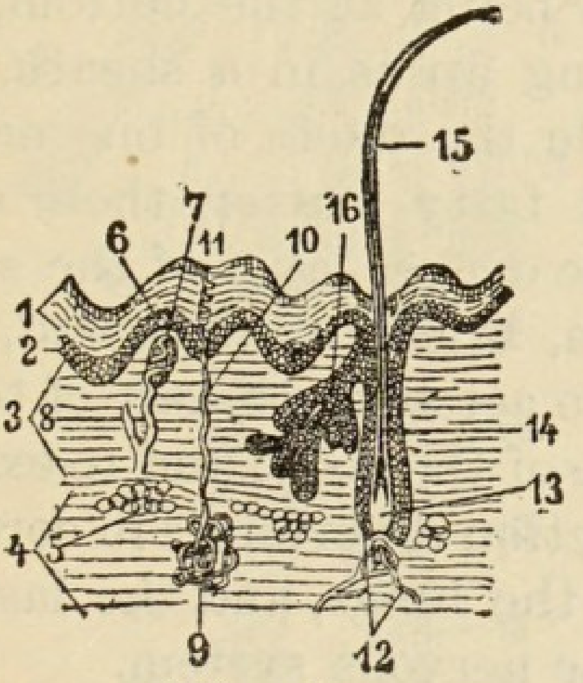


Fig. 17.

Magnified section of skin, sweat glands and hairs. 1, horny layer of the epidermis; 2, deeper layer of the epidermis; (the rete Malpighii); 3, the dermis or true skin; 4, panniculus adiposus; 5, fat cells; 6, papillæ or ridges of deeper epidermis; 7, nerve papillæ; 8, nerve fibres; 9, the coiled end of a sweat gland; 10, sweat duct; 11, opening of sweat duct; 12, nutrient artery; 13, hair bulb; 14, shaft of hair; 15, hair; 16, sebaceous glands.

layer. The surface of the true skin projects into the cuticle or epidermis in conical processes, or papillæ, in which are the *touch corpuscles*, the terminations of the sensory nerves of the skin. The true skin also contains a network of capillary blood vessels.

In the sub-cutaneous tissue, fat is stored to act as a cushion, and the *sweat glands* are found. These glands discharge on the surface by minute openings, visible with a lens as rows of pits upon the ridges of the skin. They are always perspiring in a manner, when perceptible known as *sensible perspiration* when imperceptible, *insensible perspiration.*

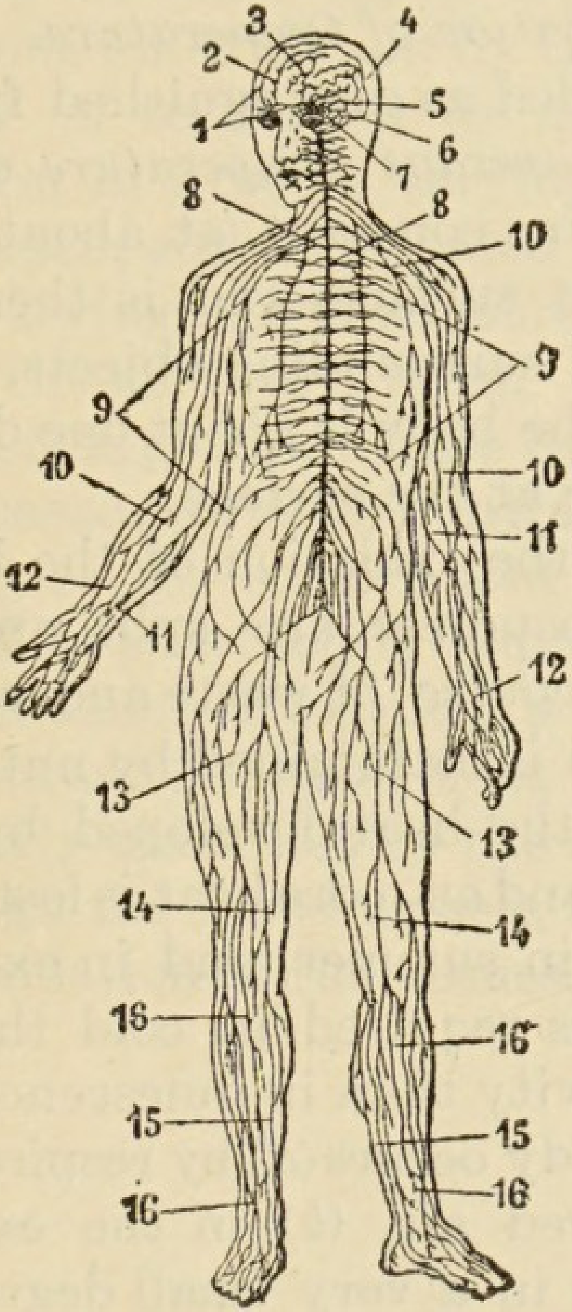
The Hairs spring from pits lined with cells of the superficial layer, but sunk into the deeper layer or true skin. Each of these pits is known as a *hair follicle*, the root of the hair being at the bottom, and the shaft of the hair passing up as in a sheath, and near the top of the follicle the ducts of one or two sebaceous glands discharge fatty matter, these small glands being situated in the deeper layer of the skin.

The function of the skin, briefly summarised, is to protect the deeper parts, to act as the organ of touch, to regulate the temperature of the body, and to excrete perspiration. This last function it performs in correllation with the kidneys and the lungs, and the last but one in conjunction with the nervous system.

The Nervous System.

The Nervous System consists of the *brain* and *spinal cord* as the central organs, from which proceed nerves to the various parts of the body.

Nerves are either sensory or motor, the *sensory nervcs* are those that carry impressions to the centre, and the *motor nerves* are those that from the centre set the various parts in motion, or control movement.



The Nervous System. 1, the brain, right and left lobe; 2, great longitudinal fissure; 3, cerebrum 4, occipital lobe; 5, the base of the cerebrum, 6, cerebellum; 7, medulla oblongata; 8, 8, spinal cord; 9, 9, nerves of the trunk branching from spinal cord; 10, 10, 10, nerves passing through arm; 11, 11, inner nerve of the arm; 12, 12, nerves communicating with the thumb; 13, 13, anterior nerve of the upper part of the leg; 14, 14, posterior nerve of the upper part of the leg; 15, 15, posterior nerve of lower part of leg; 16, 16, anterior nerves of lower part of the leg.

Fig. 18.

There is also a chain of nerve *ganglia* situated down each side of the front of the spinal column, known as the *sympathetic chain*, and connected by short branches with the spinal cord. This system of nerves controls the involuntary muscular tissues of the organs and vessels, and regulates the unconscious functions.

One important function mainly controlled by the nervous system is the *regulation of temperature*.

Man being a warm-blooded as distinguished from a cold-blooded animal, the *average temperature* of the healthy human body remains constant at about 98½° Fahrenheit at or near the surface, and is therefore usually warmer than most surrounding objects. The blood in the centre of the body is about one degree higher in temperature than at the surface.

The Source of Heat is the oxidation of the living tissues, when complex substances are split up into simpler substances in the course of waste and repair. As the repair of the tissues is maintained by nutritive material, it follows that the heat developed by the body is derived from food, and as more heat is lost from the body in winter than in summer, and in exercise than in rest, more food is required in cold than in warm weather, and in activity than in quiescence.

Loss of Heat from the body occurs (*a*) by respiration, in the warmed and expired air, (*b*) in the excreta leaving the body, but only in a very small degree, (*c*) by far the argest amount through the skin (1) by conduction to objects in contact, (2) by radiation into space, and (3) by the evaporation of sensible and insensible perspiration.

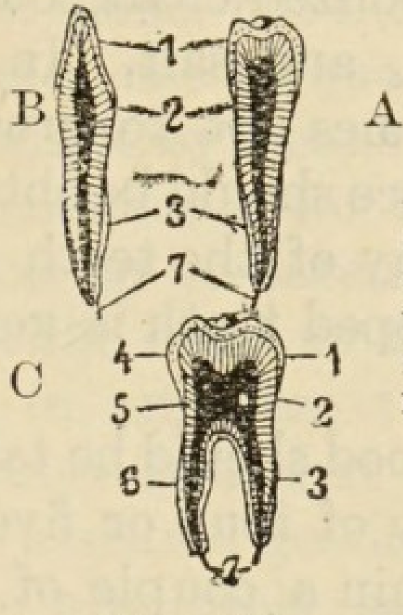
The Regulation of Heat.—As the temperature of the healthy body does not change, it follows that the amount of heat lost and of that produced must balance each other. Assuming that the quantity and quality of food taken are sufficient to satisfy the demands for oxidation by the tissues, it requires great nicety of regulation to maintain the temperature uniform in a body varying in the amount of energy developed, and surrounded by an atmosphere continually varying in temperature. This regulation depends upon the nervous system. Under the influence of cold the nerves governing the capillary blood vessels of the skin cause them to contract, diminishing the blood supply at the surface, and checking the perspiration, the effect of which is to diminish loss of heat. Under the influence of warmth, a reverse action takes place, increasing the loss of heat. The production of heat is similarly controlled by the nervous system in causing, through the blood vessels, a diminution or increase in the oxidation of the tissues.

CHAPTER III.

Personal Habits.

Habits Generally.—Individual habits are extremely important in the maintenance of personal health. Habits are easily formed, but not so easily broken. The functions of the body, such as those of the heart and lungs, are rhythmic, and the habits of the body should be also more or less rhythmic. Regular hours, regular meals, and regular action of the bowels are most desirable. There are some habits over which it is desirable to cultivate complete control, so that they may never obtain mastery, and may be changed at will, such as habits of partaking of or abstaining from certain kinds of foods and drinks, especially alcoholic, or the habit of smoking, which, unrestricted, may become a bondage. There are some habits that it is desirable not to acquire at all, such as those of opium eating, morphia taking, and the use of pick-me-ups. If it be necessary to take food hurriedly, it should be taken in a liquid or easily digested form, and whenever solid food is taken, the habit of mastication should be cultivated. Regular habits of retiring and rising should also be observed, only to be broken under exceptional circumstances. If rules of regularity are not kept, guides to conduct and habit are lost, and it requires considerable strength of mind and perseverance to regain them.

Care of the Teeth.—In children under seven years of age, the number of teeth is twenty, and they are known as the milk teeth, these are shed and are replaced subsequently by thirty-two teeth, sixteen upper and sixteen lower. The set in each jaw consists of four central incisors, and on each side, one canine, one bicuspid of a single cusp, one bicuspid of two cusps, and three molars or grinding teeth. These are known as the permanent teeth. Unless the teeth are in good



Verticle section of teeth —(A) incisor, (B) canine, and (C) molar. 1, 1, crown of tooth; 2, 2, neck of tooth; 3, 3, fang of tooth; 4, enamel; 5, dentine, or ivory; 6, cement of fangs; 7, 7, nerves in nerve canals.

Fig. 19.

condition, mastication is not thorough, and indigestion is liable to take place. Although hard foods are beneficial in strengthening the setting of the teeth in the jaw, the use of the teeth for cracking nuts, bending wire, testing metals, &c., is injurious, and if it does not break them, it injures the enamel, so that they easily decay. After meals, portions of food are apt to remain between and about the teeth, and hence some people habitually use tooth picks of some horny material, and rinse their mouths after eating. Food remaining about the teeth is liable to decompose, injuring them and fouling the breath; *tartar* may cake upon the teeth, and they may become discoloured and decay, so that the teeth should be brushed thoroughly at the least every morning, and the mouth thoroughly washed out. Various preparations are used with the tooth brush for this purpose, some of the best known of which are camphorated chalk, carbolized chalk, cuttle-fish bone, borax, orris root, myrrh, and salt. In children, the second teeth are sometimes apt to grow irregularly, when this is the case advice should be obtained betimes. As years go on, any decay of the teeth should not be neglected, as a well-stopped tooth is generally better than a false one.

Meals and Bowels.—Food should be taken at regular intervals during the day of four or five hours, if the last meal be taken within a couple of hours of bed time, it should be light, as a heavily laden or empty stomach is not conducive to sleep. Meals should be taken deliberately and not hurriedly, so as to allow time for proper mastication. Experience teaches us what are the most suitable forms of food. When young, few articles of diet come amiss, but as age advances it will be found that some foods are more or less easily digested by particular individuals. Total abstinence from alcohol is possible for all persons, and in any case it is desirable to make it a rule of life to ascertain how much alcohol can be abstained from, rather than how much can be consumed. In no case should alcohol be taken except at meals, and then in very limited proportions. In fact it should be regarded as a condiment rather than a drink, unless highly diluted. In hot climates, and to some constitutions, a diet almost restricted to vegetable food is found beneficial, and it is possible to exist upon a vegetable diet alone, but the most economical method (that is, in reference to quantity) of sustaining life in all its functions, is by means of a mixed diet, although the present tendency is for far too large a proportion of animal food to be eaten. It is important not to heavily work the brain or the body immediately after a meal, nor in any case to eat to repletion. It is perhaps for this reason that so many find that smoking after a meal assists digestion, because if the appetite has not been absolutely satisfied, smoking will complete the satisfaction, and in addition will tend to delay for a time mental and physical exertion.

Unless observed in moderation, smoking is apt to be injurious by hindering the digestion, weakening the heart, affecting the sight and dulling the mental and physical functions. In short, regularity and sobriety in all things are essential to perfect health.

Another important influence upon the digestion and the general well-being of the body and mind is the action of the bowels, and a daily habit at a regular hour should be assiduously cultivated. Failure to cultivate this habit results sooner or later not only in an ill-effect upon the general health, but in actual disease. *Constipation* by causing retention of the waste products in the bowels, allows some of these substances to be absorbed and the vitality of the system to become lowered. It gives rise to hœmorrhoids, or piles, which may become extremely painful, and, in addition to causing great personal discomfort, may impair the digestion. It may also become injurious, by causing the fœces to become impacted in the bowels, and occasion obstruction, and possibly give rise to dangerous inflammation. In chronic constipation purges generally make matters worse, even if they sometimes afford temporary relief. The bowels should be kept regular rather by exercise, habit, and if necessary the use of oatmeal, brown bread, vegetables and fruit.

Exercise.—Both the mind and the body are kept in health by a due proportion of exercise of all their functions. Continuous education of the mind is as beneficial as continual training of the body. The involuntary muscles of the body themselves undergo rhythmic exercise in order to maintain the natural functions. At all ages bodily exercise is beneficial, but mostly so during childhood ; bodily training therefore should form an essential part of every school course, and the tendency to allow girls greater freedom in this respect is a most healthful sign of the period. Women as a class can never hope to compete successfully with men, if they neglect this very essential portion of their educational training. The effects of varied exercises are to render the muscles firmer and better proportioned, to increase the action of the lungs, and the aeration of the blood, to develop the action of the heart in rapidity and strength, to increase the action of the skin and evaporation from the surface, to quicken the circulation and render the temperature more equable, to improve the digestion and to stimulate the action of the bowels, kidneys and other excretory organs, so that excretal matters are more completely got rid of, and lastly, it is essential for the preservation of a healthy mind. Nevertheless, undue exercise may sometimes prove injurious, and although fatigue may be a healthy result, over-fatigue is to be avoided. Especially is it dangerous to suddenly take more exercise than a person has been accustomed to. Exercise should be increased daily until the required endurance has been attained, a process known by athletes as that of "training." In competition and emulation there is great danger of over-straining, and hence great efforts should not be made without previous training, and even then with wariness. The more varied the forms of exercise, the better the general results.

Various forms of Exercise.—Exercise may be taken outdoor or indoor. *Outdoor exercises* have the advantage of the open air, of greater space, and in many cases of changing scene. On the other hand, *indoor exercises* are useful in unsuitable season or weather, and under special circumstances, if for instance, in winter in towns, one can only obtain walking exercise, out of doors, it will be found of great advantage to supplement it by arm exercise indoors, especially after the morning bath, when a pair of six-pound dumb-bells used for ten minutes will invigorate a sedentary town dweller.

We may also divide exercise into utilitarian and diverting. *Utilitarian exercises*, whether carried on for profit or for health only, are of a productive form, and embrace manual and other forms of labour or physical work, such as gardening, hay-making, etc., and carpentering, turning, engineering, and constructive work generally. *Diverting exercises* in many cases may be also productive or useful, but their principal objects, in addition to pastime, are the cultivation of health, and indirectly, of intellectual and moral characteristics; they embrace the sports and games and accomplishments of a like kind.

Some of these exercises are of a *locomotive type*, in that they transport one to considerable distances. Others are of a more *stationary type*, and are performed within a limited area. The locomotive types of exercise give opportunities for adding to their zest and interest by the pursuit of some branches of science and art, such as geology and mineralogy, botany (including fern collecting), entomology, (including butterfly and moth collecting), archæology, photography, sketching and painting, and many others. The more stationary types are, many of them, competitive, in the form of games, which are invaluable in the formation of character. A word of warning must, however, be given with regard to *competition*. In the struggle and excitement to win a game or a contest for superiority, the physical powers may be easily overstrained, and it is very necessary that for such contests systematic *training* should be undergone, and periodical *trials* of capability should be made, in order that the limit of endurance and strain may be known beforehand, and efforts of an overstraining character be rendered unnecessary, or reduced to the smallest proportion compatible with the best results.

Perhaps of all forms of exercise, *swimming* puts into action most muscles of the body, and cultivates not only the physical system, but also certain moral characteristics, in addition to habits of cleanliness. To children it teaches courage and self-reliance, and may be of use in an emergency on the water. To those who can swim, *rowing* probably ranks next as a safe and healthy exercise, putting into action the muscles of the legs as well as those of the arms and trunk ; and as one of the locomotive forms of exercise gives opportunity, especially on rivers, for the cultivation of a knowledge of natural history and other subjects. *Cycling*, although not expanding the chest so much as rowing, gives similar opportunities, as well as the like benefit of country air ; but great care should be taken to avoid any overstrain upon the heart that riding up steep hills may possibly produce, and to avoid any pressure upon the soft parts that an ill-constructed saddle may produce. There have been of late a number of saddles put upon the market, especially constructed to avoid perineal pressure, and the least symptom of such pressure should induce the rider to try a change of saddle. The advice to continue riding on a saddle that irritates until you get hardened can only be mischievous ; you may get hardened, that is, suffer less and less from the immediate irritation, but the ultimate effect of hardening the tissues and canals must prove later on a serious matter. *Walking* is, of course, the most general of exercises, and although it is, perhaps, regarded to-day as a slow method of locomotion, it brings into play many muscles of the body, besides those of the lower limbs, especially in a hilly country, and it enables the pedestrian to penetrate into many beautiful places to which he could not otherwise obtain access.

In conjunction with walking may be mentioned *drilling*, and military evolutions, and *volunteering*, which, in addition to the effects of exercise, instil discipline, promptitude, and method, and have also the advantages of association. To those who can afford it, *horse exercise* is one of the most delightful forms of obtaining health and enjoyment. On horse-back and on foot, and with the gun, the spear, and the rod, there are the various health-giving *sports* of hunting, shooting, and fishing. Indoors are some corresponding *accomplishments*, such as boxing, fencing, and dancing, for training the muscles, and the hand, the eye, or the foot.

Amongst *games*, in addition to cricket and football, hockey and rounders, which are the favourite school games, there are three that are also much appreciated at home, namely, fives, tennis, and golf. Those who have passed middle-life, should be cautious in playing fives, or tennis, as they are essentially games that depend upon sudden efforts and quick springs, particularly trying and sometimes dangerous to the more rigid tissues and organs of those who are ageing, and who should prefer golf as a more leisurely pastime. Lastly, must be mentioned *gymnastics*, with and without apparatus capable, with its many kinds of exercises, far too numerous to mention, of supplying movement for each particular muscle in the body, and when no other form of exercise is possible, can always be found to supply some apparatus or some movements to cultivate health and strength.

Rest.—The object of rest is re-creation of strength and energy. Hence to the brain worker, gentle bodily work may at times prove more restful even than sleep. Rest of the mind does not necessarily mean rest of the body, nor rest of the body that of the mind, but repose is necessary to both. During waking hours they may be alternated, but there comes a time when both must be refreshed by sleep. The rhythmic parts of the body such as the heart, the lungs, the stomach &c., take their rest in between their movements, but the body as a whole, requires a period of rest in each twenty-four hours. The amount of actual sleep required varies in individuals, although an epigrammatist has put the rule of life as "eight hours work, eight hours play, eight hours sleep, and eight shillings a day."

Heavy sleepers require less sleep than light sleepers. The younger a child is, the more of its time is passed in sleep, and children especially when they have begun to work their brains methodically, should never have their sleep curtailed. Open-air exercise conduces to the cure of sleeplessness, and the habit of taking drugs to procure sleep should be positively avoided. A hot or foot bath, or muscular movements at bed time will frequently obtain rest for the sleepless. Early hours are conducive to restful nights, and the cultivation of early habits in all respects is beneficial to health.

Personal Cleanliness.—In the cultivation of health personal cleanliness is one of the most important matters to be attended to. Cleanliness of the skin and its appendages, the hair and the nails, is as important as cleanliness in habits, cleanliness of the teeth, the clothing and the dwelling. Want of cleanliness and neglect of the body are common causes of disease, and the reason they are so is that they mean that poisonous substances, irritating matters, dirt and dust generally are not removed, and this applies particularly to the surface of the body.

Care of the Skin.—As we already know, the skin contains a large number of minute tubes opening on to the surface, some of which excrete the perspiration, and others the oleaginous matters that keep the cuticle and the hair soft and pliant. The pores on the surface are numbered by millions, and any uncleanliness not only leads to their obstruction, but also to the accumulation of a material on the surface of the body which forms a cultivating ground upon which many low types of animal and vegetable life flourish. In addition, obstruction of the sweat glands prevents the casting off of waste products from the blood by perspiration. It is true that the kidneys and the lungs also cast off similar waste products, but a greater strain is thrown upon them when the skin is not acting properly. Similarly, the obstruction of the ducts and sebaceous glands causes an accumulation of fatty secretion on the skin and in the tubes leading from them.

In various parts of the body, little projecting points, sometimes with black spots in them, especially on the face, may be seen, and when pressed between the nails a sebaceous matter may be squeezed out of them. Unless these matters that accumulate at the orifices of the ducts and upon the surface of the skin are removed, the skin tends to remain cold, due to inaction, clammy due to accumulation of waste materials, malodourous from decomposition, and ultimately becomes diseased with some form of skin complaint, in addition to the possible production of injury to the kidneys or lungs. The skin is full as we have already seen of sensitive papillæ, and of blood capillaries, and the accumulation of dirt tends to blunt the sensitiveness of the touch, and to prevent the dilatation and contraction of the capillary blood vessels which expand and contract under the influence of the nerves, and so regulate the temperature, and therefore heat and cold are more liable to be injurious to those persons who neglect cleanliness of the skin than to those who cultivate it. This cleanliness is obtained obviously by washing and bathing, and history at all periods tells us of the extraordinary results upon the health of individuals caused by baths, so much so, that in many cases they have gained the reputation of producing miraculous cures. The effect of baths varies with the temperature and composition of the water.

The Warm Bath.—Warm water is much more

effectual than cold in softening and removing dirt from the skin, and when combined with the use of soap and friction, is most cleanly and healthful. Exposure to the cold air after taking a warm bath, when the blood is necessarily flowing freely to the surface of the body, is likely to lower the temperature rapidly, and produce a chill; this should be avoided. Cold sponging after a warm bath or douching of the body afterwards, is an effectual preventive, or, if it is necessary to go out, the body should be warmly clad and kept in continual motion until a warm room is reached. After violent or prolonged exertion, when a cold bath may be dangerous, a warm one is beneficial, as it promotes the elimination of waste products from the skin, dilates the surface vessels, facilitates the action of the tired heart, and prevents after stiffness. If the opportunity be taken to put on dry underclothing, it also prevents risk of chill, and gives great comfort.

Soap.—Alkalies form emulsions with greasy substances, and the ancient Romans in their baths used pot-ashes for cleansing purposes. Pot-ashes are the ashes of burnt woody plants, and mainly consist of the salts of potash, one of the principal alkaline elements. To use a strong lye, which is a form of solution of potash in water, would be rather a severe experience in the present day, but the Romans resorted to it for the purpose of removing the fatty and other refuse matters from the surface of their skins. The effect is, that the skin becomes dry and parched, and loses temporarily its suppleness and gloss. In order to counteract this condition, the body was anointed after the bath with various kinds of perfumed oil. Nowadays, instead of using the alkali and the oily matter separately, we use them combined in the form of soap, the result being that the whole effect is obtained at one operation. Instead of using soft soap, which is a combination of potash salts with oils, we use for the skin hard soap, which is a combination of soda, salts and fat, when these are boiled together, we obtain glycerine and stearate of soda, which is soda-soap. There should be no free alkali in soap, else it is likely to irritate the skin. A rough way of judging whether there is an excessive quantity of free alkali in the soap is by slightly licking it, when a caustic taste will be clearly recognised, although some little experience may be necessary to judge accurately, because soap is also nauseous to the taste. If soap be used for washing purposes with cold water containing excess of lime salts (hard water) it forms an insoluble compound with them, and therefore much is wasted and it is much less cleansing. Hence hot water, from which the lime salts have been previously deposited by boiling, furnishes a better cleansing medium in conjunction with soap than cold water, unless soft, as rain water, and even then, the temperature not being so high, the greasy matter is not so easily softened and removed. Friction, whether applied by hand or brush, or in any other manner is naturally of great assistance to the action of soap. When greater cleansing power is required, as in the washing of clothes and fabrics, a more alkaline soap is used, such as potash or soft soap, and soda is also added to the water to render it still more alkaline.

Cold Baths.—The cold bath, although to a certain extent cleansing, is more useful as invigorating the system—in stimulating the functions of the body—and rendering the skin less susceptible to changes in temperature of the external air. It should be taken first thing in the morning and should be of short duration. The natural temperature of cold water in winter may approach freezing point, while in summer it may rise to 65 or 70 degrees Fahrenheit. It is therefore obvious that if a cold bath means water at its natural temperature in summer, it may mean iced water in winter. The shock of extremely cold water may to some persons be unpleasant and even injurious. If the temperature be made to suit the individual, a cold or moderately cold bath may be taken by the most robust or the most weakly all the year round. Experiment has proved to the writer that water at about 82 degrees F. produces no shock of cold and yet has no feeling of warmth, so that any temperature below that point may be chosen to suit the individual. That temperature is best which while feeling pleasant also acts as a stimulant to the system, and tends to produce a glow upon the skin. Any temperature between 60 and 80 degrees F. may be regarded as a safe temperature for a cold bath. The point is to encourage the usage of morning baths rather than to recommend severe temperatures, that in many persons would produce discomfort, and in some, possibly, dangerous effect.

A most important part of the cold bath is the towelling or rubbing down afterwards. The movement provides brisk exercise and the friction stimulates the skin. So beneficial is this rubbing than many physicians recommend dry rubbing to those who cannot take cold baths, but there is no reason why anybody should be unable to bear with impunity a cold bath at some temperature between 60° and 80° Fahrenheit.

Sea Bathing.—This form of bathing derives its advantages from various causes. It necessitates more exposure to air and sunlight than an ordinary bath ; the temperature of the water, which averages about 55 degrees F., produces a stimulating shock ; the shock is chiefly overcome by active movements of the body, and this exercise is most healthful ; the movement and aeration of the water are stimulating to the skin, and the saline constituents also assist in this action. Altogether, sea bathing means greater effort and greater vigor accompanying the bathing, and some good must also be derived from the inhalation of salt-laden ozonized sea air. Yet cautions are necessary.

Cold water should not be entered until at least two hours after a meal. Although there is no harm in taking a cold bath when the body is warm or hot, the water should not be entered immediately after violent or prolonged exertion. The reason for this is that the body is throwing off waste products and continues to throw these off for some time after exercise, and, these waste products being of a more or less poisonous nature, if their elimination is checked may produce serious consequences, for it has been proved that the sweat of the human body is poisonous to lower animals. The stay in the water should not be too long. As soon as the stimulating feeling of the water has passed off, and before any sense of coldness to the body can be felt, the drying and rubbing down process should be commenced.

Hot Air and Hot Vapour—Hot air and vapour baths are useful for persons who lead sedentary lives, or whose skins are imperfect in action. They increase the secretion and emanation from the surface of the skin, which is subsequently cleansed by hot water and soap applied with hard gloves. Any risk of chill is avoided by subsequent cold spraying, sponging, douching or plunge.

Care of the Hair and Nails.—These appendages to the skin should always be kept carefully cleansed, because they so easily catch and accumulate dirt. From time to time the hair should be washed with soap and water, and when dry a little lubricant may be applied to prevent it becoming too dry and brittle. The continual use of grease as a matter of habit is not desirable, in preference it should be well brushed and combed several times daily to stimulate the sebaceous secretions of the scalp. The nails should be kept rather short in order to prevent them scraping up dirt, and be frequently cleansed by removing the accumulations beneath them. The hand and nails should be carefully washed and cleansed before every meal. The nails are more safely cleansed by means of a bone, horn or wooden pick, than by a nail brush or knife. A nail-brush is liable to accumulate decomposing soap and organic matters, and a knife not only roughens the under surfaces, so that they may accumulate more dirt, but it may also penetrate the skin and inoculate foreign matter.

CHAPTER IV.

Surroundings.

Surroundings materially influence the health of individuals. Meteorology, geology, and biology are the sciences which, in combination with physics, chemistry and bacteriology, embrace the knowledge of our surroundings. It is only possible here, within a reasonable compass, to touch upon some of the principal points within the wide circle of these sciences—and the object of this chapter is rather to direct attention to the many-sidedness of the influences bearing upon health, than to attempt the impossible task of compressing an account of them into a few pages.

Light.—It requires a certain length of time for light or darkness to produce marked effects upon health, Plants turn towards the light, without which there is no fructification, and few even can flower without sunlight. Under the influence of light, plants absorb carbonic acid, fix carbon, and exhale oxygen, a process of nutrition, tending also to maintain the purity of the atmosphere. The lower forms of plants, such as fungi, do not require light for their growth. In fact the action of light is injurious to the lowest plant forms, and especially to those microscopical forms or germs which are the cause of some diseases. The germs of tuberculosis, or consumption, are injured and even destroyed by light, and the same is true of many others. Thus we see that light is beneficial to the higher forms of vegetable life and injurious to the lower, and as the higher are beneficial and some of the lower injurious to man, light is essential in this respect to health. Upon adult animals the effect of light or its absence is only seen after long exposure, but upon young animals, and especially upon the very young, the action of light is powerful in producing healthy development. Dark places are therefore injurious to very young animals and especially to young children. The influence of the open air upon young children is materially enhanced by the influence of sunlight. These are some of the reasons why narrow courts, dark streets, and small windows have an injurious effect upon the children in the slums. Deficient light is moreover generally accompanied by deficient space, and by air wanting in quantity and quality. Sunlight warms and dries the air, sets up currents, drives away stagnant air, dissipates humidity, and encourages cleanliness by disclosing dirty places.

Artificial light, unless very intense, produces injurious effects only by fouling the air.

Warmth.—The sun's rays cause heat to be absorbed, and given off in different degrees when striking respectively upon air, water or soil, and thus produce the principal effects of climate. The temperature of the air is gauged by the thermometer, an instrument which, for popular purposes, is graduated on the Fahrenheit scale (freezing point 32 degrees and boiling point 212 degrees), and for scientific purposes by the centigrade scale (freezing point 0 degrees and boiling point 100 degrees). Air when heated tends to rise, when cooled to fall. When the soil is heated it rapidly warms the air above it, but when water or the ocean is heated, the heat diffuses in the water, and warms it very slowly, so that the air above it is cooler than that above the land. In the day time the air above the land tends to rise and that above the sea to fall, so that there is a current of air over the sea towards the land known as the day breeze. During the night, as land cools much more rapidly than the sea, a reverse current sets in, producing a land breeze towards the sea. From the fact that the temperature of water is more uniform than that of land, it follows that a place in the proximity of large volumes of water has a more even temperature than very inland places, where the climate is characterised by extremes. This in conjunction with ocean currents constitutes the difference

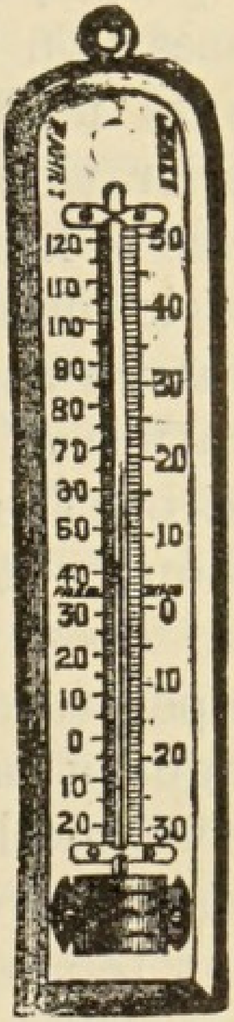


Fig. 20.
Thermometer showing Fahrenheit and Centigrade scales.

between inland and insular climates. Altitude also influences the climate, there being a fall in temperature of about 1 degree F. for every 300 feet rise above the sea level. Freezing point has a very prejudicial influence on plants, and at this temperature most vegetation ceases; on the other hand, at above 100 degrees F. plants undergo a largely increased circulation and evaporation and their growth is quickened. The lowest forms of life, especially those germs that are likely to attack human beings, find their most beneficial temperature at about that of the human body. A temperature of over 260 degrees F. (especially if moist) destroys them, but a low temperature, as freezing point, although it may stop their growth and multiplication, does not absolutely kill them, and when the temperature rises again they may revive. Hence the danger of eating polluted ice. All animals, especially the warm blooded, are dependent upon warmth, which is an important factor in their development. A constant temperature of about 104 degrees F. being, for example, required to hatch a hen's egg. A temperature, of boiling water on the one hand or freezing on the other rapidly kills if applied to the human body by means of water, but if by means of air it may be supported for a considerable time. External air temperatures have little influence on the heat of the human body, as copious perspiration prevents it rising and increased consumption of fatty food prevents it falling, in addition to the latter, however, clothing and shelter are necessary for man in the cool and colder climates. Cool air and cold water are tonic and bracing, because under their influence more oxygen is absorbed by the lungs to increase the combustion and compensate for loss of heat, so that the waste products are more freely oxidised, repair of the tissues is more rapid, and an invigorating effect is produced. In summer, when the temperature is high, abdominal or intestinal diseases prevail, in winter respiratory diseases. It is therefore important to provide cooler or warmer clothing and shelter, in order to equalise the temperature in different parts of the world or at different seasons of the year, especially is warm housing necessary in the colder season for those employed in sedentary occupations, or when resting.

Artificial heat mainly produces bad effects upon health indirectly by fouling or overdrying the air.

Moisture.—Moist vapour being a better conductor of heat than air, the effects of temperature are intensified by humidity, which prevents perspiration and rapid evaporation from the surface of the body. This explains why steam and boiling water are more effectual than hot air of the same temperature in killing the germs of disease. It also explains why very high temperatures can be borne in the hot dry air of a Turkish bath. If the air be dry, very cold weather is not so piercing as when the air is moist, for the same reason.

Nevertheless, a certain amount of moisture is necessary for the maintenance and growth of vegetable and animal life; in its absence a desert is produced. The effect of breathing hot dry air continuously for a length of time is familiar to those living in rooms heated by close stoves.

Air.—The atmosphere is important in equalizing the temperature of localities, and its movement brings gaseous nutrition to plants, animals and man. Deprivation of food and water can be borne for a considerable time, but deprivation of air causes suffocation and death in a few minutes. The effects of impure air depend upon either the diminished amount of oxygen, or the presence of injurious gases.

Water.—Although proximity to the sea is beneficial to health, the mouths of large rivers with shallow shoals and banks are unhealthy. In the same way shallow lakes or swamps where vegetable decomposition takes place and the air is overladen with moisture are also unhealthy. An inadequate supply of water to dwelling-places, resulting in uncleanliness and insufficient washing and flushing, is a fertile source of disease. Polluted water is the known cause of the spread of many diseases, especially of cholera, typhoid fever, diarrhœa and dysentery.

Soil.—The soil affects the health either through its composition or construction, or through its contour. Hills are more healthy than enclosed valleys, and thick belts of trees or high buildings surrounding houses cause stagnation of the air. Generally speaking impervious, or non-porous soils when well levelled and drained, and pervious soils porous to a depth of over 20 feet are not unhealthy. The sands, gravels, and chalks are pervious, and more healthy than the rocks and clays. The amount of animal matter in natural soil is not great, but where human beings are congregated it may increase to a dangerous degree, and so become the cause of disease. Unless the surface be kept clean and be rendered impervious so as to prevent the soakage of foul liquid, the soil will be polluted and favour the growth of the germs of a number of diseases, particularly those of malarial or marsh fever, tetanus, or lock-jaw, typhoid, cholera and dysentery, and of yellow-fever and plague. In the soil there are both air and water, known as *ground-air* and *ground-water*. When the barometer falls, or when fires are lighted in the house, ground-air may escape into the house; in the former case owing to the lowering or diminution of air pressure, in the latter case due to the suction of the fires. Such air, especially from below the subsoil is injurious. Below the surface at varying distances according to the nature of the soil there is usually a layer of ground-water, which generally rises and falls in proportion to the rainfall; when it rises it drives out the ground-air above it, and when it falls it leaves the soil above it moist, and therefore in a favourable condition for the growth of low and injurious forms of life. Such soil becoming polluted, pollutes also the ground-water and the ground-air, and the moist vapours from it are very injurious if they enter dwelling-houses. The nearer the ground-water is to the surface, the more unhealthy the site is likely to be, and the laying down of drainage systems has by lowering the ground-water level, improved the health of many places. The water in the subsoil that collects in shallow wells is usually polluted and dangerous to drink.

These facts show how necessary it is to keep the soil in the neighbourhood of dwelling-houses free from pollution, not only on account of the results of decomposition on the surface, but also of the soakage below the surface by which the subsoil becomes foul, and in its turn may foul the ground air and the ground water.

Plants.—The effect of plants upon the atmosphere is to purify it by absorbing carbonic acid, and giving off oxygen. Plants absorb moisture, and this power is utilised in the planting of the very absorbent blue gum tree (eucalyptus globulus), in marshy districts to reduce the malarious effects of wet marshes. The general effect of thick trees is to obstruct the rays of the sun from above, and evaporation from below, lowering the temperature and increasing the humidity of the air, and the absence of trees generally produces opposite results, so that the destruction of forests has often led to a great change in climatic conditions, converting the climate from an insular, or equable to an inland or extreme type. Belts of trees sometimes check cold winds and malarious currents of air, but close round dwelling houses the stagnation of air produced is sometimes injurious. Herbage not being obstructive to air currents is always beneficial, preventing the soil from becoming overheated, and reducing the glare of sunlight. Plants supply food to animals and men, but when they die they decay, and are converted into their elements. This conversion takes place through the agency of minute organisms or germs, many of which are injurious to animals and to men.

Animals.—Many animals supply food to man, and are so far beneficial. But some animals, and especially some domestic animals, are subject to a number of diseases, some of which are communicable to other animals and to men. Hence it is necessary to keep a watch over the condition of domestic animals. For instance dogs and cats may harbour parasites ; horses may communicate glanders, fowls and pigeons have been suspected of spreading croupous diseases. The housing of domestic animals is also important in as much as they are liable to give rise to nuisances prejudicial to health from want of cleanliness and aeration, and the accumulation of refuse and excretal matters. Not only horses, cows and donkeys, but smaller animals, such as rabbits, may become a nuisance, and even dogs and cats, if kept in any number. Some insects also are believed to occasionally convey disease, as part of the lives of some parasites are passed in their bodies ; a disease due to what are known as filaria may be communicated to man by the sting of the mosquitoe ; the germs of consumption have been found in the bug, and is supposed to be communicable to man with its bite.

Man.—Man himself is likely to infect his fellow man injuriously either when suffering from disease, or even when living in too close proximity. Overcrowding is injurious, because it fouls the air excessively, lowers the health, is liable to spread consumption, gives rise to typhus fever, and other diseases, and raises the sickness and death-rate. The excretions and secretions of both man and animals may convey the contagia of some of the specific diseases, and contaminate soil and water, as well as the air, being dispersed in various directions during decomposition. In closely-confined places in the proximity of dwellings, surfaces and soil polluted by excreta and other decomposing organic matters may form the breeding ground of contagion.

Parasites.—Parasites are vegetable or animal beings or germs that attack and live upon plants, animals and man. They may be either animal or vegetable forms, the germs or microscopical organism of infection being known to be the lowest forms of vegetable parasites

Flies and ticks although only temporary parasites may convey disease. Similarly fleas, bugs, and lice,

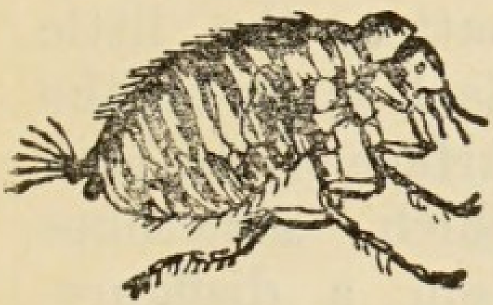


Fig. 21.
Flea (Magnified).

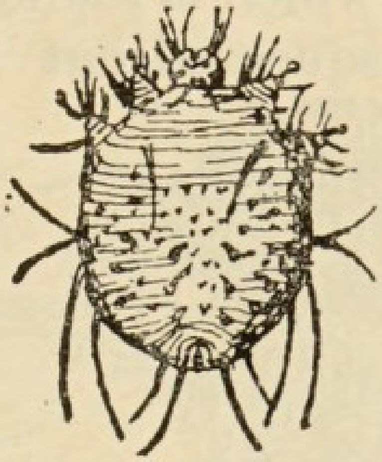


Fig. 22.
Itch-mite (Magnified).

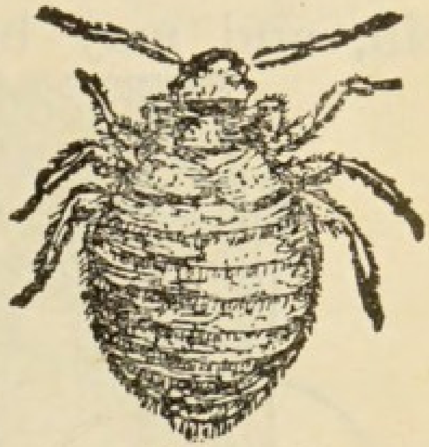


Fig. 23.
Bug (Magnified).

which under uncleanly conditions are liable to infest the body of man, may not only convey disease, but —bugs have been found to convey the germs of consumption in their bodies—these parasites may themselves set up forms of irritation which may give rise to varieties of skin disease.

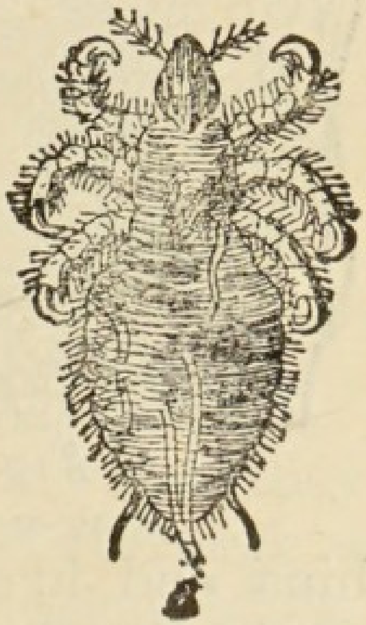


Fig. 24.
Head-louse (Magnified.)

The itch-mite is a well-known form of parasite attacking the body, it burrows under the skin, especially of the hands and is easily transferred from one uncleanly person to another. The head-louse is also well known, and there is another known as the body louse which attacks dirty people and is easily communicated by contact; personal cleanliness is the best method of avoiding the harbouring of these parasites. There is another form of common parasite known as demodex, which is found in the pores of the skin, and may be squeezed out with a little fatty matter, the little black spots on the surface of the skin which sometimes seem a disfigurement are caused by these parasites.

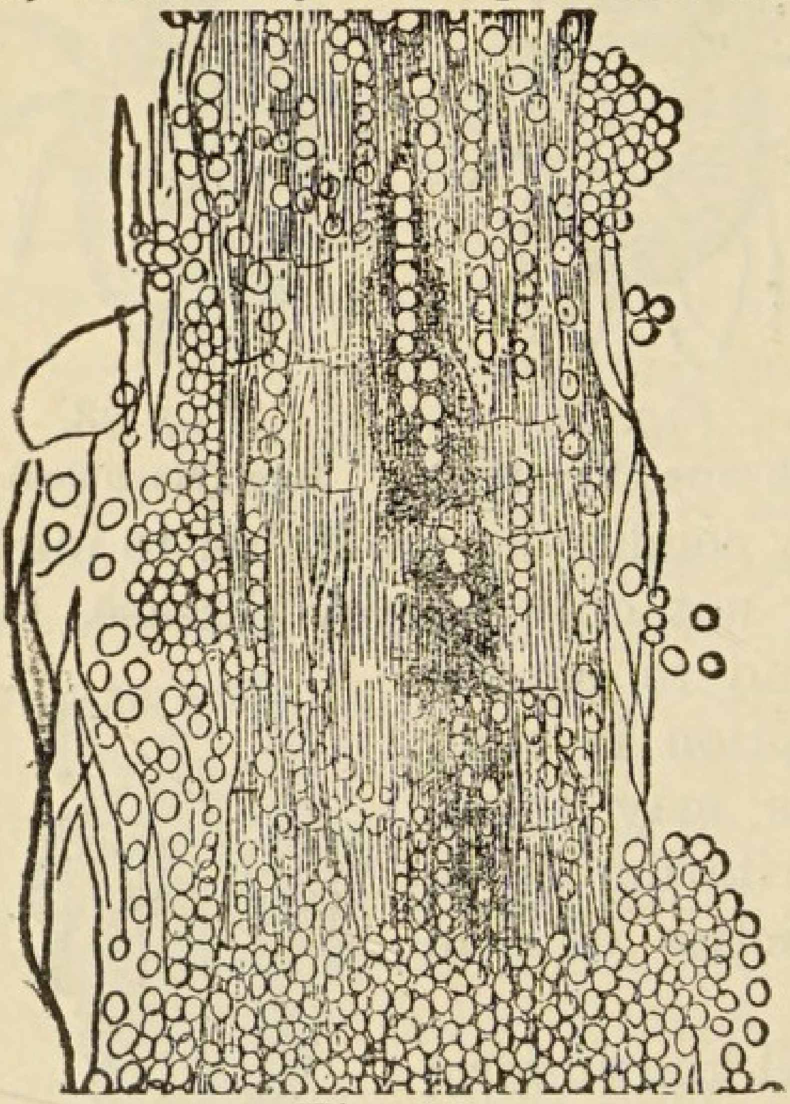


Fig. 25.
Ring-worm cells.

In addition to those which attack the outside of the body there are certain parasites which attack the inside and reach their destination by means of water or food. The tape worm, thread worm, trichina and hydatid are such forms and will be referred to again under the heading of food.

The germs of infectious disease known as micro or microscopical organisms, are only visible under the highest powers of the microscope. They attack both the inside and the outside of the body; the best known of those that attack the outside are the ringworm cells and the favus cells, those that attack the organs of the interior are: the various germs of consumption, tubercle, cholera, diphtheria and a number of others.

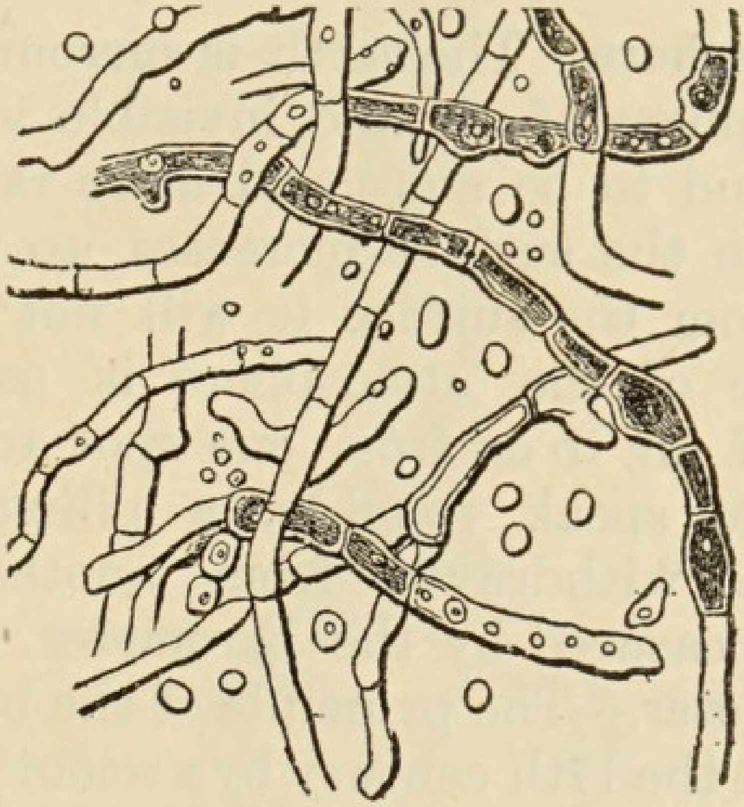


Fig. 26.
Favus cells.

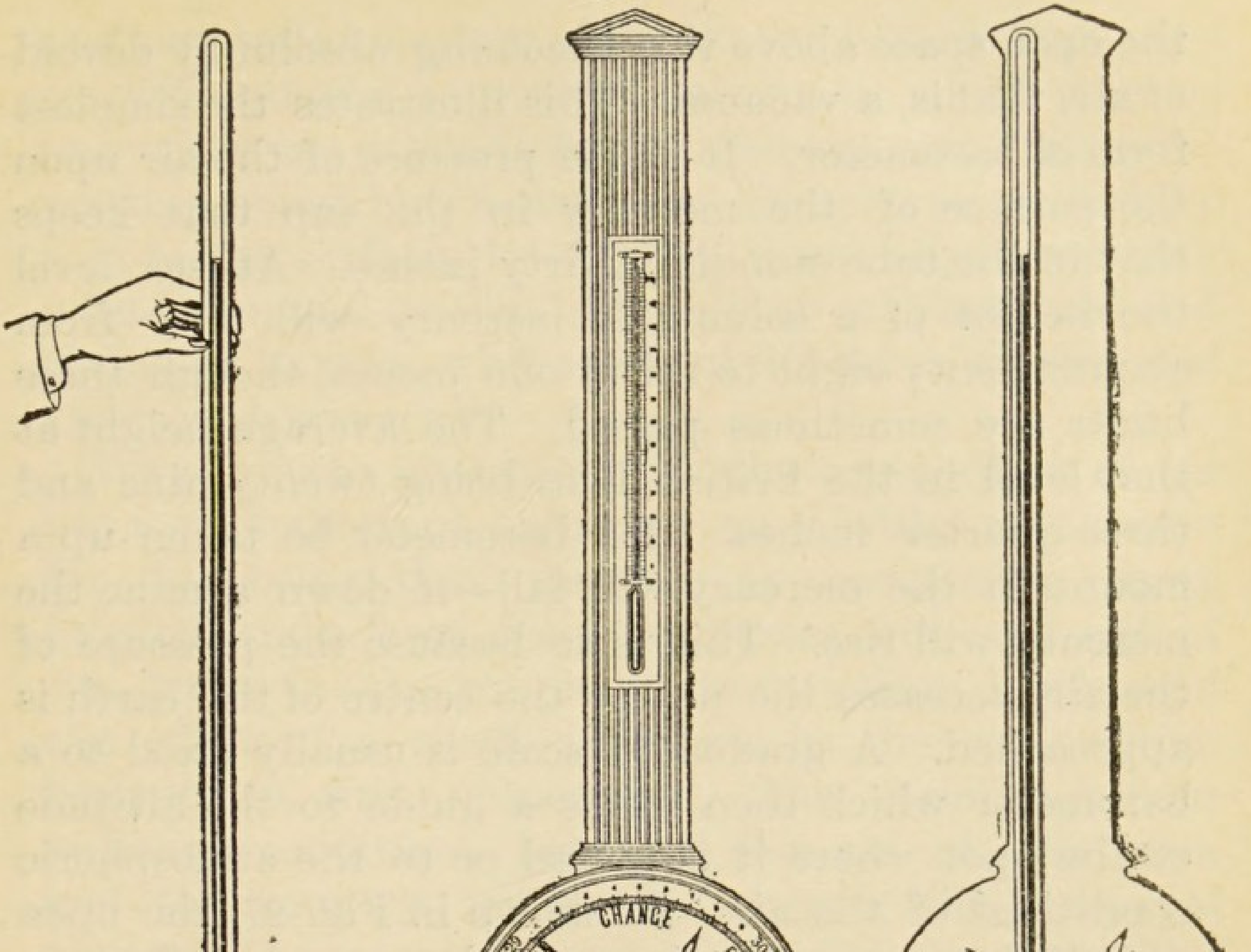
These germs vary in the manner in which they are conveyed, some through the air, others through water or food, and others again through abrasions of the skin or of the membranes lining the inner passages of the body.

CHAPTER V.

Air.

The Atmosphere. The earth is surrounded entirely by an atmosphere of air and invisible water vapour, which is found to be more and more rarefied as the distance from the surface increases, so that at some five miles from the surface it will not support life. The pressure of the atmosphere is caused by the movement of air to or from one spot to another, so that it is, to speak roughly, a piling up in one place, and a withdrawal from another, and this pressure is measured by the barometer.

The Barometer.—The principle of the barometer was discovered in the 17th century by a scientist, Torricelli, by means of the following experiment: Take a glass tube some thirty inches long, closed at one end, and filled with mercury. Place the thumb on the open end, invert the tube, and plunge the end closed by the thumb into a cup partly filled with mercury, after which withdraw the thumb. It will be found that the mercury will fall in the tube only about three inches, so that a column of thirty inches or so above the top of the mercury in the cup will remain standing in the tube,



Torricelli's experiment. Barometer in general use. How the Barometer works.

Fig. 27.

the open space above this becoming absolutely devoid of air, that is, a vacuum. This illustrates the simplest form of barometer. It is the pressure of the air upon the surface of the mercury in the cup that keeps that in the tube standing thirty inches. At sea level the height of a column of mercury will vary from about twenty-eight to thirty-one inches, though these limits are sometimes passed. The average height at that level in the British Isles being twenty-nine and three-quarter inches. If a barometer be taken up a mountain the mercury will fall—if down a mine the mercury will rise. This is so because the pressure of the air increases the nearer the centre of the earth is approached. A graduated scale is usually fixed to a barometer which then forms a guide to the altitude of the spot where it is placed or to the atmospheric conditions of the air. As shown in Fig. 27, the open end of the tube may be turned up and a float so adjusted on the mercury, so as to move a hand on a dial. Other liquids may be substituted for mercury, though the latter on account of its great specific gravity is found the most convenient.

Composition. Pure air by volume contains nearly twenty-one per cent. of oxygen, and seventy-nine per cent. of nitrogen, a variable quantity of aqueous vapour, traces of carbonic acid, ammonia, and ozone. Impure air possesses less oxygen and ozone, and more carbonic acid and ammonia, as well as impure gases and suspended matters. The atmosphere is kept pure by diffusion (the process of mixing by which gaseous impurities are diluted) by the gaseous and suspended matters being blown away or being precipitated by rain to the surface, by oxygen chemically combining with them, and by plant life taking carbonic acid and giving off oxygen, whilst animal life takes oxygen and yields carbonic acid.

Very minute alterations in the composition of air have an important influence on health, the reason for this being that the air is constantly being inhaled and a large quantity passes into and out of the lungs in the course of twenty-four hours, and the effect of a small alteration in the composition becomes in time pronounced. The variation under ordinary conditions between the air of the town and the country, so far as oxygen, the principal element, is concerned, is at most only about one half per cent, and yet we know that there is an essential difference in the health giving properties. This is partly due to the presence of ozone (a concentrated form of oxygen) in country air, and its absence from the air of towns, and also to the lesser amount of carbonic acid which although extremely slight, is sufficient to produce some result. In pure mountain air it averages about ·03 and in towns about ·04 per cent. When it reaches $1\frac{1}{2}$ per cent it produces headache and sickness, at $2\frac{1}{2}$ per cent it extinguishes light, at 5 per cent it produces insensibility, and over this amount proves fatal. Carbonic acid together with other gases is produced by respiration, combustion, putrefaction, and industrial processes. Being a heavy gas it tends to sink and accumulate in porous soils and at the bottom of wells, hence it is dangerous to descend some wells, especially if old and disused, and it is usual to first test the air by letting down a lighted candle to the bottom, as any accumulation of the gas will extinguish the light and demonstrate that the air is not respirable.

Ammonia is derived mainly from animals and putrefaction, and other suspended matters are also found in great variety in the air. Workers upon metals and minerals often suffer from breathing the dust due to their trades. The pollen of grasses and flowers is irritating to some people, causing hay fever, and the germs of disease are also in some cases carried short distances by the air.

Many injurious products are derived from combustible material, especially from coal and gas, of which carbonic acid and sulphur compounds are most injurious. Putrefaction and fermentation are the natural processes by which dead matters are destroyed, but the decomposition produces various gases and low forms of life which are injurious in the proximity of dwellings; hence waste matters and refuse should be removed from the neighbourhood of houses. Sewers and drains also give off injurious gases which lower the health and tend to cause disease. The air of marshes is a well known cause of malarial fever. The gases given off from many manufacturing processes are also injurious to health, and hence by law they must be condensed.

Respiration.—The effect of respiration upon the air is to reduce the amount of oxygen and to increase the amount of carbonic acid, at the same time to increase its temperature, render it moist and add organic vapours to it. The most injurious constituents cast into the air by respiration are the organic vapours, but as these are difficult to estimate and are in proportion to the amount of carbonic acid, the volume of carbonic acid is taken as the gauge of pollution. The usual amount of carbonic acid in the atmosphere is taken at 0·4 part per thousand, and the pollution produced by respiration should not be allowed to exceed 0·6 per thousand, that is to say 0·2 beyond the standard. The length of time that it takes for the carbonic acid present in a room to increase by this amount depends upon the cubic space and the ventilation. These will be considered later on.

Combustion.—The combustion of coal, gas, oil, candles, etc., produces a number of compounds which add impurities to the air, such as carbonic acid, carbonic oxide, various sulphur compounds, tarry matters, and particles of carbon. A cubic foot of coal gas when burned gives off nearly as much carbonic acid as a man in the same time, and in addition sulphur and other compounds, and as a flat flamed gas-burner burns from three to five cubic feet of gas in an hour it can be understood what a large amount of pollution is produced in the absence of efficient ventilation. For the same amount of light, oil and candles foul a room still more, and it is the innumerable coal fires in towns that cause a diminished purity of the atmosphere, and often add to the density of fogs.

A simple experiment will illustrate the effect of combustion upon air and the essential principles of ventilation. Take a short piece of candle about an inch in length, light it, and stand it upon an even surface, then take a straight cylindrical chimney, such as is used with an argand gas burner, and place it over the candle. Great care must be taken that the bottom end of the chimney is even, and also that the surface on which it stands is smooth, so that no air can enter from below ; waxing or greasing the bottom edge of the chimney where it meets the surface will secure this. If the candle-end be thus left to burn inside the chimney, and the bottom be air-tight, it will be found that in the course of a very short while the accumulation of carbonic acid due to combustion will first dim and finally extinguish the light. If before the light is extinguished a piece of tin, nearly but not quite as wide and, say half as long again, as the diameter of the chimney, be carefully inserted down the chimney, a little to one side, and touching the sides, until the bottom end of it is level with the dim flame, the light will at once revive, and continue to burn brightly. This is due to the fact that, before the piece of tin is introduced there is no inlet, but only an outlet, and consequently no interchange of air, or *ventilation* can take place, so that the products of combustion (carbonic acid, etc.), accumulate. After the piece of tin is introduced, both an inlet and an out-let are formed, the outlet being up the side of the tin over the hot flame (which acts as a propulsive force), and the inlet down the other side, the fresh air naturally flowing to the bottom of the chimney, to replace that removed.

Decomposition.—Putrefaction and decomposition of organic matters vitiate the air by the emanations and effluvia that proceed from them. Fœcal matter in decomposing produces gases that are melodorous and injurious to health. In cholera, typhoid, dysentery and diarrhœa, the decomposing stools if not disinfected or removed from the neighbourhood of dwellings, are liable to spread these diseases. The air of cess-pools, sewers and drains, often contains poisonous organic gases, and the respiration of such gases lowers the vitality, induces symptoms of ill-health and sometimes actual disease, either directly or indirectly. The air of marshes, conveying the emanations from decomposing vegetable matters, produces a condition of mal-nutrition, and is the cause of malarial forms of fever. The air of graveyards is also found to contain the gases of decomposition in greater or less quantities according to the nature of the soil and the depth of burial.

Industrial Processes.—These give rise to fine solid particles floating in the air, as well as to gaseous impurities. The grinding and cutting of metals, and the manufacture of pottery, cotton goods, and other articles of commerce, produce dusts. Effluvia from factory chimneys and the fumes from brick fields and cement works also foul the air. Very offensive vapours are produced by tallow and glue making, bone boiling, and processes of a similar kind. Chemical works give out various acid gases which destroy the vegetation in their neighbourhood, and cannot be beneficial to animal life.

Purification of the Atmosphere.—The air is purified (1) by *dilution :* this takes place by means of diffusion the light and heavy gases mixing with one another ; (2) by *perflation :* this takes place by the wind or draught blowing the gases away to a distance during which process dilution also takes place ; (3) by *rainfall* : the atmosphere is washed, the suspended particles are precipitated to the ground, the gases are absorbed by the water and are carried to the earth ; (4) by *oxidation* : the ozone taking a prominent part in this process ; (5) by *decomposition* : as many of the gases are unstable compounds they easily split up under various influences into other combinations. But the most important means by which the purification of the air is brought about is the function of plants to decompose carbonic acid, fixing the carbon and setting free the oxygen.

Amount of Air required.—We have seen that the respiration of men and animals deprives the air of oxygen, and charges it with carbonic acid, watery vapour, ammonia and organic matters, and that an adult man abstracts from four to five per cent. of oxygen from the air at each inspiration, and expires about the same amount of carbonic acid and watery vapour. An average adult, when not at work, gives off about 0·6 cubic foot of carbonic acid per hour, rendering impure about 3,000 cubic feet of air, the standard limit of impurity being 0·6 cubic foot of carbonic acid per 1,000 cubic feet. As 1,000 cubic feet of air contain 0·4 of carbonic acid, therefcre the addition of 0·2 cubic feet will reach this limit, and as an adult gives off 0·6 per hour, 3,000 cubic feet of fresh air per hour are required in order not to exceed it.

Cubic Space.—In a temperate climate it has been found that practically the air can only be changed three times per hour without discomfort, so in order that 3,000 cubic feet may be supplied, the space per head must be 1,000 cubic feet. If the space be smaller, less than the proper amount of fresh air will be delivered, or it will be cold and draughty.

Ventilation.

Principles.—The movement of air is brought about by diffusion or rapid mixture, by the difference of the temperature of the air in different places, and winds, caused themselves by the difference of temperature in different layers of air. In order to ventilate a place enclosed on all sides (including the top and the bottom) it is necessary that there should be an inlet and an outlet, otherwise there will be no movement of air, as none could enter or leave the enclosed space. In an ordinary room, the chinks of the doors and windows allow small quantities of air to pass in and the open chimney flue allows air to pass out. Warm air being more expanded and accordingly lighter tends to ascend, and cold air being denser and heavier, to descend. The air in a room therefore tends to arrange itself in layers, the warmest being at the top and the coldest at the bottom. Even the coldest layer in the room is generally warmer and sometimes much warmer than the external atmosphere. The consequence of this is that the air in the chimney flue or other outlet shaft tends to rise and to discharge at the top into the outer air, drawing behind it some of the air of the room, which in its turn tends to draw air into the room through crevices and other openings; if the door or window be open less impediment is offered to the entrance of air, and so the amount entering a room is increased. If, in addition, a fire be lighted at the bottom of the flue, or some other means of heat such as a gas burner be employed, then the draught up the chimney or shaft will be increased, or if the wind blow across the top of the mouth of the shaft, *aspiration* or a process of suction up the chimney will be brought about. Again, if the wind blow in at an open door or window, it will drive the air before it up the shaft.

The action of the wind in blowing through an open door or window and out at another open door or window is known technically as *Perflation*, and is the process that takes place when a housewife airs a room. This is more effectual than ventilation, and requires much less time to effect its purpose, because it forcibly blows the foul air out of the room before it, and replaces it entirely by fresh air. Ventilation does not effect as much as this, a smaller quantity of air, in proportion to the bulk in the room, entering at a time. It is therefore evident that if this small quantity of fresh air were to blow directly from the inlet to the outlet in a stream very little change in the air of the room would take place, and in order that this result may not be brought about it is necessary that the incoming air should, by diffusion, mix with the air of the room. For diffusion to take place the air should not be allowed to enter too rapidly, or if it enter rapidly should enter at several points at a distance from one another, and in small streams. The best position for an inlet is at the lowest and for the outlet at the highest point. It is not practicable in most cases to put the inlet at the floor level on account of draught, and it is usual, therefore, to allow it to discharge about six feet above the floor. It should be directed upwards, so that the current of cool air entering may easily diffuse into the warmer air of the room before descending.

Methods.—Ventilation may be described as of two kinds, *natural* and *artificial*. Natural ventilation is brought about by utilizing the ordinary natural forces already described. Artificial ventilation is produced by the application of mechanical or some other force, such as artificial heat.

For the purposes of natural ventilation, inlet ventilators may be placed in the windows, the doors, or the walls of a room. There are a number of appliances adapted to be used in the glass of windows, but the simplest method of ventilating by means of an ordinary sash window, which will always be an inlet on account of the difference between the temperature of the inner and the outer air, is to raise the lower sash of the window two or three inches and insert a strip of wood below it so as to prevent the air from blowing directly in below, but to allow it to enter

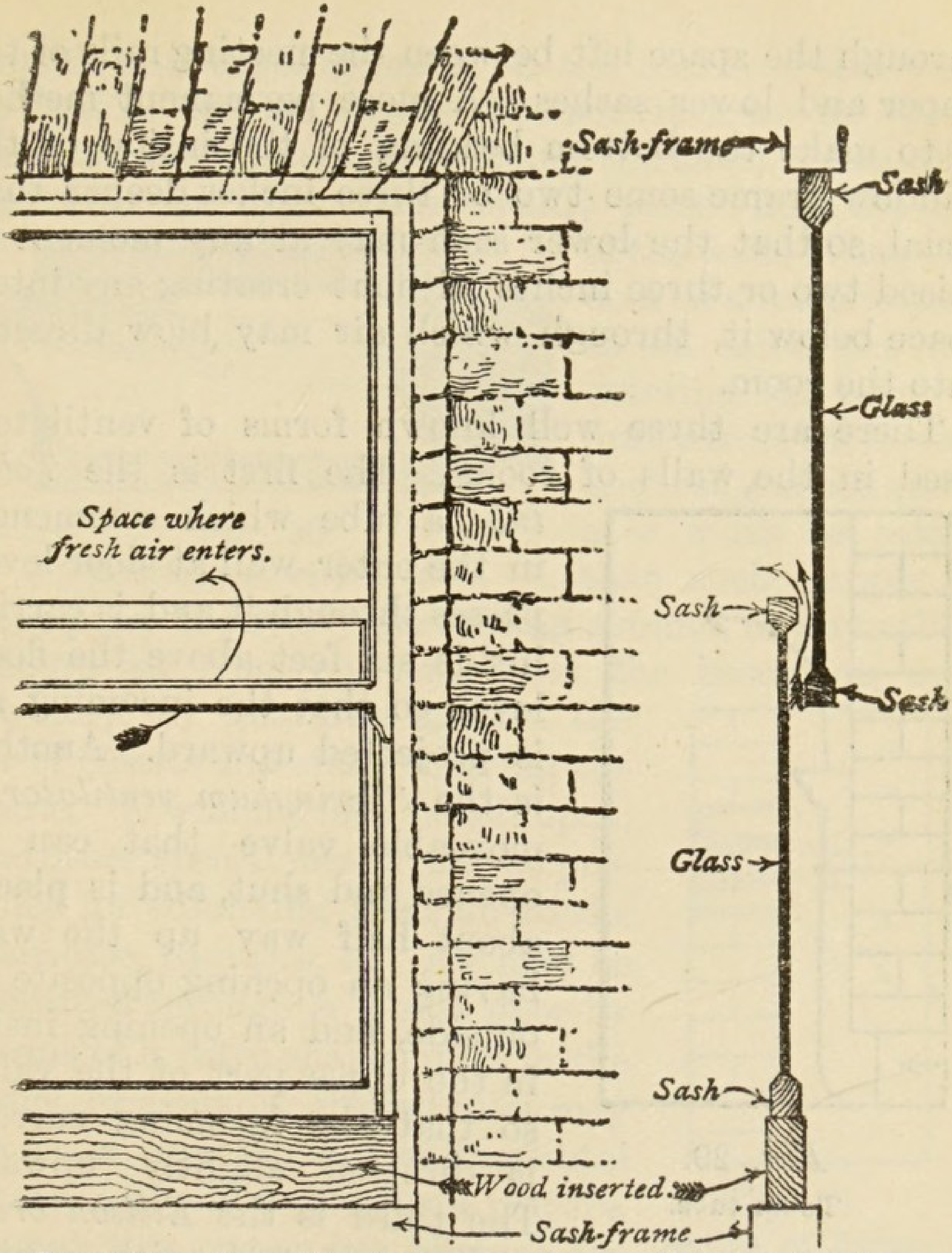


Fig. 28.
Sash window ventilator.

through the space left between the meeting rails of the upper and lower sashes. A more permanent method is to make the bottom beading of the inside of the window frame some two or three inches deeper than usual, so that the lower sash may at any moment be raised two or three inches without creating any interspace below it, through which air may blow directly into the room.

There are three well known forms of ventilators used in the walls of rooms. The first is the *Tobin tube*, a tube which commences in the outer wall at floor-level, passes through it and is carried inside six feet above the floor-level, so that the incoming air is projected upward. Another is the *Sheringham ventilator*, a moveable valve that can be opened and shut, and is placed about half way up the wall, having an opening opposite it, outside, and an opening inside in the upper part of the valve, so that the incoming current is directed slightly upward. The third is the *Ellison brick*, and consists of a brick perforated with conical holes, the small ends of the cones being on the

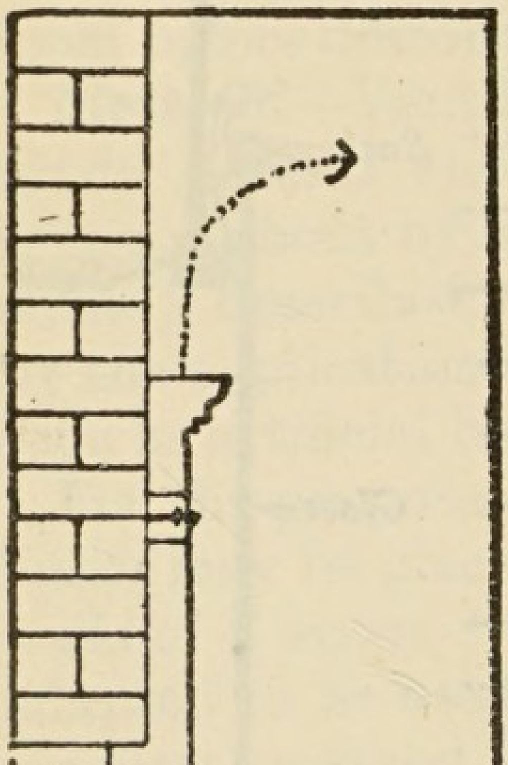


Fig. 29.
Tobin tube.

outside and the large ends on the inside of the wall, so that as the air passes through, it loses its force, expands and diffuses, so reducing the effect of draught and with this object it is usually placed near the top of the wall. When the door of a room is used as an inlet, the air entering the room is drawn from the house, and if so utilised great care must be taken that such supply is kept pure, firstly, by preventing ground, or any other impure air from entering from the basement, and secondly, by guarding against the air of closets and sinks entering the house. A window may be left open, and other special means may be provided for admitting fresh air to the stair-case, passages, &c. Air may be admitted through a closed door by means of a valve-shaped inlet in the panel, or a similar shaped inlet may be made over the top of the lintel of the door and hidden by a picture, though this system has obvious disadvantages.

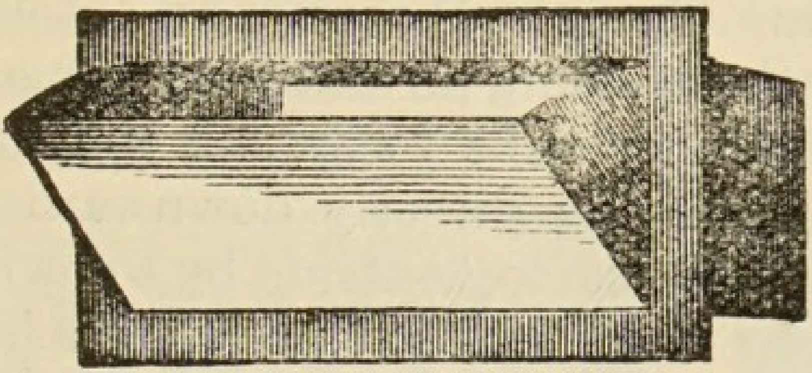


Fig. 30.
Sheringham ventilator.

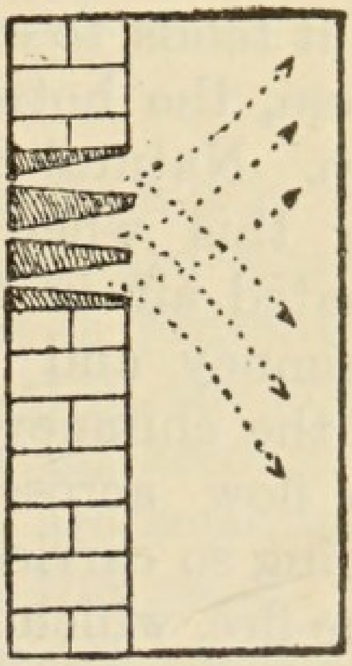
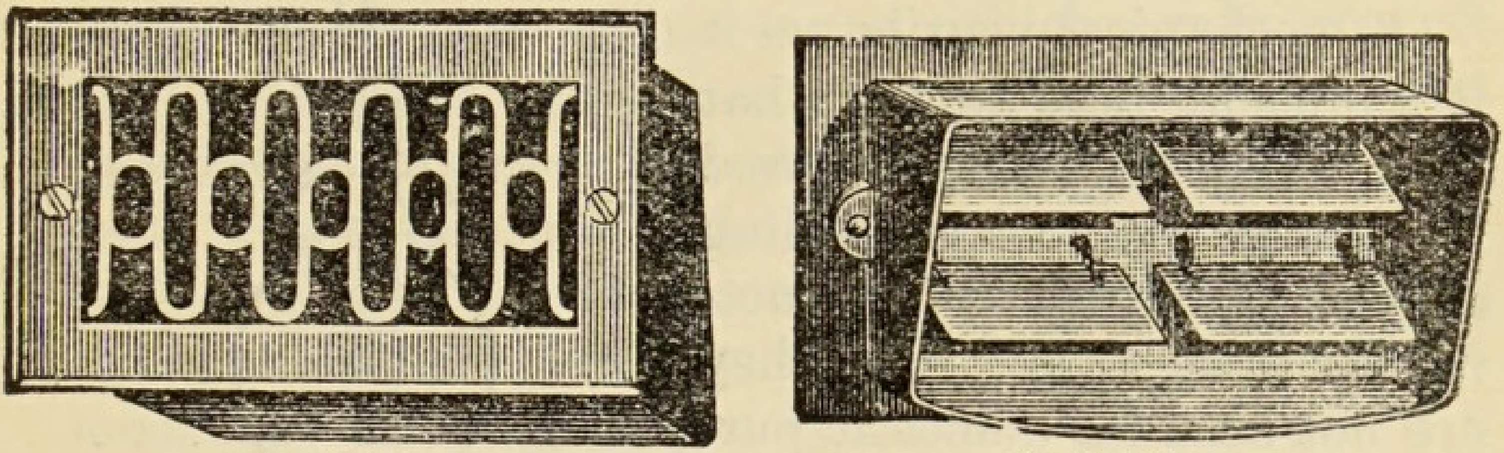


Fig. 31.
Section of Ellison brick placed in a wall.

The ceiling of a room cannot be used generally for inlets, but if the ceiling has a roof above it a form of ventilator known as McKinnell's is sometimes fixed. This consists of a small tube within a larger, a space being left between them. The inner becomes an outlet and the outer an inlet, there being an outward flange round the bottom of the inner tube to spread the air and prevent it from descending directly downwards, the whole being crowned on the top outside by a cowl.

Outlet ventilators may be placed in the wall or in the ceiling (see upper part of Fig. 33.) The best outlet ventilator is the open chimney flue, and no room should be constructed for habitation without such a flue or shaft. It is a powerful extractor, and as it tends to extract the air from the bottom of the room, the hotter and fouler air accumulates at the top. Natural forces in some measure compensate for this when the fire is lighted, because of the heated air in front of the fire, part flowing up the chimney and part rising to the ceiling in front of the chimney breast. The cold incoming air tends to flow across the room to the fireplace, and in doing so carries with it the air previously heated by the fire, which having flowed across the upper part of the room and become cooler, has descended, so that a continuous imperceptible swirl takes place and diffusion goes on at the same time. If artificial light be used in the room the natural process is overborne by the increased accumulation of the products of combustion and the maintenance of a higher temperature of the air in the upper layers. One of the methods of overcoming this in ordinary dwelling-rooms is to insert in the chimney breast, as near the ceiling as possible, a Boyle's valve outlet. This consists of thin talc plates hinged on a frame-work which



Front View. Back View.

Fig. 32.
Boyle's valve outlet.

only open inwards towards the chimney, and in the absence of any draught inward and upward remain naturally closed, so that down-draught is prevented. These outlet ventilators usually act best in the lower rooms of a house, in the upper rooms on account of the shortness of the chimney-flue they are sometimes apt to allow smoke to blow back into the room. In the ceilings of rooms outlet ventilators are sometimes fixed over gas pendants, and the foul air is carried along a tube above the ceiling and discharged through the outer wall, the propulsive force being the heat of the gas.

Ventilating gas pendants are used in private houses to abstract foul air. In public halls or theatres the star burners and large central gas lights, with cone shaped outlets above them, are used on a larger scale for the same purpose.

Of mechanical ventilators it is sufficient here to say that fans, pumps and jets are used for the purpose of propelling air into buildings and extracting air from them. But they are not used for domestic purposes or in ordinary dwelling houses.

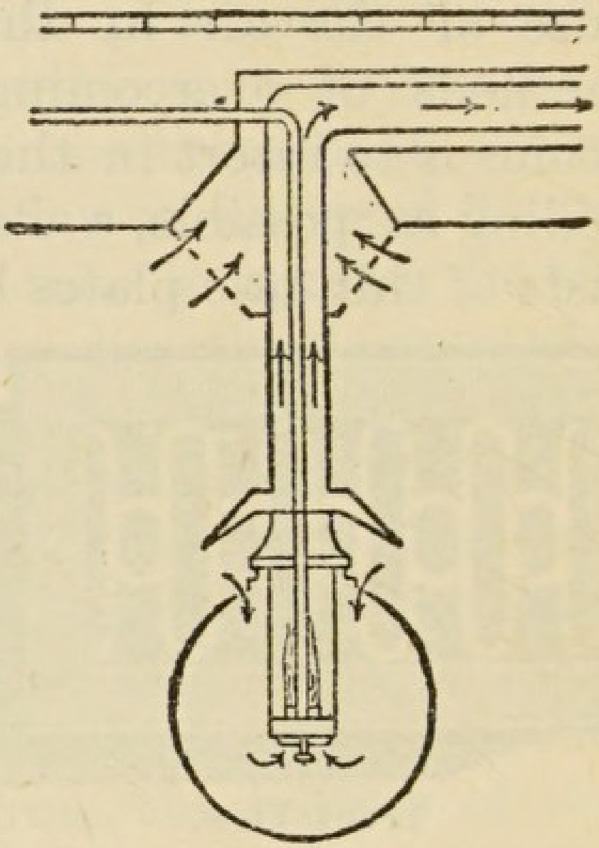


Fig. 33.
Ventilating gas pendant.

Warming and Lighting.

Closely connected with the subject of ventilation is that of warming and lighting.

Temperature.—The effect of artificial heat as we have already seen is to act as a motive force on the air and promote ventilation, and the effect of artificial lighting substances, such as gas, oil, and candles, when burnt is to pollute the air. The best temperature for habitable rooms is about 62 degrees Fahrenheit, a variation of 5 degrees above or below being permissible, but a variation of 10 degrees is excessive. A room with a temperature of 72 degrees Fahrenheit is hot and oppressive, and at 52 degrees a sedentary occupation cannot be carried on with comfort.

Open Fires.—Of all the methods of warming, the open fire is the best, because it promotes free ventilation, and projects the heat in a radiant form so as to warm all objects within range, which again give off heat to the air and other surrounding objects. An open fire will extract from 5,000 to 20,000 cubic feet of air from a room per hour ; the amount will be dependent upon many conditions—one of the important ones being the proper burning of the fuel, the less black smoke given off, and the more the mass acquires a red heat the greater proportionate amount of heat will be derived from the fuel. In order to prevent the fuel burning away too quickly, and to cause that in the front of the fire to give off the greatest heat, many forms of grate are made in which the air cannot enter at the bottom, but must traverse the fuel from the front. This can be effected in an ordinary grate (if not too high above the hearth) by fitting a vertical plate in front of the space between the bottom bars and the hearth. In this manner the air is prevented from entering the grate from below while the ashes are still able to fall. This contrivance is known as Teale's Economiser, and tends to cause a slower and more complete combustion of the fuel.

The points to be observed in the choosing of a grate are—the back of the grate should be about one-third the width of the front, and the sides should slope accordingly; both back and front sides should be of fire-clay, and the back should slope forwards, so as to lean over the fire, and contract the throat of the chimney above it; the bottom of the grate should be deep from before backwards, and either consist of a solid slab of fire-clay; or, if the underbars be retained the slits should be narrow, and the space beneath should be closed in front by a shield. The effects of this construction are: to shut off any upward draught from beneath the fire; to prevent too rapid combustion of the whole mass of fuel; to cause incandescence to reach the fuel at the back of the grate gradually by extension from the front, and to cause the smoke given off during the process to be more or less consumed in passing over the fore part of the fire when

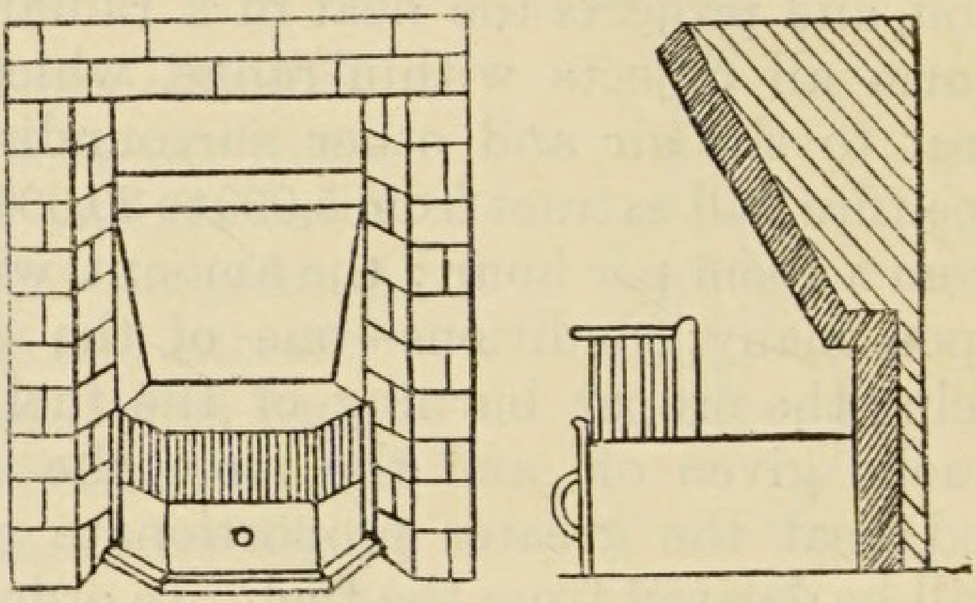


Fig. 34.

The Teale Grate.

doubling round the projecting back to reach the chimney. These principles are carried out in the Teale grate. Fire-grates situated against the outer wall of a building are apt to lose some of their heat by conduction through the wall. For ventilating purposes the grate is best situated in the wall farthest removed from the door and from the window, and for heating purposes it should stand well out into the room so as to radiate freely over as wide an area as possible.

Several kinds of *ventilating grates* have been introduced, such as the Galton grate and the Manchester School grate. The principle of these grates is that they are surrounded by an air-chamber at the back and sides, into which the air is admitted by a channel through the outer wall, and becoming warmed flows through openings over or at the sides of the mantelpiece.

Gas Fires.—Various kinds of gas fires have also been introduced, but none of them should be used except in a fire-grate, or where a flue may be inserted to carry off the products of combustion. They are cleanly, but vary in the amount of gas that they consume; their temperature is much more uniform and does not vary like that of a coal fire, so that they are apt, unless regulated to its requirements, to overheat a room after having been alight several hours.

Closed Stoves.—Closed stoves are more economical and cleanly than open fires, but not so healthy, as they heat the air as it passes over them, that is, they heat mainly by convection instead of by radiation like open fires. They should be made of wrought iron lined with firebrick, or of porcelain; if made of cast iron unlined, they are apt to give off poisonous gases, such as carbonic oxide. They all tend to dry the air, and a vessel of water is usually placed over them for the purpose of evaporation, to supply moisture. Some stoves are made to burn gas instead of coal or coke, and these are usually made in the form of ventilating gas-stoves, two of the best known of which are Bond's Euthermic stove and George's Calorigen. In these stoves fresh air is admitted from the outside, and conducted through the stove by a closed pipe to discharge into the room, after being heated by the gas

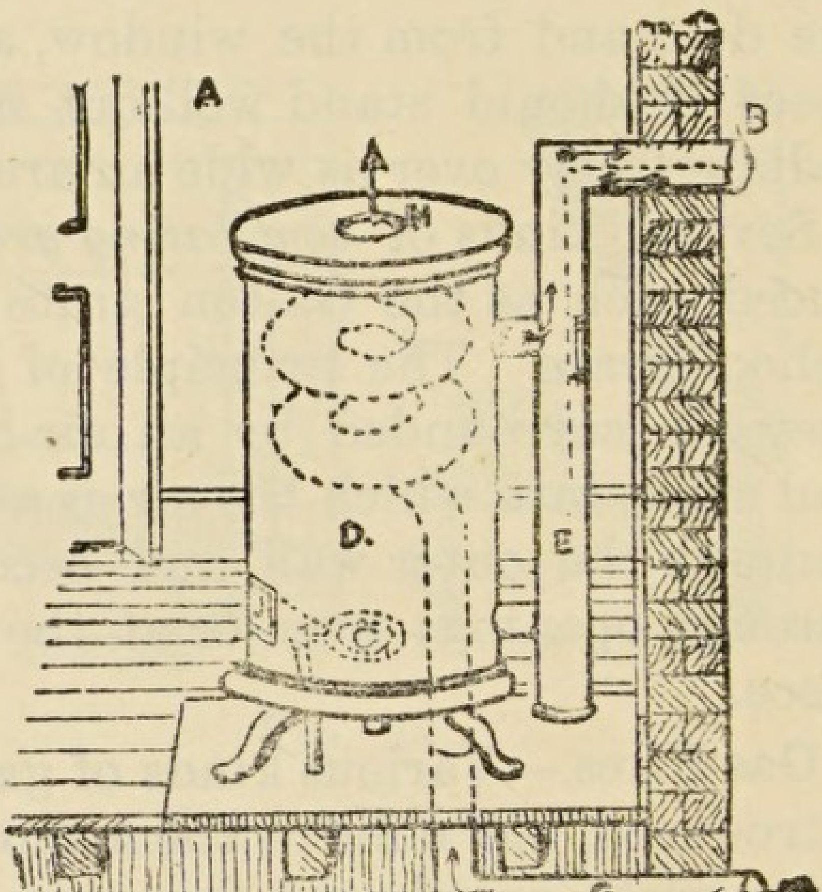


Fig. 35.

George's Calorigen stove.

A, Room; B, Inlet and outlet to gas chamber; C, Gas burners; D, Gas chamber; E, Inlet; F, Outlet; G, Fresh air inlet; H, Fresh air outlet.

burners inside the body of the stove; the body of the stove itself is separately ventilated by an inlet opening to admit fresh air, and an outlet to carry off the products of combustion which should on no account be allowed to enter the room.

Hot Water and Steam-pipes.—Large halls or rooms cannot be effectually warmed by open fires, and here

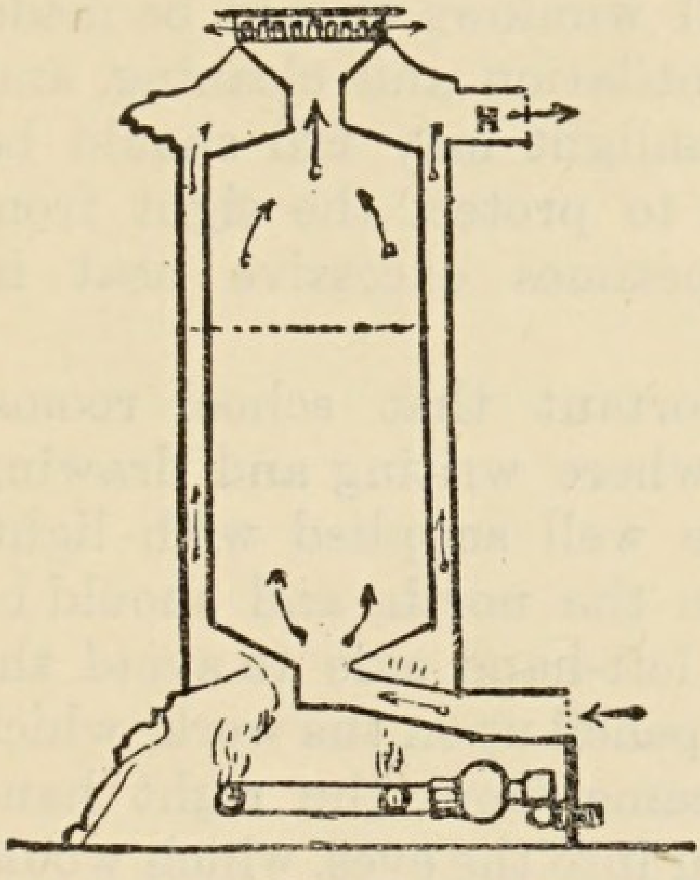
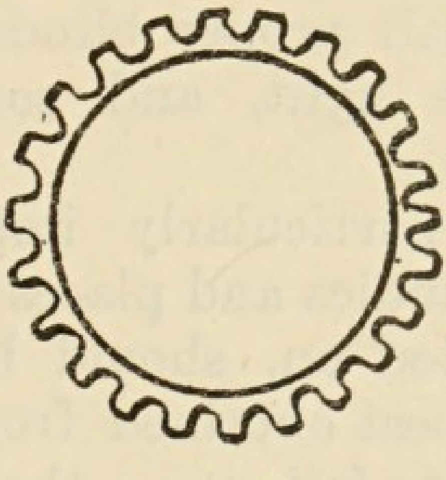


Fig. 36.



SECTION.

Bond's Euthermic stove.

pipes twisted into coils, or radiators, are installed at proper points, through which hot water or steam is allowed to circulate. The cost of installing such a system of heating is considerable, and great care has to be taken to prevent freezing during the winter, and consequent explosions. In some instances large buildings are also heated by air passing over hot flues or coils before entering the building.

Lighting.—Lighting may be natural or artificial.

Natural Lighting is by means of windows which should be of an area of at least one-tenth of the floor space of the room, and should reach as near to the ceiling as possible. It is almost unnecessary at the present day to say that all windows should be made to open for purposes of ventilation and cleaning, and that those upon which sunlight may fall should be fitted with proper blinds to protect the sight from excessive light, and sometimes excessive heat in summer.

It is particularly important that school rooms, offices, studies and places where writing and drawing are carried on, should be well supplied with light. This is best obtained from the north, and should be allowed to fall upon the left-hand side to avoid the shade of the hand, pen or pencil upon the work, which would take place if it came from the right hand side, and to avoid reflection into the eyes, which would take place if it came from the front.

Artificial light as already mentioned is liable to foul the air by the products of combustion, except in the case of the electric light, and for this reason there should be extra ventilation provided during the time that artificial light is being used, or better still, special provision should be made for carrying off the products of combustion. Two well-known gas lamps on this principle are the Wenham and the Benham gas pendants.

Oil lamps give a soft, mellow light, but their flame is hot, and apt to cause headache if too close to the head. A green or other coloured lamp shade will protect the eyes from the direct rays of light.

CHAPTER VI.

Water.

Uses.—Water is required (*a*) for drinking (*b*) for domestic purposes, such as cooking and cleansing, (*c*) for public use, as for flushing and cleansing of streets and sewers, and extinguishing fires, and (*d*) for manufacturing purposes.

Three-fourths of the surface of the globe is occupied by water, and it forms about three-fourths of the weight of animals and plants. In the air it exists as vapour, and many natural phenomena are due to its presence. As hot and cold water, it is used to convey temperature, and as steam for the same purpose, and also as that motive force which makes most modern locomotion possible.

Composition.—Chemically pure water consists of two parts by volume of hydrogen with one of oxygen, but it is such a great solvent of other substances, that it is never so found in nature, indeed such water is insipid and unpalatable. Naturally pure water is inodourous, tasteless, transparent, and when viewed through considerable depths, of a blue colour. Water readily absorbs gases, and especially oxygen from the air ; in the absence of gases water tastes flat, and the presence of carbonic acid gas renders it sparkling and sharp.

There are many kinds of water but they may be classified under the heads of fresh water, salt water and mineral water. *Mineral Waters* are those that have flowed through certain strata, and have dissolved out the mineral constituents, and most of them are more or less medicinal. *Salt Water* or sea water forms the ocean, and cannot be used for drinking purposes, but is sometimes employed at sea-side resorts for the use of public cleansing. *Fresh Water*, which concerns us most, as water used for domestic purposes, may be either hard or soft. Soft water is most useful in producing a lather with soap ; hardness is caused by mineral salts in solution, the principal of which is carbonate of lime, washed out from limestone rocks by water impregnated with carbonic acid. As this can be removed by boiling and other means, it is known as temporary hardness, but the presence of sulphate of lime, which cannot be so readily removed, causes what is known as permanent hardness.

Sources.—Fresh water may be derived from rainfall, the land surface, rivers and lakes, the subsoil, springs, deep wells and artesian wells.

Rain Water is very soft, and consequently is excellent for washing purposes in the country, but in towns it takes up impurities of the air in falling, and so becomes contaminated.

Surface Water, unless it is upland surface water, remote from dwellings and cultivated land, is likely to be contaminated, and especially when it collects in stagnant pools.

River or Lake Waters, when constantly flowing, and not polluted by town sewage, refuse, agricultural land or manufactories, may yield a good supply of water, especially in the upper part of a river basin.

Subsoil Water in the neighbourhood of dwellings is nearly always impure from the soakage through the

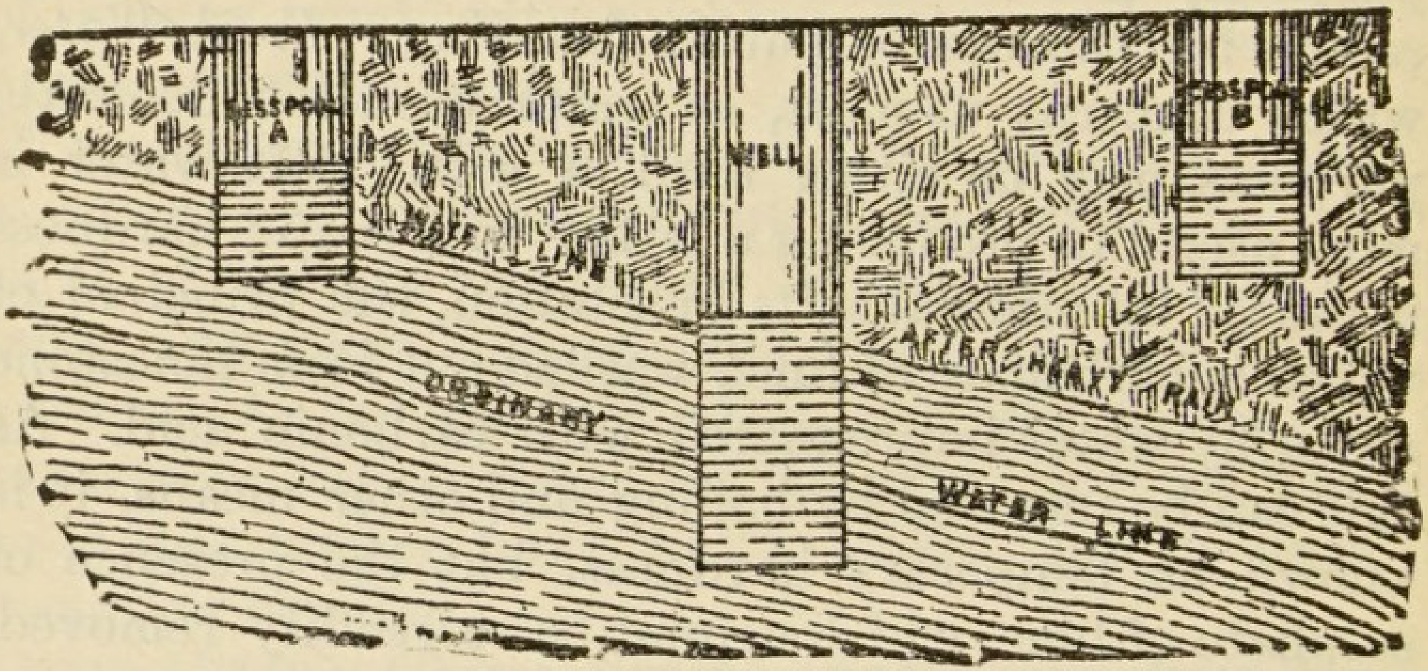


Fig. 37.

Effects of cess-pools on wells.

soil, hence shallow wells under 20 feet deep usually contain contaminated water, although it may appear clear and sparkling. Such wells are also liable to contamination by the entrance of impurities from above, but the most frequent causes of pollution are cesspools in their neighbourhood.

Spring Water is rain water that has sunk through the soil until it has reached an impervious stratum, such as clay, along the surface of which it tends to run, and where the stratum of clay appears at the surface, as on the side of a hill, the water issues as a spring, and sometimes makes good drinking water, unless loaded with dissolved minerals, when it is classified as a mineral water such as are to be found at all spas.

Deep Well Water is derived from strata considerably below the surface and the subsoil, the surface water being kept out by a stone coping, and the subsoil water being excluded by stone-work or masonry built in the sides of the well to a depth of some 20 feet. Like spring water, deep well water is, as a rule very good and palatable.

Artesian Well Water is derived from a well deeper than the ordinary deep well, which is usually sunk first, and from the bottom of which a smaller boring is made to a greater depth, generally from 1000 to 1800 feet. They are called Artesian wells because the first was made in Artois, in France. The principle upon which the well is based is the fact that the strata in a district usually run .in a curve and come to the surface at a considerable distance from the centre of the lowest point of the district, so that a kind of pocket is formed. The rainfall round the circumference of this pocket percolates in between the strata, and so falls in towards the centre. If then, in the centre of the district, an Artesian well be sunk to an impervious stratum below the surface, which carries above it a mass of water, the water, finding a vent, will rise up in the well, and if the pressure of water accumulated between the impervious strata below be sufficient, it will rise to such a height as to overflow from the well. In many instances the water of such wells is bright, sparkling and palatable, in some it contains so many salts as to be undrinkable.

Quantity of Water required.

About four pints of water are lost every day from the body of an adult man by means of the kidneys, skin and lungs, and this has to be replaced. For cooking, about a similar quantity is required making one gallon for dietetic purposes. For ablution and bathing about five gallons are required, for laundry and house washing about six gallons, for water-closets five gallons, making a total of seventeen gallons for domestic purposes. About six gallons for municipal purposes, such as street washing, extinguishing fires and supplying fountains, and about seven gallons for trade and manufactures must be allowed, making about thirteen additional gallons per head per day. The ancient Romans so fully appreciated the value of water, that they provided largely in excess of this amount, judging from the number of aqueducts, some still in use, some in ruins. In estimating the amount of water per head necessary, it must be remembered that thirty gallons is an average (the London average is thirty-one gallons), and that one day considerably more, and another day considerably less, may be used by any particular individual. There should be no restriction upon water for domestic as distinguished from trade purposes. It is desirable that water should not be supplied by meter, but should be paid for by rateable value, in order that the poor may have no inducement to restrict the quantity of water they use.

Storage.—If water is obtained from running rivers and natural lakes (which are but expansions of rivers) as a rule no provision for storage is made, although sometimes it is necessary even in this case to form a reservoir. Storage of water on a large scale is effected by producing artificial lakes or reservoirs. These are made by constructing a dam across a valley lying at such an elevation that the water may be distributed from it by gravitation. When in country districts the supply is obtained from wells and springs it is generally necessary to pump the water up to a reservoir situated at such a height that it may be delivered by gravitation. Such reservoirs should be large enough to hold a supply for two or three months in case of drought. When water is derived from deep wells, as in the chalk for instance, it is often found that the supply is most abundant during the dry season on account of the time (several months) that it takes the water to percolate through the various strata.

Domestic Storage.—Tanks or cisterns are necessary in all houses, in order that water may be at hand for use when required. In towns these are filled automatically by pressure from the service pipe.

Cisterns may be made either of slate, or brick lined with cement, or of metals (zinc, lead or galvanized iron). No red lead should be used for the joints of cisterns made of stone, slate or brick, but only good cement. Some soft waters dissolve lead and in these cases lead is objectionable. With hard waters a carbonate of lead is formed on the surface and prevents any further action. As a general material galvanized iron may be considered the best for cisterns.

Cisterns should be so situated that they are easy of access for the purpose of cleansing from time to time, and they should be covered with a well-fitting lid. The overflow pipe should be made to deliver directly into the open air, or, if this is not possible, it is better to have no overflow pipe rather than one that discharges into a drain or other place from whence polluted air can gain access to the cistern. A cistern that supplies drinking water, or water used in the preparation of food, or in fact any cistern that has a draw-off tap to it, should not directly supply any water-closet basin, but should be cut off from direct connection by means of a small flushing tank for closet supply. All cisterns should be so placed as to avoid being frozen in winter, and service pipes and supply pipes should also be protected from frost. In addition drinking-water cisterns should be so situated that they cannot possibly be exposed to any form of pollution or foul air from other sources.

In towns the public water supply is carried from reservoirs, by gravitation in pipes usually made of cast iron to the various streets, and from these street mains by iron communication—and leaden surface-pipes to the highest point possible in the houses. So long as the water is flowing it is under pressure, but if it be turned off at the main the pressure ceases and the water falls in the pipes. The tendency therefore is for the receding water to suck in any air in the neighbourhood of any opening in the pipes. There is a danger in this method of supplying water, a system known as the "*intermittent*," the water being supplied only for a few hours daily. A far preferable system is that known as the "*constant*," in which the water is always under pressure in the pipes and is never allowed to recede. This system is much less liable to contamination, allows taps to be fixed on the house-mains or service pipes for the supply of drinking water at any time, enables the cisterns to be reserved for the supply of closets, gives a supply of water at any moment in case of fire, and as it does not limit the supply induces greater cleanliness.

Impurities of Water.

Water readily absorbs gases; oxygen and nitrogen, especially the former, are so absorbed from the atmosphere; carbonic acid is also readily taken up by water. These gases are not in themselves impurities, but rather make water more palatable, and when they are driven off as in boiling, the water becomes insipid. This is one of the difficulties in the use of condensed water. Noxious gases, especially those produced in manufactures and sewer gas, however, are also readily absorbed by water.

It has already been mentioned that water in passing through various strata in the soil readily dissolves minerals. The most common of these are carbonate and sulphate of lime, chloride of lime, sulphate and chloride of magnesium,—sulphate of magnesia (Epsom salts), and sulphate of soda (Glaubers salts) in water cause diarrhœa as they are purgative salts. The presence of common salt in water, if in large quantities denotes the proximity of the sea or rock salts, and in small quantities pollution by sewage. The presence of salts of ammonia, especially nitrate and nitrites, generally indicates that nitrogenous matter from sewage has gained access to the water and must be regarded with great suspicion. Iron in water gives a chalybeate taste; it is not necessarily injurious, and to anæmic persons is even beneficial. Lead is a very dangerous impurity of water as it accumulates in the system of the consumer and may cause lead poisoning and paralysis. Soft waters, especially of acid, peaty, moorland character, readily dissolve the lead from the pipes through which they flow, so also do highly oxygenated waters, but not to such an extent. The organic impurities in water, however, are the most important. Brown peaty waters are not dangerous in themselves, although they may taste unpleasant and may occasion diarrhœa in those unaccustomed to their use. The organic matter from animal sources is very dangerous, being usually derived from sewage in some form, either from privies, cesspools, manure, or other accumulations of filth and refuse. Contamination of this kind is generally indicated by the presence of ammonia. If compounds of these gases, together with common salt are found, sewage contamination may be regarded as almost certain. The danger of sewage contamination is due to the fact that the germs of diarrhœa, dysentery, typhoid and cholera may also gain access to the foul water, and these diseases may so be spread. Malarial fevers are regarded as being probably propagated by means of drinking water. Various parasitic intestinal worms may also be taken into the system with impure water.

In examining filtered river water for the presence of minute germs, the vast majority of which are innocuous to man, it is generally held that the number present should never exceed 100 in a cubic centimetre, (or the 50th part of an ounce) for the water to be fit to drink. In many deep well waters the number is much less than this and in some cases only a few are found.

Purification of Water.

Some waters, as from mountain streams, deep wells and some springs, are pure enough to drink. Others such as river and lake waters require to be filtered in order to render them purer. On a large scale the water is first conducted into a subsidence reservoir, where much of the floating matters settle, and a week or two's storage here will considerably purify the water. After this the water is passed through filter beds, consisting of fine and coarse sand and gravel of a thickness of about three feet, and from these it is taken to the service reservoirs. In this manner all the fine particles and organisms are filtered out, dissolved organic matter is oxidised, and the water is aerated.

It may be taken as an axiom that a water supply that requires domestic filtration after delivery is not fit for public service. It follows that domestic filters should not be required where a public water supply exists. If a domestic filter be required, the only forms that exclude the germs of disease, are those constructed of fine porcelain or diatomaceous earth, such as the Pasteur-Chamberland and the Berkefeld. The former is much slower in action, but more perfect in results.

Many other filters are made which depend upon various forms of charcoal and spongy iron for filtration, and are more or less useful for excluding the larger particles and colouring matters, but do not completely

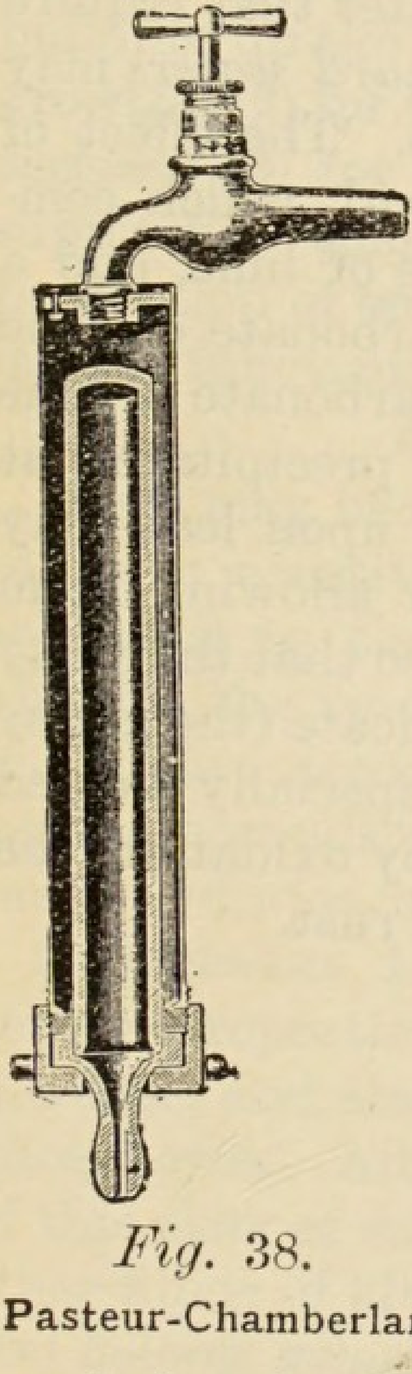


Fig. 38.

Pasteur-Chamberland tap filter.

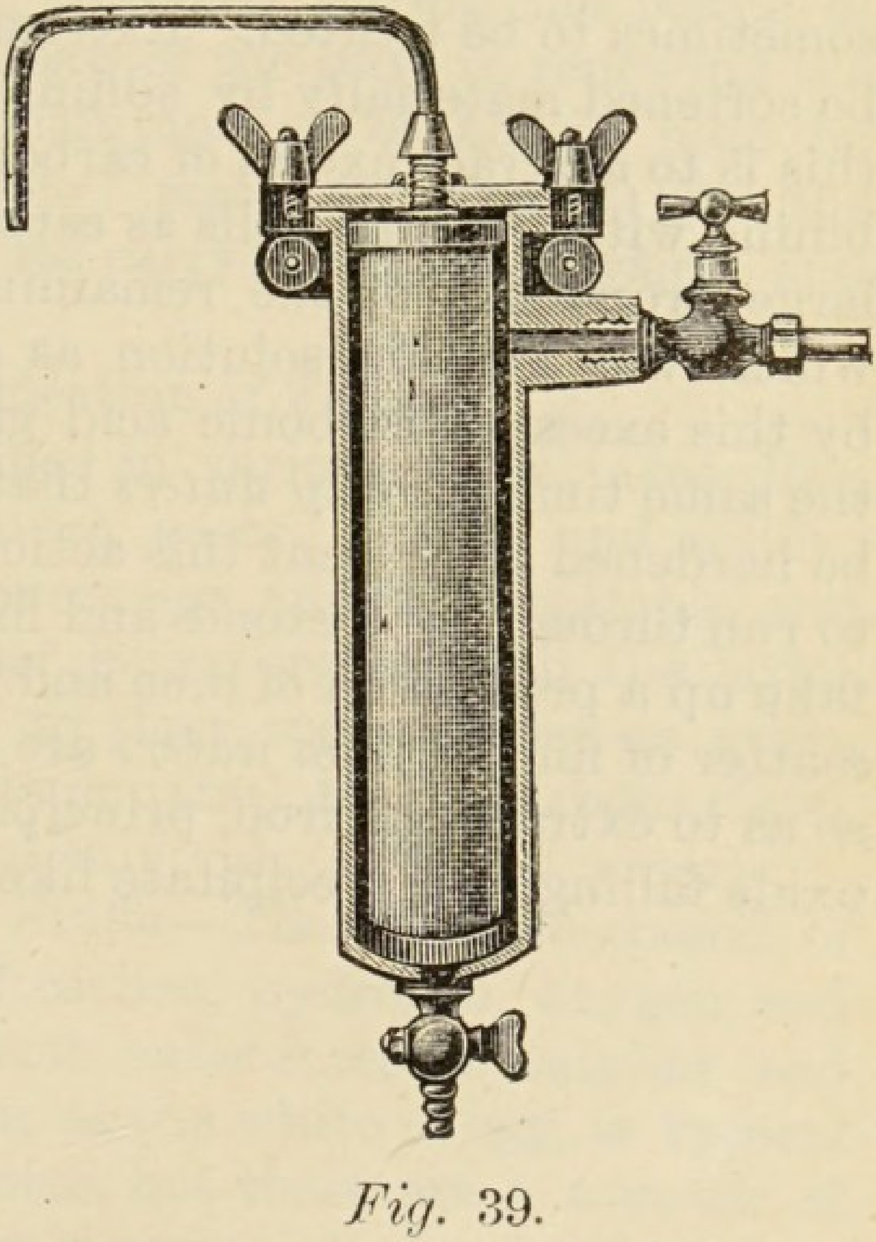


Fig. 39.

Berkefeld tap filter.

exclude minute disease organisms. The most reliable filter is the Pasteur-Chamberland, but this must be perfect in construction, and must be cleansed from time to time, to keep it in good working order. The water from it is liable to be flat to the taste, but this can be remedied by allowing it to be aerated by keeping it in motion or letting it fall from a height in pure air.

There are three other kinds of water that require sometimes to be treated. Extremely *hard waters* may be softened materially by adding lime. The effect of this is to abstract excess of carbonic acid, which combining with the lime, falls as carbonate of lime, and a large proportion of the remaining carbonate of lime which was kept in solution as a bicarbonate of lime by this excess of carbonic acid gas is precipitated at the same time. *Peaty waters* that act upon lead may be hardened to prevent this action, by allowing them to run through lime, stones and flints, so that they may take up a proportion of lime and of silicate (the glassy matter of flint). *Iron waters* are also specially treated so as to extract the iron, principally by oxidation, the oxide falling as a precipitate like iron rust.

CHAPTER VII.

Food.

Uses.—Food is required (1) to supply material for building up the body, especially during the period of growth ; (2) for the repair of the body in renewing the tissues ; (3) for the maintenance of bodily heat by supplying combustible material ; and (4) for the production of energy for carrying on the physical and mental functions.

Classification of Foods.

Foods may be classified in various ways ; according to their constitution—as gases, liquids and solids ; according to their source—as animal, vegetable and mineral, the two former being organic and the latter inorganic ; according to their composition—as nitrogenous proteids or (albuminates), hydro-carbons (fats), carbo-hydrates (sugars), minerals (salts and water).

Nitrogenous Food Stuffs.—These are composed of certain proportions of carbon, hydrogen, oxygen and nitrogen, and also of such substances as sulphur and phosphorus. Albumen, as the white of egg, is typical of this class of substances, but there are a number of other kinds of albumen in animal foods ; to this class also belong gelatine in bones, casein in milk, gluten in cereals, and legumen in pulses.

Most nitrogenous food stuffs are mixed with fats, or carbo-hydrates in the substances in which they are found, for instance milk contains in addition to casein, fat (cream), salts and water; and meat also contains fat, salts and water. The essential point of this *proximate nutritive principle* is that it is distinguished from other food stuffs, by the fact that it contains nitrogen. These nitrogenous substances form and build up the body in its growth and make good the waste by repair, and their breaking up also causes the production of heat and of force.

Hydro-Carbons.—These bodies consist of carbon and hydrogen with a little oxygen, and are represented by the fat of meat, butter, suet and dripping from animal sources, and vegetable oils, such as olive, palm, cocoa-nut. The breaking up of fats contributes largely to produce animal heat, and at the same time a certain amount of energy. Surplus fat is deposited in various parts of the body, where it acts as a cushion, and as a reserve store to be drawn upon when required.

Carbo-Hydrates.—These consist of carbon, hydrogen and oxygen, the oxygen being in a sufficiently large proportion to form with the hydrogen water or hydrate, hence the name. This class of food embraces sugars and starches, and the starches are converted into sugars in the body before absorption. They are mainly derived from vegetable sources, although some animal products also contain sugar, such as the sugar of milk. The varieties of starch are numerous, and differ in their appearance under the microscope, so that those derived from potato, wheat, rice, &c., are easily distinguishable. There are also a number of different kinds of sugar, derived respectively from the cane, grape, beet, and other sources. The function of carbo-hydrates is to produce heat and energy, and after conversion into fats to enable heat and energy to be stored up.

Minerals.—The mineral salts are in great variety, the chlorides and phosphates of the alkalies together with salts of iron being the most abundant. The vegetable acids, viz., tartaric, citric, malic, and acetic, are present in various fruits and vegetables, and are necessary for the prevention of scurvy. Minerals are necessary in the composition of the various parts of the body; the alkalies keep the fluids alkaline; the acids assist in the composition of many secretory juices; the salts assist in absorption and excretion; iron is necessary for the blood, and phosphorus for the bones and nerves.

Water, which may be included amongst the minerals, is absolutely necessary as a solvent and absorbent, and all foods contain more or less of it, and most of them a large proportion. Liquid foods contain over three-fourths of their bulk of water, meats and green vegetables over a half, and only the drier forms of food less, rice, for instance containing but one tenth. Some foods although they contain very little water are not dry, because they contain a large amount of fat, as for instance, butter and bacon.

Three-fourths of the weight of the human body consists of water, and its functions are largely carried on by the water taken into and given off from the system, which assists the movement and interchange of the various fluids.

Dietaries.

Construction.—It has been mentioned that foods may be classified according to their composition, that the bases of that composition are the proximate principles that they contain, and that these proximate principles are known also as food stuffs. The proportion of each of these food stuffs requisite for the maintenance of health has been ascertained *experimentally* by subjecting individuals to particular diets of known composition, and calculating theoretically the amount of daily loss by excretion from the various parts of the body. *Practically*, these theoretical computations have been tested by means of fixed diets for soldiers, criminals, athletes, workmen and many other classes, their condition of health being kept under observation at the same time.

Conditions affecting diet.—A number of observers have formulated standard diets, but there are several conditions to which these are subject, especially age, climate, occupation, and state of health.

Age.—Nature has provided infants with a type of perfect food in the form of milk, as during the first nine months of life a child should derive its sustenance and growth entirely from a diet of milk, and cannot digest starchy food. The percentage composition of human milk is as follows :—

Nitrogenous (proteids)	2·97
Hydro-carbons (fats)	2·90
Carbo-hydrates (sugars)	5·97
Minerals (salts)	0·16
„ (water)	88·00

As a child grows it requires more organic food ; an adult would have to drink nine or ten pints a day to obtain sufficient nourishment from milk. This would mean taking too much water, and an insufficient amount of sugar, although the latter error could be remedied by additional sugar and starches. Children require more food in proportion to their size than adults, because they have in addition to repairing waste, to add new tissues for growth. After middle-age less food is usually required than the amount that most town-people eat. Old people on account of their weakened digestion, have to assimilate their diet more to the conditions of childhood.

Climate.—In the tropics animal food should be eaten in smaller proportions than in temperate climates. The natives of such countries live mostly upon starches, or food containing starches and sugar, and

Europeans in the tropics should have a light easily digested diet. In temperate regions more animal food may be eaten. In cold climates, in addition to animal food, a great increase should be made in the fatty foods, in order to maintain the temperature of the body.

Occupation.—A person at rest requires a less proportion of food than a person at ordinary work, and hard work necessitates a still greater supply of nourishment. Open air work produces a good appetite and strong digestion, so that not only a large amount of food can be eaten, but it can be also more easily digested. Plain nourishing foods of the types of cereals, pulses, vegetables, bacon, and cheese, may form a staple diet for the countryman, but those of sedentary habits require easily digested food, and in smaller quantity. Mental work cannot be engaged in after heavy meals, which should therefore be avoided, and more frequent and lighter meals be substituted.

Sickness.—Sick or ailing persons require a greater proportion of liquid food, and such light substances as milk puddings, and white fish. The addition of soda-water to milk in sufficient quantity, will often render it digestible to those with whom it would otherwise disagree, and the beating up of eggs in water, with or without the addition of sugar, will make what would otherwise be ropy and adhesive, a more pleasant liquid which may be further improved by a little flavouring.

Standard Diets.

Numerous experimenters have formulated diets, but from what has already been said it will be observed that the quantities of proximate principles requisite for a healthy adult man depend upon the amount of physical work performed. The following table gives an average standard of the amount of elementary principles that should form a diet under varying conditions.

STANDARD DIETS—PROXIMATE PRINCIPLES.

Figures approximate to assist memory.	Rest.	Ordinary Work.	Hard Work.
	Ozs.	Ozs.	Ozs.
Proteids (Albuminates) ...	2·5	4·5	6·5
Fats (Hydro-carbons) ...	1·0	3·0	5·0
Carbo-hydrates (Sugars)...	12·0	14·0	16·0
Salts (Minerals) ...	0·5	1·0	1·5
Total food (water-free) ...	16·0	22·5	29·0
Water (in solid food) ...	16 to 24	22 to 23	28 to 42
Water (as liquid) about ...	50	65	80

Thus a man requires when at rest about a *pound* of water-free nutritive material as a minimum ; for ordinary work 2 ozs. is added to each of the first three principles and ½ oz. to the salts ; for hard work 2 ozs. is again added to each of the first three principles and ½ oz. to the salts.

In order to calculate the amount of food necessary, a percentage table of the composition of food stuffs is also required. A few of such percentages are given in the following table, and from them calculations may be made.

PERCENTAGE OF PROXIMATE PRINCIPLES IN CERTAIN FOODS.

Food.	Water.	Proteids.	Carbo-Hyd'tes.	Sugar.	Fat.	Salts.
Bread	37	8	47	3	1	2
Peas	15	23	55	2	2	2
Potatoes	75	2	18	3	0·2	0·7
Meat (lean) ...	72	19	—	—	3	5
Milk	86	4	—	4	4	0·8
Eggs	74	14	—	—	10	1·5

If the proportion of the proteids and carbo-hydrates in a dietary be sufficient, it is a very simple matter to add the water, sugar, fat, (butter, etc.), or salts.

Various Foods.

Dividing foods as nitrogenous and non-nitrogenous, and again as animal and vegetable, they may be considered more in detail.

Nitrogenous Animal Foods.—The flesh of animals, one of the main sources of food supply, is of two kinds, red and white. The red meats include beef, veal, mutton, lamb, pork, game and salmon ; and the white meats include other fish and poultry. White meats are more digestible than red. Beef is the most nutritious of the meats, but is more difficult of digestion, and is therefore more suitable for the robust and active than for the delicate and sedentary. To a less extent this applies also to veal, except that it is less nutritious than the other red butcher's meats, as it is naturally red and only artificially whitened by bleeding. Mutton is more easy of digestion than any other butcher's meat and better suited to delicate and invalid persons. This also applies to lamb, but lamb is less nutritious. Pork is difficult of digestion and is rendered rather less so by salting, drying, or smoking. Fish may be red, white, or fat fish. The red, such as salmon, is most difficult of digestion ; the white, such as whiting, haddock, sole and turbot, are the most easy of digestion ; and the fat fish, such as herrings, mackerel, and eels, are intermediate. The object of most sauces added to white fish is to make up for the absence of fat. Fish, especially white, is more digestible than butcher's meat and it is less stimulating. Most butcher's meat becomes tender by being kept a short while after killing, but fish should be eaten as fresh as possible. All shell fish, except oysters, are regarded as more or less indigestible. Game is hung in order to render the flesh more tender, but poultry should be eaten fresh and young. All young animals are necessarily more tender than old ones, and females than males, and some breeds and varieties are more tender and succulent than others. Eggs present animal food in a very compact form, but to be palatable they should be fresh. The older an egg is the better it floats in salt water or brine. The white of egg consists principally of water and albumen; the yolk of fat, phosphoric acid and sulphur. It is the last which, combined with hydrogen, causes the smell to be so offensive during decomposition. Eggs are digestible by most people according to the amount of cooking they have undergone. Those who desire to partake of a nutritious food to satisfy them for a considerable number of hours take hard boiled eggs as a portable form of nourishment. Milk is a model food complete in itself for the young, and is the model of a typical food, but is too watery for an adult. Cream, which is the fat of milk that rises to the surface, is partaken of in various forms. The skim milk that remains is consumed as such, or, if treated with rennet separates into whey which is the watery part, and curd which is the solid part. The curd consists of casein, the basis of cheese, and is found almost pure in curd cheese. There are various kinds of condensed milk in the market; those from which the water only has been abstracted for purposes of condensation; those from which the cream has been extracted also; and those to which sugar has been added, with or without the abstraction of cream. They are of very variable composition, and care should be taken to obtain a reliable brand.

Cheese is made in different varieties according to the proportion of cream that it contains. Stilton contains much, Cheddar less, and Dutch very little. Cheeses that are kept long contain the fungi of blue, green or red moulds, cheese mites, and ultimately, maggots, or the larvæ of certain flies.

Nitrogenous Vegetable Foods.—These include the cereals, such as wheat, oats and barley ; and the pulses such as peas, beans and lentils.

Wheat is the basis of ordinary flour. White flour is ground wheat from which the bran has been abstracted; in whole and brown meal however the bran is allowed to remain. Bread is made from all of these, either as white, brown, or whole meal. The effect of the bran is to stimulate the intestines, and to remedy constipation, but it is apt to act as an irritant and laxative to some persons, or to all if used to excess. In the making of bread, the spongy character is produced either by adding yeast, and causing fermentation to be set up so as to produce carbonic acid gas in the interstices of the dough, which causes it to "rise"; or by adding baking powder, a combination of tartaric acid and bi-carbonate of soda,

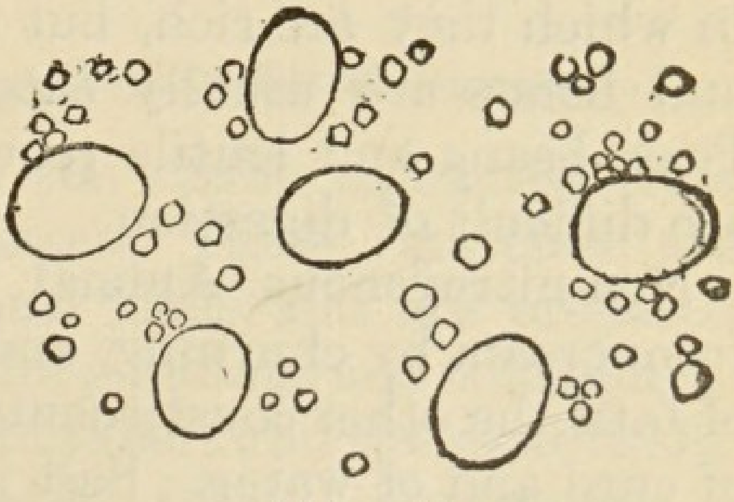


Fig 40.
Wheat Starch (magnified).

which in the presence of water produces carbonic acid and "charges" the dough; or, by mixing the flour with water highly charged with carbonic acid gas only, so as to "aerate" it. Oats are rich in nitrogen and fat. Oatmeal will not make bread because, unlike wheat, it contains very little adhesive gluten, but it makes excellent porridge and cakes. Barley contains the least nitrogenous matter of these three cereals, and is principally used for malting, the "wort" formed in this process, obtainable as maltine, is, on account of it containing a ferment called *diastase*, very digestible and nourishing. Pearl barley is barley from which the husks have been removed, the seeds becoming rounded in the process of rubbing. Indian corn, or maize, is used as food principally in the form of corn-flour and hominy. Rye is made into black bread.

The pulses contain nitrogen in the form of legumen, in which they are rich, but they are deficient in fats, and hence are usually eaten with bacon or butter. Peas, beans and lentils require well cooking as they are difficult of digestion.

Non-nitrogenous Animal Foods.—Butter is made from cream by churning, and consists almost entirely of fats, the other constituents being a small proportion of curd and of water. Salt is added as a preservative, and to improve its flavour. Butter is a light and easily digested form of food. So is the butter-milk, or liquid left after the making of the butter. Clotted cream is cream that has been scalded. Lard is made from the fat of pigs. From other animals margarine is obtained and is treated to render it similar to butter, for which when pure it is a wholesome substitute.

Non-nitrogenous Vegetable Foods.—These include rice, arrowroot, sago, tapioca, cornflour, potatoes, sugar, green vegetables and fruits. Rice, strictly speaking, contains nitrogenous matter, but only in very small quantity, about 88 per cent. being starch. Arrowroot is obtained, by washing, from the pulp of certain tubers found in the Indies and carefully dried. Sago is similarly extracted from the pith of various species of palms. Tapioca is obtained, by heating, from the cassava, a tropical plant. Cornflour is the starch extracted from maize by various processes. These starches are readily digestible wholesome foods, and are prepared in various forms, and used for puddings and thickening.

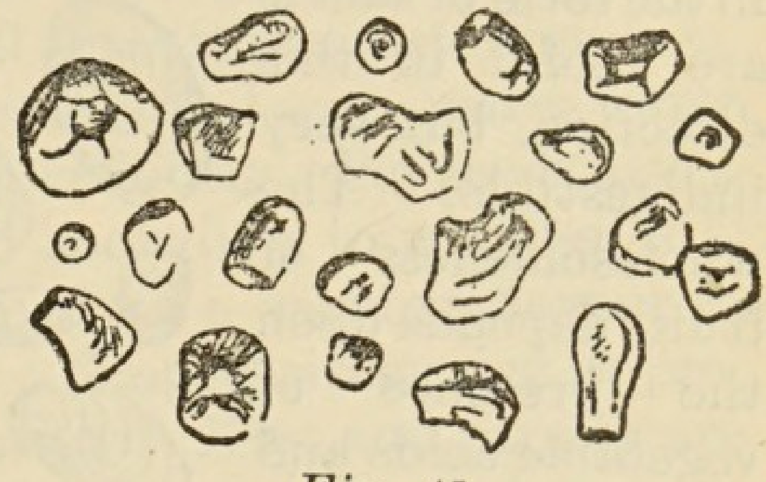


Fig. 41.
Tapioca Starch (magnified).

Potatoes are underground tubers and the most useful of vegetable foods, they consists of three-fourths water, a small quantity of nitrogenous matter and the rest principally starch. *Cane sugar*, the extract of sugar cane, is used in the form of loaf sugar, crystals, brown sugar, molasses, or treacle. Much sugar is also made from beetroot. *Grape sugar* is contained in sweet fruits and in honey, it is uncrystallizable. Green vegetables include cabbage, spinach, lettuce and many others. Vegetables, if fresh and well boiled, are most digestible, but should be rejected if stale; they contain little nitrogenous matter, and their greatest value lies in their salts, which are preventitives of scurvy and similar diseased conditions of the system. Raw vegetables in the form of salads are useful in this direction, but very indigestible. The wholesomeness of fruits depends upon the presence of vegetable acids and salts, which render them aperient, prevent scurvy and maintain a healthy condition of the tissues and fluids of the body. Fruit should not be eaten immature or over-ripe, and some fruits are rendered more digestible by cooking, but their medicinal effect is reduced.

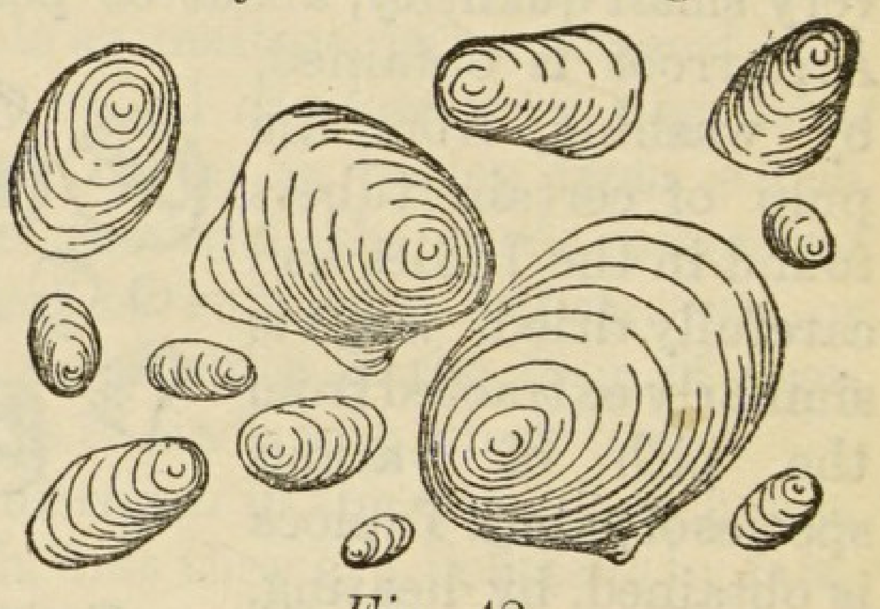


Fig. 42.
Potato Starch (magnified).

Condiments.—Some vegetable foods, such as garlic and shallot, are used as flavouring materials, and may when so used be regarded as condiments. The most common condiments are common salt, acids, such as vinegar and lemon juice, pungents, such as mustard, pepper and ginger, aromatics, such as mint, parsley and spices. Salt is not only a condiment, but a necessary accompaniment of food for daily use. Vinegar, which consists principally of acetic acid, should only be taken in moderation, it allays thirst, but in excess hinders the digestion of food by preventing its decomposition, hence its use as a preservative. Lemon and lime juice are mostly valuable for the prevention of scurvy. Mustard contains a pungent oil which promotes appetite and in small quantities assists digestion, but in large quantities when mixed with warm water it will cause irritation and vomiting. Pepper is also a stimulating digestive, and according to whether it is black, white, long, or red, gives a varying flavour to food, to which it is added. Ginger, either dry or preserved, is an excellent digestive. Mint and parsley are flavouring materials. The spices, such as cinnamon, nutmeg, clove, and carraway, have a warming agreeable flavour, and stimulate digestion.

Preparation and Cooking of Foods.

The objects of cooking food are to render it more pleasant, easily masticated and digested, to produce chemical changes which render it more easily assimilated, to make it more acceptable to the palate by flavouring and variety, and, most important of all, to sterilize it or destroy any noxious parasites or germs. Salads are not usually cooked, but the vegetables of which they are composed should be very carefully cleansed. Fruits that have shells or skins may if the digestion will allow, be eaten uncooked. Oysters and milk have been known from time to time to convey disease, and although it spoils oysters to cook them through, it is never wise to partake of milk unless boiled.

The processes of cooking employed are boiling, roasting, baking, stewing, broiling, and frying.

Boiling.—*To retain the nutritious matters*, the flesh in bulk is plunged into boiling water, and in a few minutes the external albuminous layer is coagulated. The temperature is then allowed to fall to about 160 degrees Fahrenheit, and the cooking continued. *To extract the nutritive matters*, the flesh is cut into small pieces, placed in cold water and gradually heated up ; if it is desired to extract the gelatine as for soups, it is heated to boiling point, if not, as for beef tea, it is cooked at a lower temperature, or in a water bath.

Roasting.—The same principle of coagulating the outside albumen applies to roasting, when the flesh is first placed close to an open fire, and then removed a little further away.

Baking is similar to roasting, only being in a close oven the *empyreumatic* products and volatile fatty acids do not escape.

Stewing is simmering or slowly cooking with or without a little water, the temperature being kept below boiling point.

Broiling is roasting quickly on a gridiron.

Frying is boiling in oil, instead of water, quickly and evenly.

Preservation of Food.

The processes employed are drying, freezing, salting, the addition of antiseptics, smoking, protecting by a covering from the air, sterilizing by heat, and hermetically sealing.

Drying, or Desiccation.—Various meats, fish, fruit and vegetables are dried in the sun or in a current of air to preserve them, and are much used in this form. In some countries pulverised dried meat is a preparation used.

Freezing does not kill, but inhibits, or checks the growth of, bacteria. Food in ice houses, and refrigerated foods are kept some degrees below freezing point as a rule, and when so preserved is known as *chilled* food.

Salting is an old method of preservation. The salt itself is antiseptic, but in addition the saline solution displaces the fluids in the tissues, depositing salt and hardening them.

Antiseptics are also used, principally boracic acid and salicylic acid, but their frequent use is liable to cause stomach troubles, especially the addition of boracic acid to the milk for infants.

Smoking partly dries and partly acts antiseptically.

Covering with air-proof substances as fat, oil, sugar, gelatine, creosote, etc., is capable of limited application.

Sterilizing.—The food is placed in a metal or glass vessel which is closed up leaving only a small aperture, heated to boiling point until steam escapes, and then the hole is hermetically closed by soldering or sealing. Acid tinned foods are liable to dissolve and absorb tin if kept long in tin before eating, and tinned meats will sometimes decompose and bulge the tin; these of course should be avoided. Glass vessels are safer receptacles for hermetically preserved foods than metal vessels. To prevent the action of light, coloured glass is used, and in some cases glazed earthenware.

Beverages.

These include water, mineral and aerated waters, tea, coffee, cocoa, and alcoholic drinks.

Water necessarily forms the bulk of all beverages. A man requires about three pints daily, in addition to what is taken in natural combination with solid food.

Mineral waters so called, are waters which are impregnated with carbonic acid gas, and to which salts of soda or potash, lemon juice, or common salt are added in small quantities. They are pleasant drinks, and in moderation stimulate digestion, but if taken constantly or in excess, produce an opposite result. Tea, coffee, and cocoa are well-known beverages prepared from tea leaves, coffee beans, and cocoa nibs or their extracts. Tea contains the most tannin, which is a powerful astringent, and strong tea is a common cause of indigestion. Indian teas contain more tannin than Chinese teas, and should therefore be more quickly infused to avoid excess of tannin. Slight tea-dyspepsia is readily cured by ceasing to drink tea, and taking a little bi-carbonate of soda for a few days, and may be avoided by drinking tea weak, and not at unusual times. There are in use several forms of teapots and special teaspoons and cages for making weak tea, the principle of these is to remove the tea from boiling water as soon as it is seen to be infused, the period of infusion should not exceed eight minutes for Chinese tea and half that time for Indian or Ceylon tea, and the tea leaves should on no account be used a second time. Alcoholic beverages include beers, wines, and spirits. The very light ales are almost non-intoxicating, and as a rule wholesome, the lighter wines are to be preferred to the heavy kinds such as port and sherry, which may contain perhaps as much as one-fourth alcohol. Spirits consist of about half alcohol, and should be regarded medicinally rather than as ordinary beverages.

Experiment has shown that the limit of noninjurious consumption of alcohol is about $1\frac{1}{4}$ to $1\frac{1}{2}$ ounces a day. This represents according to strength, from two pints to one pint of beer, from half to a quarter of a pint of wine, and from an eighth to a sixteenth of a pint of spirit, reckoning twenty ounces to the pint. The amount of liquid can of course be easily increased by the addition of water, etc.

Excess of alcohol produces hardening of the stomach, liver, heart and blood vessels, leads to degenerative changes, which bring on gout and premature old age. Great excess may produce acute disease, delirium tremens, and paralysis. Children and young adults do not require alcohol, and it is possible for most persons to do without it altogether; in no case should it be taken between meals. Active workers suffer less than the sedentary from its use. A small proportion of alcohol, however, increases the flow of blood to the stomach and liver, and assists the process of digestion when it requires stimulating. The effect of alcohol is to enlarge the vessels of the skin and to stimulate the heart, so that a larger amount of blood passes through the blood vessels to the surface, and the temperature of the body is lowered. The popular idea that alcohol warms, is therefore false; the sensation is warming, but the true effect is cooling. By its stimulating effect alcohol produces temporarily a greater power of exertion at a given moment, but as it draws upon the reserve strength of the body, its ultimate effect is exhaustion and loss of energy. This has been proved by giving to some bodies of workmen and soldiers alcohol as a beverage, and to others tea or water, and observing the effects.

Diseases due to Food.

Food may be the cause of disease, (1) in quantity, by deficiency or excess, (2) in quality, by defect of composition or by decomposition, and, (3) in purity, by the presence of disease germs.

Deficiency of food causes wasting, distressing thirst, and failure of strength, followed by death from starvation. Excess causes indigestion, diarrhœa, derangement of liver and kidneys, gout, and Bright's disease.

As to quality, starches can be omitted for a long time if fats be taken, but fat cannot be omitted. If both be omitted, ill effects follow in a few days. Nitrogenous food stuff can be omitted for a considerable number of days, the result being reduction of vigour, at first slight but afterwards progressive. The absence of the vegetable acids and salts causes scurvy. Decomposing food, especially meat, causes diarrhœa and various forms of poisoning.

Impure water in the preparation of food and the cleansing of raw vegetables, may be the means of conveying water-borne diseases, especially the intestinal parasites, such as worms, also typhoid fever, diarrhœa and cholera.

Milk may convey the water-borne diseases and also scarlet fever and diphtheria. Hand-fed infants are often, especially in the summer-time, attacked by diarrhœa, due to insufficient care in preventing contamination and fermentation of the milk. The milk, whether artificial, human, or cow's, should be as fresh and pure as possible. The vessel used to suckle from should be simple in construction, the old fashioned boat-shaped feeder being excellent and readily cleansed. The next best form is a bottle with a nipple at one end, and a stopper at the other The importance of cleansing is due to the fact that milk is an excellent cultivating medium in which decomposing germs flourish and multiply rapidly. Every time a feeding bottle is used, it should be scalded out, the nipple and stopper being thoroughly cleansed, and, if the milk be only partly consumed by the infant, the rest should be at once thrown away. The large mortality amongst infants is largely due to improper feeding, and to the contamination or want of freshness of the milk, which of all foods is most liable to rapid changes.

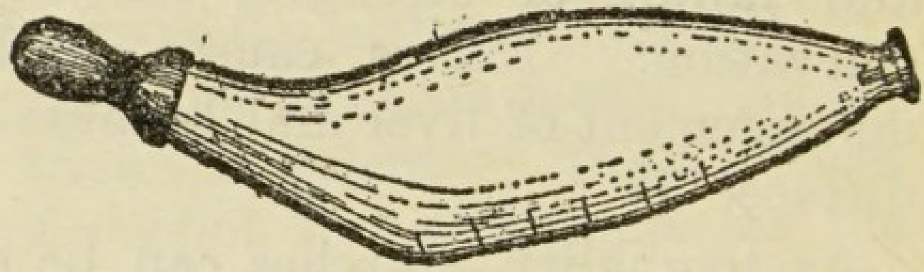


Fig. 43.
Child's feeding bottle.

Foods unfit for human consumption are those that are either decomposed or diseased. Measly pork, in which are seen little bladders the size of millet seeds,

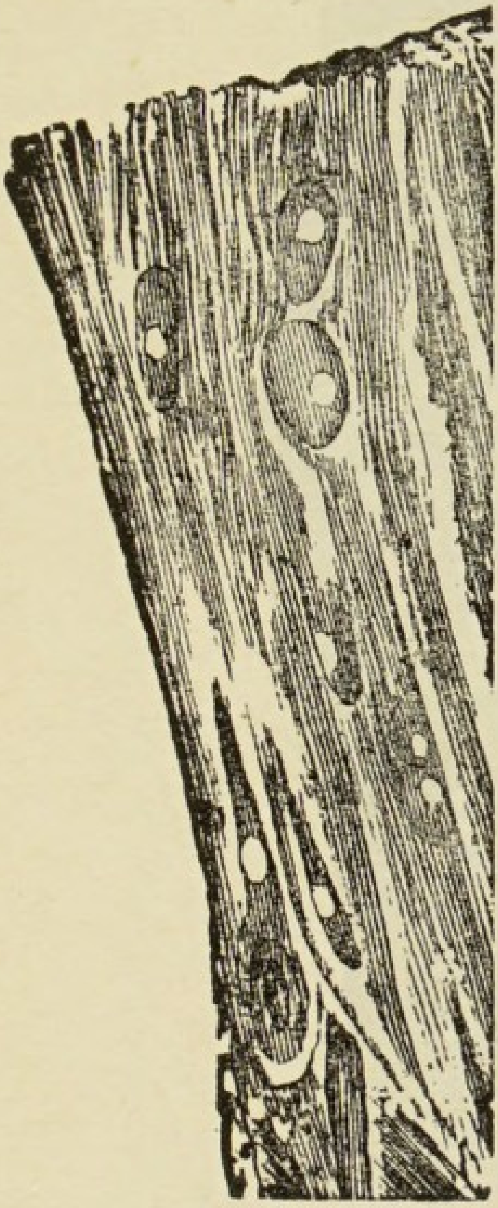


Fig. 44.
Measly Pork.

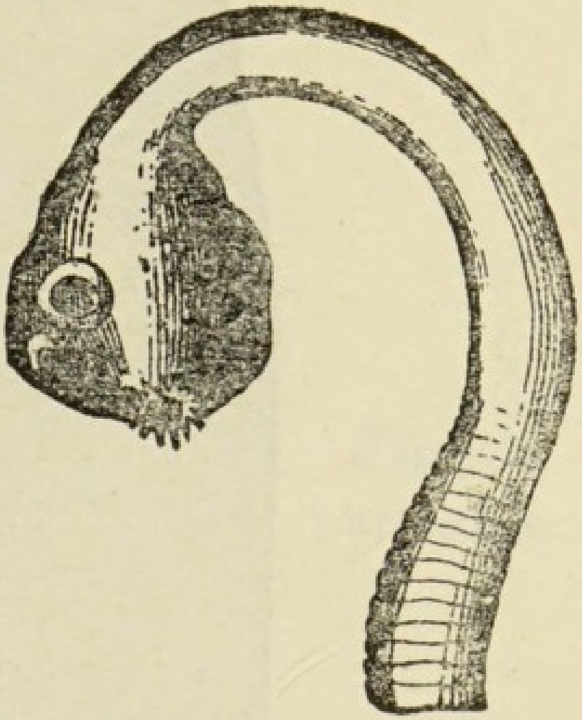


Fig. 45.
Head of tape-worm.

gives rise to tape worms, if eaten by man. Trichinæ, seen as microscopic dots in pork, when consumed cause trichinosis in man. The grape, or pearl-like bodies found in some animals suffering from tuberculosis, or consumption, are indicative of the danger of consuming this flesh as meat.

Fig. 46.
Trichinæ (highly magnified).

Adulteration of food is resorted to mainly to increase the profit from its sale, and adulterated food is food to which something has been added or from which something has been abstracted. The most common forms of adulteration are the addition of water to or the

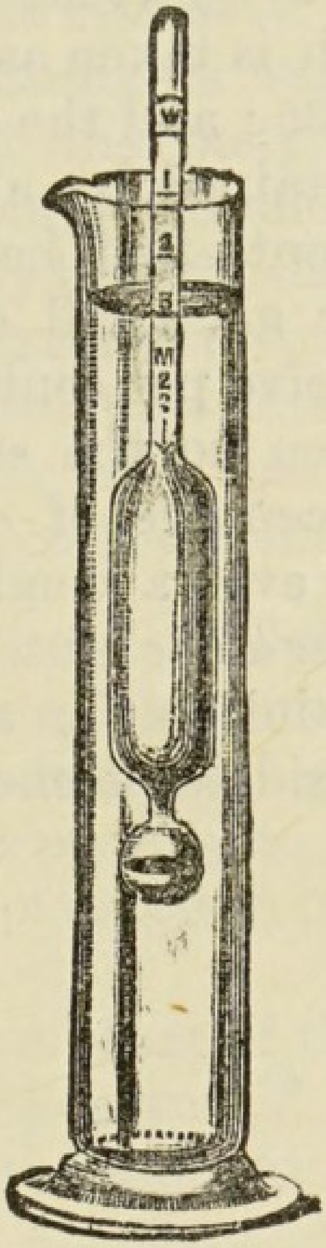


Fig. 47.
Lactometer.

abstraction of cream from milk, and the addition of water, foreign fats, and sometimes an excess of salt, to butter.

The adulteration of milk is often a serious matter for the infant and the invalid dependent for nourishment upon this food. The simple addition of water may be ascertained by the lactometer, which should show the specific gravity (that is, the density compared to water, which is taken as a standard at 1000), to be from 1026 to 1035 ; and the simple abstraction of cream may be ascertained by allowing some of the milk to stand for twenty-four hours in a tall narrow glass (the lactometer glass will answer the purpose), when from six to twelve per cent. of the milk should appear as cream risen to the surface. The specific gravity and the percentage of cream must both be ascertained to obtain even a rough idea of the quality of milk, the lactometer *alone* is useless for this purpose. But the methods of adulteration are very complicated now, and require considerable chemical knowledge.

CHAPTER VIII.

Clothing.

Air is an immediate necessity, drink ranks next, and food next, but clothing is least pressing although requisite to protect the body. In some countries, although shelter from winds and the direct rays of the sun, or from rain, may be requisite, clothing is dispensed with, or nearly so, except for purposes of adornment. Fashions unfortunately are sometimes in conflict with hygiene, the artistic and becoming appearance of clothes being more studied than their sanitary value.

Objects of Clothing.

Clothing is worn (1) to protect the body against weather, that is to say against cold, wet and heat, (2) against injury, especially to the head and feet, and (3) for the purposes of decency, propriety and ornament or decoration.

The average temperature of the surface of the body in health is about 98½ degrees F. It varies but slightly, and depends upon the amount of heat produced and lost.

The production of heat is maintained by food, while its loss depends upon the exercise taken and the clothing worn. Eight or nine-tenths of the heat is lost through the skin by radiation and evaporation, the nervous system largely regulating this. Some animals develop thick fur to prevent loss, while man resorts to clothing for the same object. As part of the food consumed is utilized in producing heat, if the loss be diminished by clothing a smaller quantity of food is sufficient, so that ill-fed persons require extra warm clothing. The means by which heat is lost from the skin is (*a*) by conduction when in contact with a cooler material, (*b*) by radiation into space, and (*c*) by evaporation of sensible and insensible perspiration.

A thick garment is warmer than a thin one, not because of any inherent virtue in thickness or thinness, but because a greater amount of air is retainable in the interstices of a thick garment provided the structure of the material allows of it. Air being a very bad conductor of heat, there is consequently a less loss of temperature if the air surrounding a naked body can be encased or rendered motionless, as it then becomes a heat retaining envelope. But because it cannot be so retained without clothing, the temperature of a naked man becomes sensibly lowered by abstraction in moving air below 80 degrees F. that is 18½ degrees below the temperature of the body's surface. For a similar reason a double is warmer than a single layer of clothing, and a tight fitting garment warmer than a loose.

In the same way as air in the interstices of the clothing protects the body against cold, so, being a bad conductor, it protects it against heat, provided that the perspiration and evaporation have free play. The reason why rubber or mackintosh garments are so oppressive in summer is because they prevent the evaporation from the surface, and they are usually too thin to protect against cold, although they will partly ward off a cutting wind. Clothing of light colour, which is a good reflector but a bad absorbent of heat, protects best against the direct rays of the sun, and the converse holds true of dark colours generally speaking.

Rain has to be kept out, and sensible perspiration absorbed by clothing ; in any case the evaporation of rain or of perspiration should be slow, otherwise it is liable to produce a chilling effect by abstraction of heat. It is difficult to imagine a material that should absorb perspiration easily, and rain slowly, but woollen material is the nearest approach to it. Being full of air it is a bad conductor, preventing loss of heat, being porous it absorbs a considerable amount of moisture, being thick evaporation is slow, and the natural greasiness of the wool, tends to throw off falling rain.

Age and Sex.—These materially influence the kind of clothing needed, the aged requiring to be well clad in wool, with special protection of the extremities on account of their enfeebled circulation. An infant requires to be specially protected from cold, by clothing, because it loses heat quickly by evaporation, its surface being large in proportion to its bulk, as is the case with everything small; for example, a cube whose sides are one inch square, has a surface of six square inches and contains one cubic inch (fig. 48*a*), while a cube whose sides are two inches square, has a surface of twenty-four square inches and contains eight cubic inches (fig. 48*b*); the proportion of surface to bulk in the former is six to one, and in the latter only three to one.

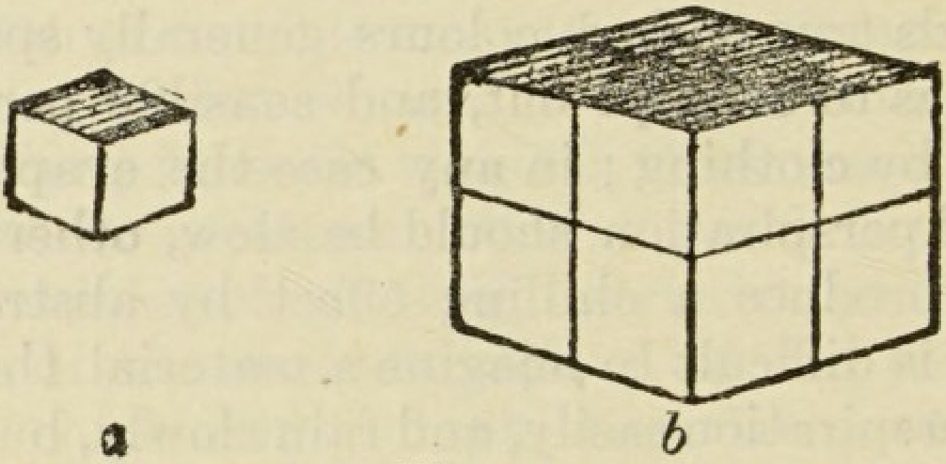


Fig. 48.

Diagram of surface and bulk.

Young children and weakly persons should wear wool next to the skin all the year round, merely varying the thickness to suit the season. It shows a poverty of resource to bare the upper and lower parts of the bodies of children in order to give them greater freedom of movement, which can be accomplished without partly depriving a child of clothing. Deprivation of clothing has a distinctly injurious tendency in a child, the temperature has to be maintained at its uniform height, in addition the child has to build up its growing tissues, and furthermore, the tissues being more active, more potential activity is required. It is true that food can be consumed by the child to maintain all three, but clothing will materially assist food in producing its results. The better maintenance of temperature in children conduces to better growth and development to which cold is inimical.

Materials of Clothing.

Clothing materials are of vegetable or animal origin.

Vegetable Substances.—The principal are linen and cotton, but hemp and jute are also used, as are some other vegetable matters.

Linen is made from the fibre of flax. Microscopically the fibres are cylindrical, with little swellings at intervals where the elementary fibres can be seen as well as at the ends of broken threads. As a material, it is smooth, soft, light and durable; it absorbs water little less than cotton, but much less than wool, and is a better conductor of heat than cotton, and much more than wool. It is principally used for underclothing, it possesses no hygienic qualities higher than those of cotton, its cost is greater but it is durable, and its coolness and power to take a gloss make it an article of luxury.

Cotton is made from the hairy covering of cotton seeds. Microscopically its fibres are flat, ribbon-like, and twisted. The fibre is hard, and does not shrink in washing. It is durable and cheap, and conducts heat less rapidly than linen, but more so than wool. It absorbs moisture better than linen, but not so much as wool, therefore as a clothing material it ranks between

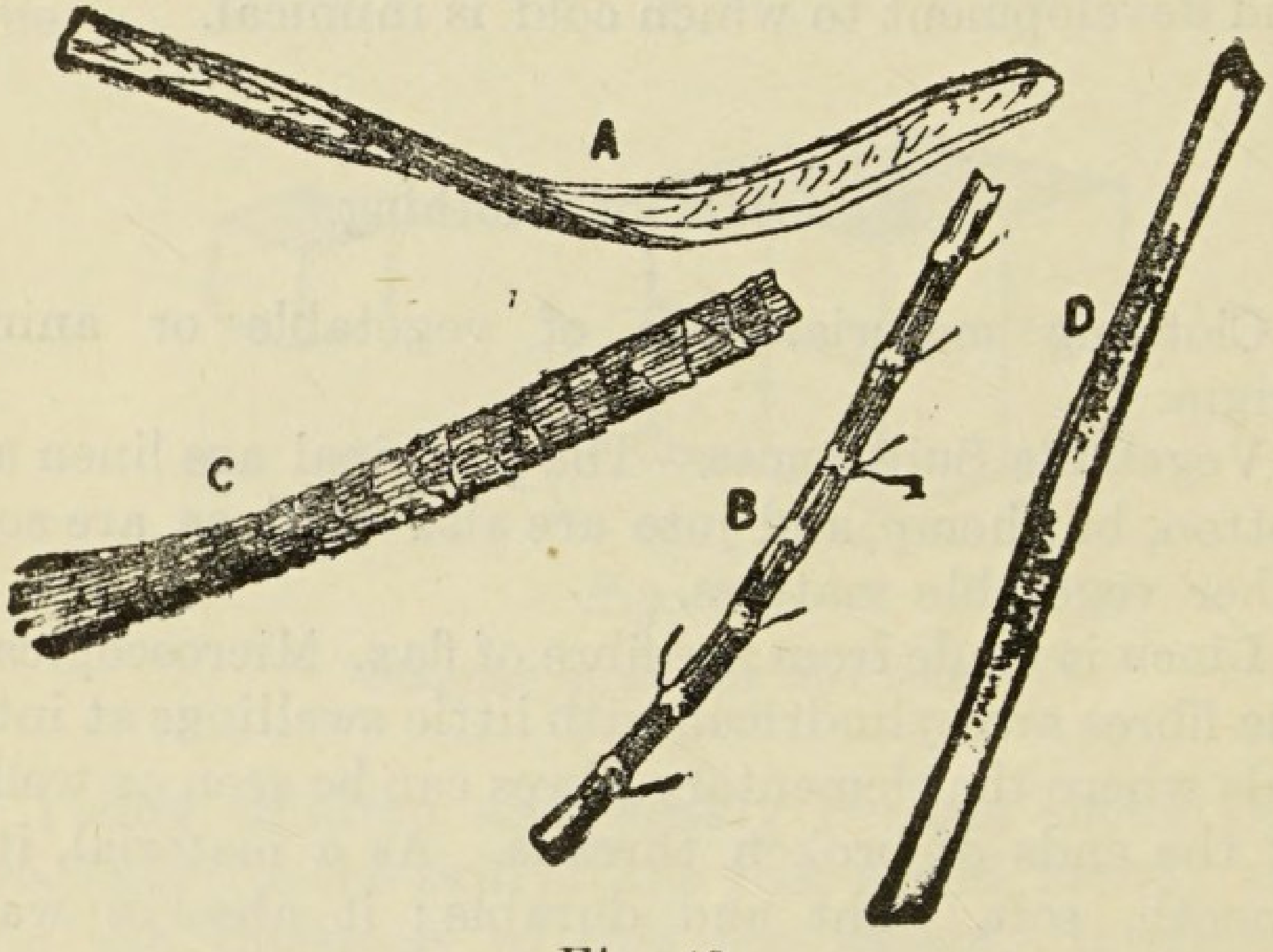


Fig. 49.
Various fibres (magnified.)
A, Cotton; B, Linen; C, Wool; D, Silk.

wool and linen. Calico and cotton shirting are made from it, as may also be stockings. Merino (so called) fabrics are made of cotton and wool. Cellular clothing is made of cotton, with honeycomb-like cells for the purpose of increasing its power of absorption and reducing its conducting power.

Animal Substances.—The principal animal substances are wool, silk, leather, furs and feathers.

Wool is the hair of various kinds of sheep, and being wavy and serrated, becomes easy to weave or to felt into continuous material. Microscopically woollen fibres are hairs presenting a series of flat overlapping scales giving a toothed, or serrated, appearance to the outline; this toothed appearance is much less obvious in human and horse hair. Through the fibre runs a central canal into which the colouring matter is absorbed when wool is "fast dyed." It is pre-eminent as an article of clothing, being a bad conductor of heat and a good absorbent of water; a bad conductor because it fixes air within its interstices; a good absorbent because it absorbs moisture into its fibres and retains water between them. During exercise evaporation from the surface of the body increases in order to give off the excess of heat produced by it, but when the exercise ceases the evaporation of the exuded perspiration still continues, and is likely to produce a chill, that is, to lower the temperature too much, and to depress the vitality, already temporarily exhausted by exercise. Woollen clothing condenses this vapour after exercise and gives out again to the body the heat, or latent heat as it is called, given off by the condensation, and therefore tends to keep the temperature of the surface of the body from falling. Tnis is why dry woollen clothing feels warm during sweating, and the best remedy for cold clammy feet is a pair of clean woollen socks. Wool unfortunately suffers from the disadvantage that it shrinks in washing, and repeated washing removes the natural grease, renders it hard, and destroys its absorbent and non-conducting character. Some wools are much finer and softer than others, and a quality can generally be found to suit most skins. Shoddy is old wool re-made into clothing material.

Silk microscopically resembles linen in its fibres, but it is much finer and more transparent, has fewer knots, is less fibrillated and has distinct borders. It ranks as an article of clothing between cotton and wool, it is very light and absorbent, but is expensive.

Leather consists of the skins of animals, tanned to preserve and render them pliant. The skins of all domestic animals are used for making leather. Chamois leather is the skin of the smaller ovines, preserved and treated with oil to render it soft and elastic. Leather, as clothing, is principally used for foot and leg coverings, but for rough purposes it may also be adopted for other garments. It protects well against cold. especially piercing winds.

Fur is used in cold climates, and when extremely cold the skin is often worn outside, acting like leather, the thick hair inside acting like wool. The hairs of the fur of rabbits and other small rodents when worked together, mat and interlock, and it is from them that felt is manufactured.

Feathers, particularly down, make warm light clothing, especially for beds.

Garments.

Garments for the Body.—In a temperate climate outer garments and under-clothing are usually worn. The garments next to the skin should in all seasons and all climates be made of wool, which may be thicker or thinner, softer or coarser, to suit each particular case, the only safe substitute being silk. No garment should be allowed to contract any part of the body, especially the chest. In cold climates, the chest, and in hot, the abdomen, requires most protection, and for these parts, the shield or belt worn should be broad, and cover the whole.

In women's clothing the weight should be suspended principally from the shoulders and partly from the hips, but not from the waist. Soft woollen material or silk, should be worn next to the skin, and the stockings should also be of wool, and be supported by suspenders, not garters. The second layer of clothes should consist of a bodice and knickerbockers, or similar garments of light or heavy material according to the season. The skirt should be short enough to avoid sweeping the path or wiping the heels. If a belt or corsets be worn, they should be neither too resistant nor too tight to allow a full and free action of the chest and abdomen. The greater participation of women in healthy athletic exercises is doing more to abolish tight lacing, rigid

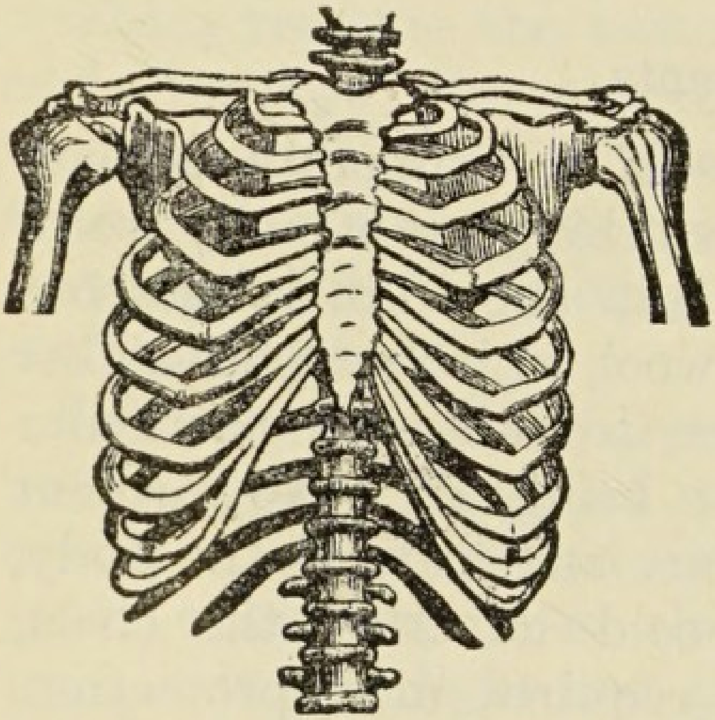


Fig. 50
Bones of thorax.
(Natural shape.)

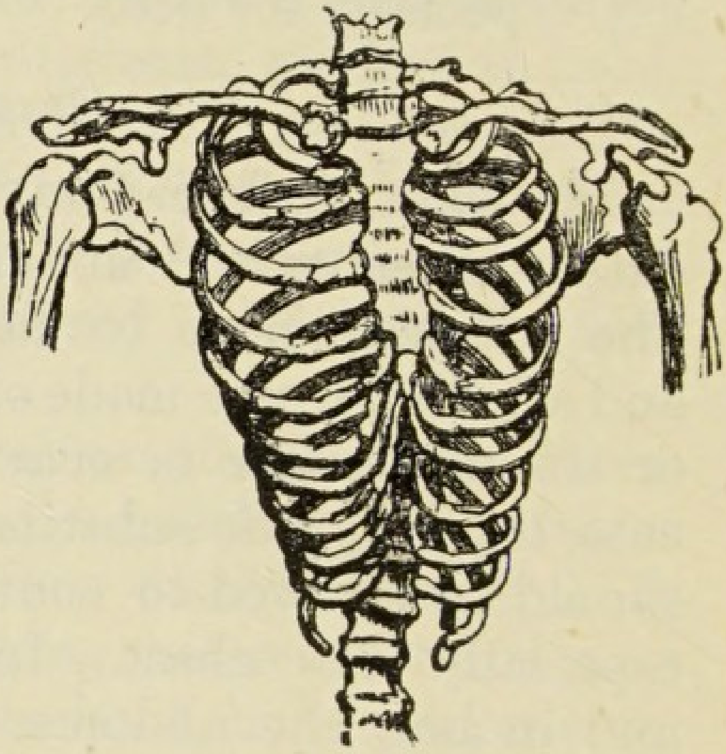


Fig. 51.
Bones of thorax.
(Distorted by tight lacing.)

corsets and high heels, than all the admonition and preaching of years.

Headgear is worn for protection against the direct rays of the sun, wet, cold, and falling objects, and may be made in all shapes and forms to suit these purposes. The warmer the season or climate, the better ventilated the headgear should be. Women with a greater abundance of hair, and really requiring less headgear, generally wear more, and that of a more elaborate character, for the sake of ornament. In any case, the head covering of males and females should not constrict the head, nor be oppressive or cumbersome.

Foot Coverings.—Socks or stockings are best made of wool, or wool and cotton mixed, although cotton only is often used. It is possible, and preferred by some, to wear no covering at all upon the feet, particularly in the house, and it must be admitted that the Western habit of walking into dwelling-rooms in boots soiled with the filth of the streets is a disgusting and unhealthy one. From the old Eastern custom of stripping and washing the feet after a foot journey, and even from the present custom of putting on slippers on entering a house we have much to learn, but, firstly we must be persuaded to enter in less feverish haste. The object of wearing boots and shoes of leather is to protect the feet from injury and wet, and the boots and shoes should be made to fit the feet and not the feet be moulded to them according to the current idea of manufacturers of ready-made articles. A boot should not be too small or it will contract the foot and impede walking, if too large it may cause bunions. The heel should be broad and low, and the widest part of the boot be at the base of the toes; the inner side of the heel and the side of the great toe should be almost in a straight line. A pointed toe is unnatural and injurious, although it is not necessary for the toe to be absolutely square, yet it should follow the natural outline of the toes of the feet. The best remedy for wet feet is a change of boots and

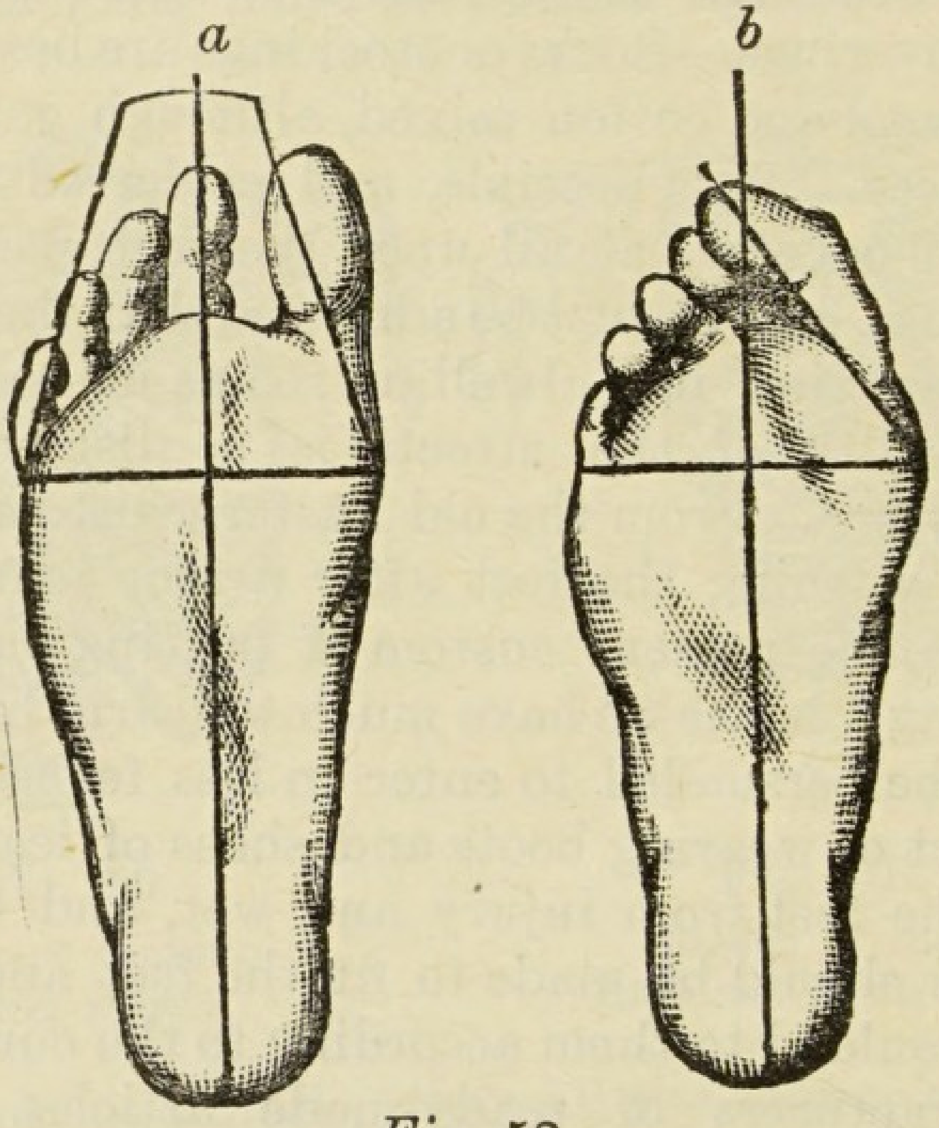


Fig. 52.

Diagram of Foot.

a, Natural shape of foot; b, Foot distorted by ill-shaped boot. The lines show the angles of pressure produced by foot coverings.

stockings, and for cold feet is a pair of clean woollen socks.

Bed-clothing should be distinct from day clothing;

cotton or linen may be worn next the skin, provided there is in the bed-clothes sufficient warmth, which may be obtained by blankets and feather, or down, coverings. Woollen and hair mattresses are healthier than feather beds.

Sophistication.—From the description of wool, silk, linen, and cotton some idea may be obtained as to the appearance of clothing materials. Microscopical examination with a hand lens will reveal the proportions in which each exists in any given material. Clothing materials are however so various and subjected to so many processes, and combined in such diverse manners, that it is not possible, without entering at great length into the subject, to indicate more than the main principles already described.

CHAPTER IX.

The Dwelling.

In considering the dwelling, the points to be passed in review are numerous. They may be enumerated as, situation, including soil, site and aspect; construction, both external and internal; air supply, including ventilation, warming and lighting; water supply, embracing both that for dietetic and for flushing purposes; drainage, including the removal of rainfall and liquid refuse; solid refuse disposal; and decoration and furniture.

Situation.—For the purposes of aspect and obtaining the largest amount of sunlight it is best in the case of a detached house that the angles should point in the direction of the four points of the compass, so that the main-fronts face south-east and north-west. Thus disposed, in the height of summer, when the sun is longest above the horizon, all four sides of the house will consecutively receive sunshine, the south-east and the south-west naturally getting the most, and on these sides of the house it is best that the living rooms occupied during the day-time should be situated. Those places that require least light, such as the larder, and rooms occupied during the night, may be situated on the other sides. A terrace-house should preferably face east and west as it only possesses two sides exposable to sunlight, the other sides, those on the north and south being covered by the adjoining houses. With reference to situation, airiness is a point to be considered ; a hollow is not conducive to airiness, nor is an excavation in a hill-side ; trees and buildings also, when closely surrounding houses cause stagnation of air and should be avoided. With

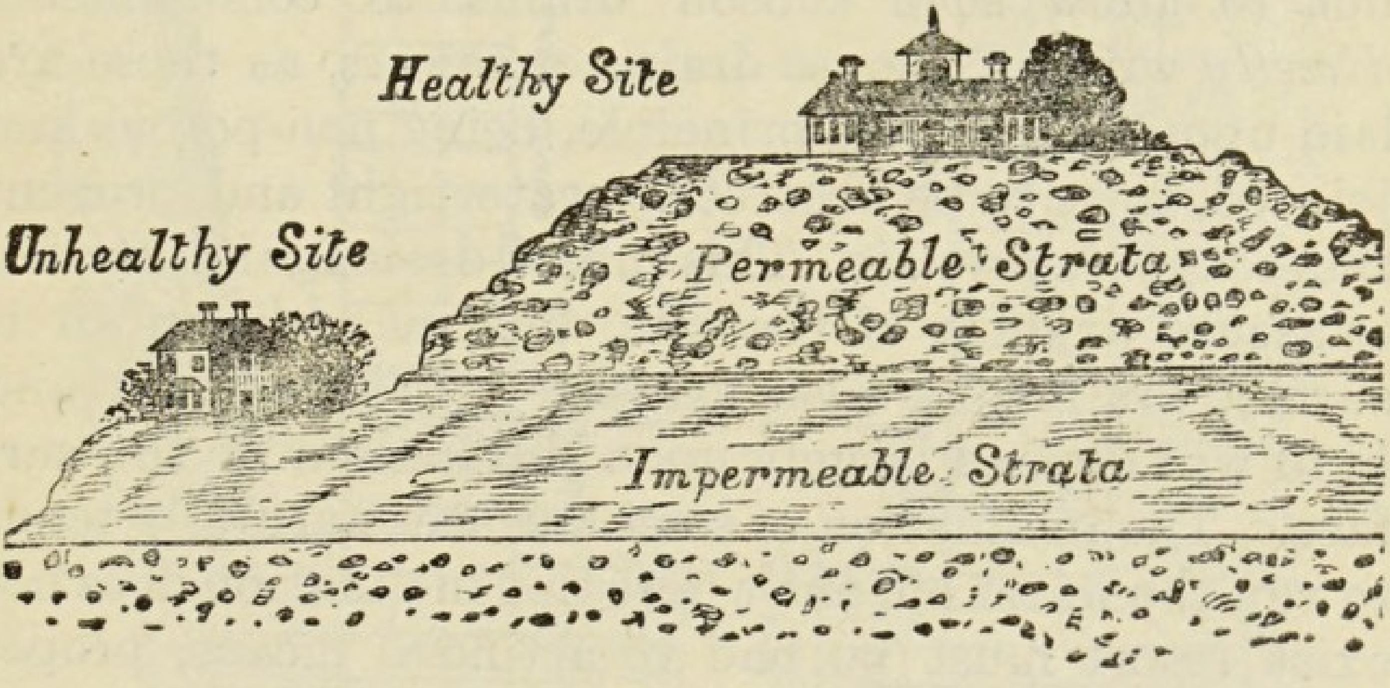


Fig. 53.
Healthy and unhealthy sites.

reference to soil, it has already been mentioned that soils porous to a considerable depth are the healthiest, and it must be added that made soils as a rule are unhealthy, and particularly when they consist of depressions filled up with refuse or polluted matter—such soils should not be built upon or should be first cleared. As already stated ground air vapour should be excluded from a dwelling-house, and the ground water, that is, the water in the soil, should be lowered as much as possible. On sites where this water is near the surface subsoil drainage becomes necessary. Subsoil drainage is carried out by laying pipes which are porous and unjointed so that the water from the soil may gain admission into them and flow away from beneath the building, but great care should be taken not to allow such subsoil drains to communicate *directly* with any house-drains or sewers, as these are laid upon an opposite principle, being non-porous and jointed, so as to be absolutely watertight and prevent the escape of sewer air. This subsoil drainage is intended to secure dryness of the site, but in addition to it surface drainage is also necessary. The amount and kind will depend largely upon the contour of the surface. The inclination of some surfaces naturally tends to run the water off, but where this inclination does not exist resort must be had to artificial means, proper gullies and pipes being laid. The banks of rivers or lakes, so often chosen as sites for dwelling-houses are often unhealthy and difficult to render dry. Such sites are rarely, if ever, bracing, and are nearly always humid, but if the soil be gravelly the subsoil water beneath the surface tends to be always in motion and not stagnant, and to run towards its natural outlet so that, provided the base of the building be raised well above the ground-level, few ill effects are produced except those of the proximity of water.

Construction.

In the construction of dwelling houses, provision must first be made for the exclusion of dampness, vapour,

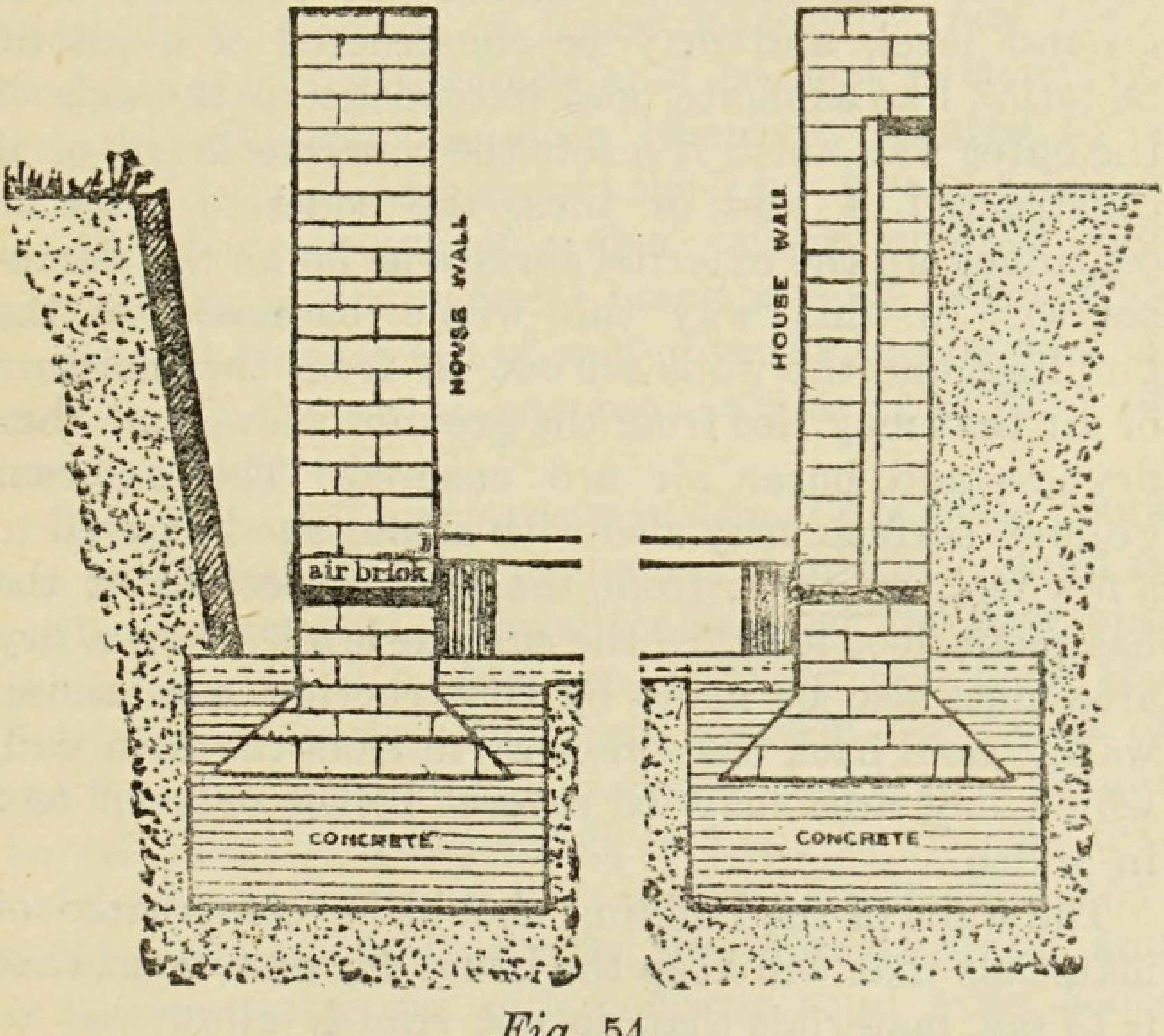


Fig. 54.

Damp-proof courses in walls (shown by black lines).

and air from the ground below, and for this purpose the surface must be sealed. This is accomplished by laying over the entire surface of the basement a solid layer of impervious material, usually concrete. The ascent of dampness in the walls from the soil below is checked by the insertion of an impervious, or damp-proof, course in the brickwork. This is inserted in the outer wall some six inches above the external ground level, and may be constructed of a plastic material, like asphalte, and extend down the side of the outer wall, until it meets the concrete layer, or if constructed of lead or tiles, the concrete may be continued up the external surface as far as the damp-course. In this way the whole basement of the building, and the walls are cut off from the moisture or air that may rise from the ground below, and thus dryness and purer air are ensured. The external ground surface may also with advantage be paved to a few feet, or more, from the wall, especially if the basement floor is below the surface level, when a dry area must also be made by constructing a retaining wall to hold back the soil or earth from the main wall, which dry area may be several inches or even feet in width.

The walls of the building should be constructed of materials that will keep the house dry and warm, that is to say, materials that do not readily allow wet to permeate them, and that are bad conductors of heat. As walls inside are usually covered with cement and painted, or sized and papered, they are rendered almost impervious to air, and the stagnant air in the pores of brick-work so treated internally is an excellent non-conductor of cold and heat.

The roof must, above all things, exclude rain and snow and is usually constructed of tiles, slate, lead or zinc, and made bent in order that the water may run off readily. Neither of these materials, nor their methods of laying, exclude cold or heat sufficiently, but this exclusion is more efficiently secured by a lining of felt or wood, and in the top rooms of a house by the construction of a flat ceiling of lath and plaster, the latter material being almost impervious to air. The same kind of ceiling is the means also of cutting off the air of one room above from that of another room below.

Over these ceilings, except in the top rooms, floors are constructed for the purpose of deadening sound as well as for support. The space between the floor and the ceiling below it often becomes very foul from the detritus and matters that fall between the joints of the floor boards, and it is desirable that floors, should be well laid and well jointed, in order to exclude this detritus, which may in time render a house unhealthy. Solid floors are undoubtedly the most sanitary, and in basements paved with concrete solid wood floors are often laid. Such floors when laid should be bedded in pitch, or else they may suffer from what is known as dry rot, a rot produced by a fungous growth due to want of ventilation beneath the floor. If a hollow floor be laid in the basement, the space beneath should be ventilated for the same reason ; this is usually accomplished by inserting air bricks in the outer wall of the house just above the damp-course. The hollowness of the walls, floors and ceilings, provided damp be kept out, are advantageous, because if the air in the hollow space or pores be still it will act as the best of non-conductors and keep the rooms warm.

Air Supply.

The staircases and passages should be ventilated independently of the rooms, and the air from sewers, dust-bins and sanitary conveniences should be cut off from communication with them. Such places as water-closets and housemaids' closets should be situated against an outer wall and be cut off from the house by a ventilation lobby.

The ventilation, warming and lighting of rooms has already been considered in the chapter upon air.

Water Supply.

We have also considered this in the chapter headed "water." The only point that need be emphasized here is in reference to the supply of water in country houses. This is usually obtained from two sources, the rainfall, and the well. With reference to rainfall the first part of a shower falling on to the roofs washes them clean and carries the washings into the rain tank ; some of the detritus settles, some floats and can be removed from time to time, but some remains suspended or dissolved in the water, and is objectionable. The first dirty washings of a rain shower can be excluded from the storage tank by using a contrivance well known by the name of Robert's Rain-water Separator. This is attached to the rainfall pipe ; the first portion of the flow is directed by the outlet-pipe away from the tank, but after a little while a small compartment at the side of the apparatus gradually fills, and when filled cants over and directs the rainfall into the tank. The other means of supply, the well, has to be very carefully watched. If it be a deep well and steyned twenty feet down but little difficulty will probably arise, but if it be shallow there is danger. In proximity to a country house wherever a well is the source of water supply, cesspools should never be allowed. This can be avoided by using earth or ash-closets, cleared daily and used for digging into

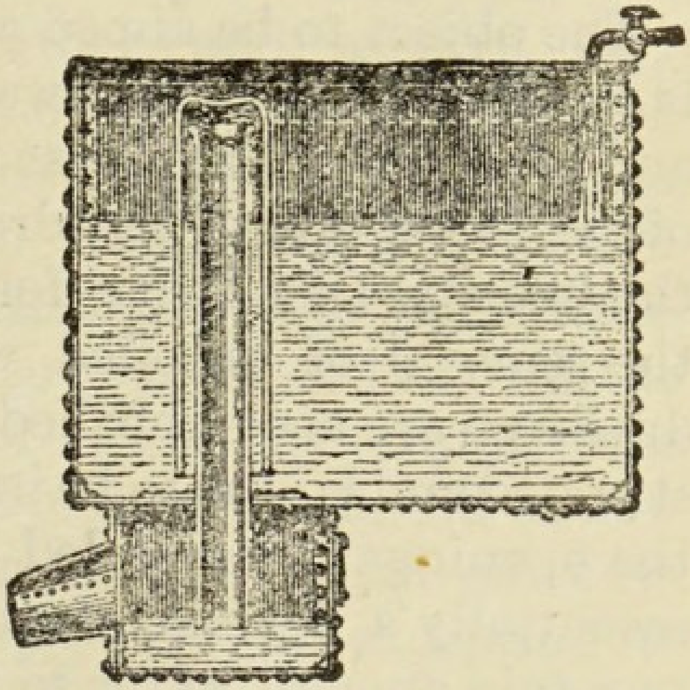


Fig. 55.
Automatic flushing tank.

or bedding the garden, and by irrigating the slop waters from kitchen and scullery over part of the garden, or just below the surface by what is known as sub-irrigation. Such irrigation is generally carried out through the intervention of a large sized automatic flushing tank in which the slops and waste waters accumulate until the top of the syphon in the tank is reached, thus the syphon is put in action and the contents flow out rapidly. This periodical or intermittent irrigation disposes of the slop water virtually without any nuisance. The great advantage of the dry earth system combined with slop water irrigation is the protection it affords to the well water.

Drainage.

The object to be aimed at in the drainage of a house is to completely carry away all water, liquid refuse, and excreta, and at the same time to prevent the air of the sewer and of the drain from gaining access to the house. Dismissing for the present the question of the removal of unsoiled water, the other objects of drainage are accomplished by means of pipes so constructed and laid as to be impervious and self-cleansing, the openings being sealed by water-traps. A trap is essentially a U bend, of sufficient curvature in a pipe to retain enough water to prevent air and gases from flowing up, but permitting a free flow of water down, and so shaped and of such a calibre as to be self-cleansing, and not to syphon out in discharging. It is an essential part of an effective water trap that the pipe or pipes discharging into or upon it must be partly or wholly disconnected from continuity, and be open directly or indirectly to the air. Hence the inlets into all the pipes connected directly with the drain should be water-trapped, and the pipes discharging on to the traps should be aerially disconnected.

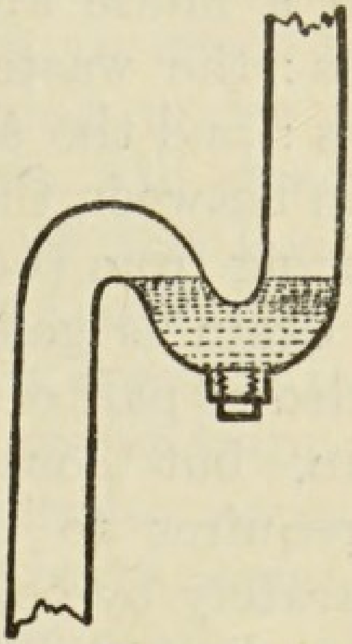


Fig. 56.
S trap.
For the inlet end of waste-pipes.

Although a water-trap when charged may arrest the direct flow of gases upwards the contained water may absorb gases in contact with it on one side of the trap and give them off on the other, and a trap may become unsealed either by the water partly syphoning out, or drying up, or by other accidents. Hence waste and other pipes discharging on to water-traps should also be protected against the ascent of gases by water-traps placed at or near the liquid in-flow and open at the liquid out-flow. The soil-pipe is an exception to this rule, because it conveys solid matters and is utilised for ventilation, and thus practically becomes part of the house-drain.

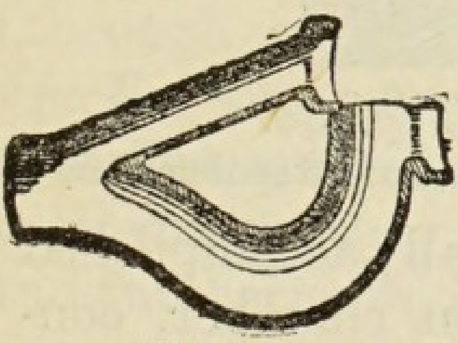


Fig. 57.
Disconnecting trap with cleansing arm.

The various pipes to be considered in connection with a house are, the cistern overflow and rainfall pipes: the waste pipes from baths, lavatories, and sinks: and the soil-pipe, house-drain and portion of drain between the house-drain and the sewer. Commencing from the sewer, the last mentioned portion of the drain is generally regarded as part of the house-drain, but constructively it requires to be treated separately by being water-trapped at the house end to exclude sewer air, the continuity of the house-drain discharging into it being broken by being open directly or indirectly to the air, the sewage flowing in a pipe, the upper half of which is removed so as to form an open channel. This is usually accomplished in what is known as a disconnection chamber, constructed of sufficient size to be also available as an inspection and access chamber, and from which, by means of an arm, ordinarily closed by a cap, a clearing rod can be pushed down towards the sewer if necessary. This chamber is open to the air either by a grating, or better, by a pipe terminating a few feet

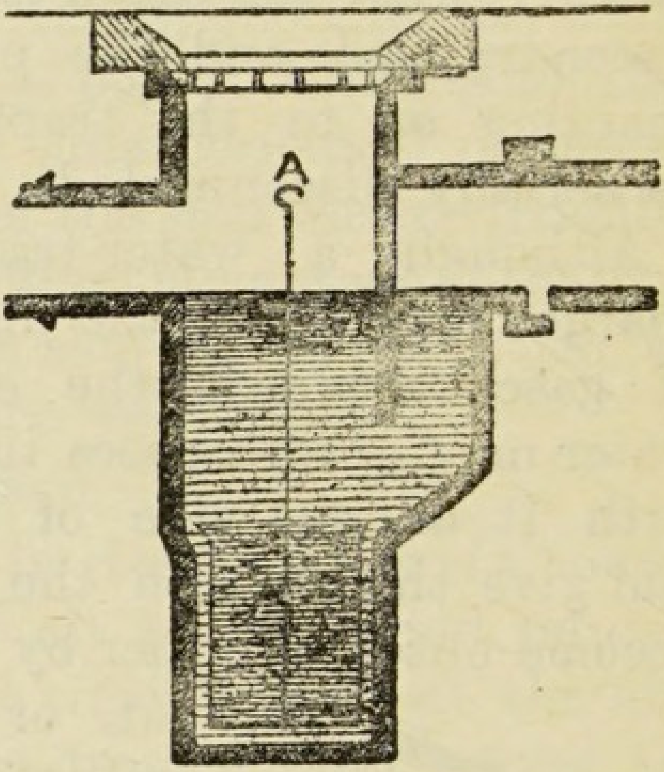


Fig. 58.
Gulley with trap and sediment tray

above ground level, and is the commencement of the house-drain proper to which it acts as an air inlet.

The house-drain must be impervious to gases and water, and especially secure if running under the house. It must be self-cleansing ; this will depend upon the straightness and evenness of the laying, the smoothness of the surface, the calibre, the gradient, and the flow of water. Every opening into the house-drain must be efficiently water-trapped, and situated in the open air or otherwise aerially disconnected from the house. It must be thoroughly ventilated ; this is effected by maintaining the continuity of the soil-pipe with the drain, carrying this pipe full bore to a point above the level of the roof, the higher open end acting as an air outlet, whilst the lower open end of the house-drain situated in the disconnection chamber acts as an air inlet, and a through current is thus obtained. Into this soil-pipe the water-closets discharge, and as they are in unbroken connection with both the soil-pipe and the house-drain, they must be securely water-trapped. And furthermore, in order to be consistent with the principle that trapped openings in direct communication with the drain must be either situated in the open air or aerially disconnected from the house, the water-closets should either be situated out of doors, or else cut off from the air of the house by cross ventilation. A water-closet basin should be treated as an opening into the drain, not as a sink, lavatory-basin, or bath, each of which is disconnected from the drain. The situation of a closet against an

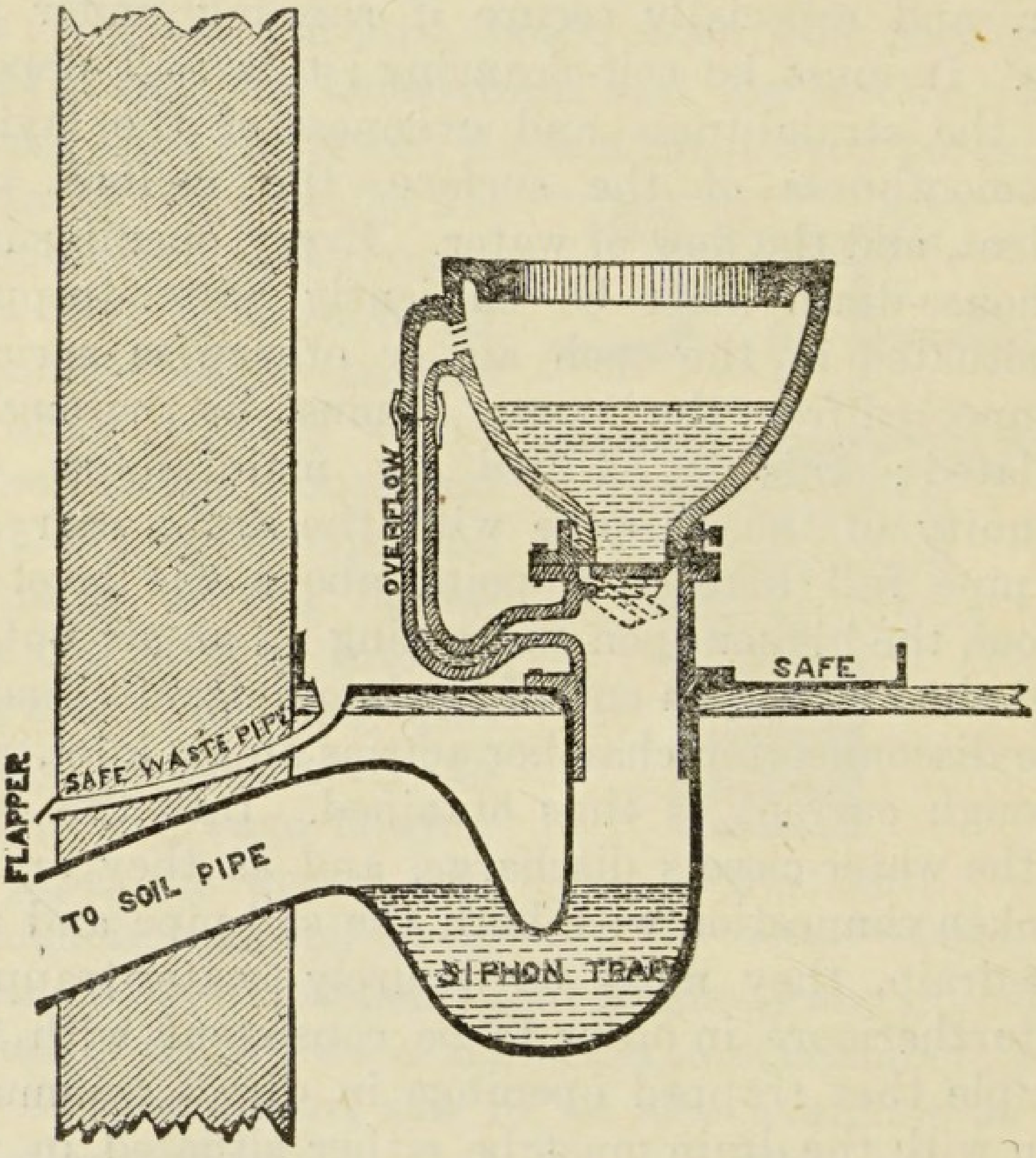


Fig. 59.

Valve closet.

outer wall, and furnished with a window, supplemented or not by an air grating, will not prevent drain air from being drawn into the house from a defective trap or pipe : and it is not easy to securely joint an earthenware basin to a leaden trap or an earthenware trap to a leaden pipe. Hence, between the closet-chamber and the house there should be some means of supplying air and of thus relieving the in-suction that must otherwise take place through the closet-chamber. This is especially requisite in a self-contained flat, which is really one large room divided into compartments.

Water-closets are of two main types, those that possess mechanical parts, and those that empty themselves automatically. Of the mechanical type the modern representative is the valve-closet, an improvement on the old pan-closet by the substitution of a water-tight valve for the pan, a valve-box for the container, and some form of self-cleansing trap that does not syphon out, for the D trap. Of the automatic type there are two kinds, the wash-out and the wash-down. The wash-out is a derivative from a mechanical type of water-closet, known as the plug-closet, in which the valve is

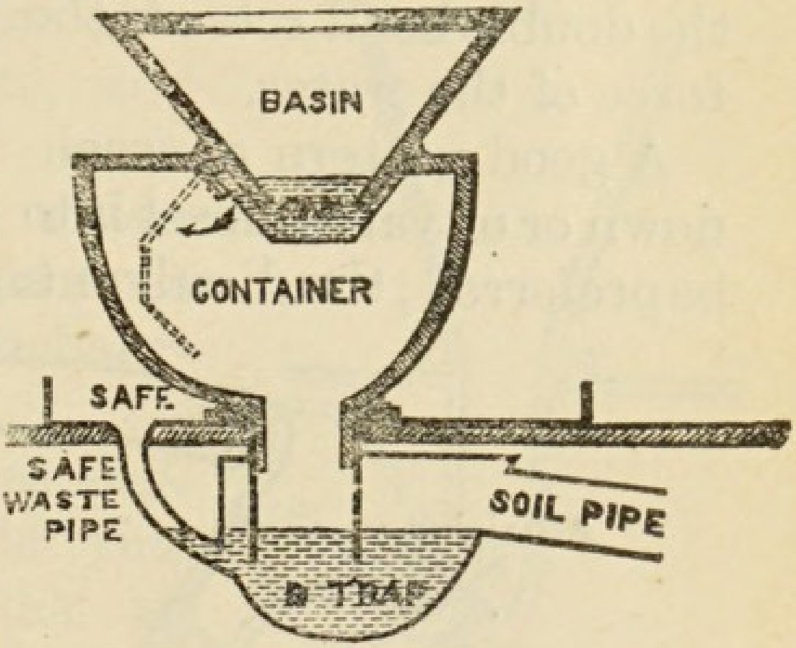


Fig. 60.
Pan closet (obsolete).

placed at the side; by the abolition of the mechanical valve and a slight alteration in the shape of the basin, this becomes a wash-out. The wash-down is an improvement of the old form of long-hopper.

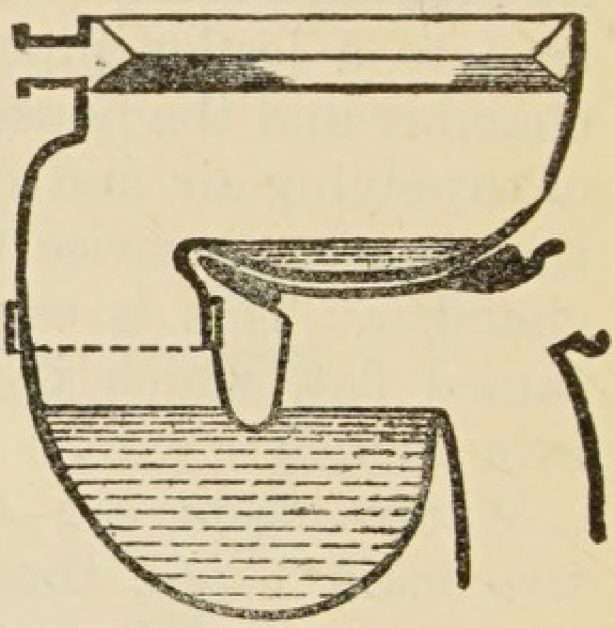
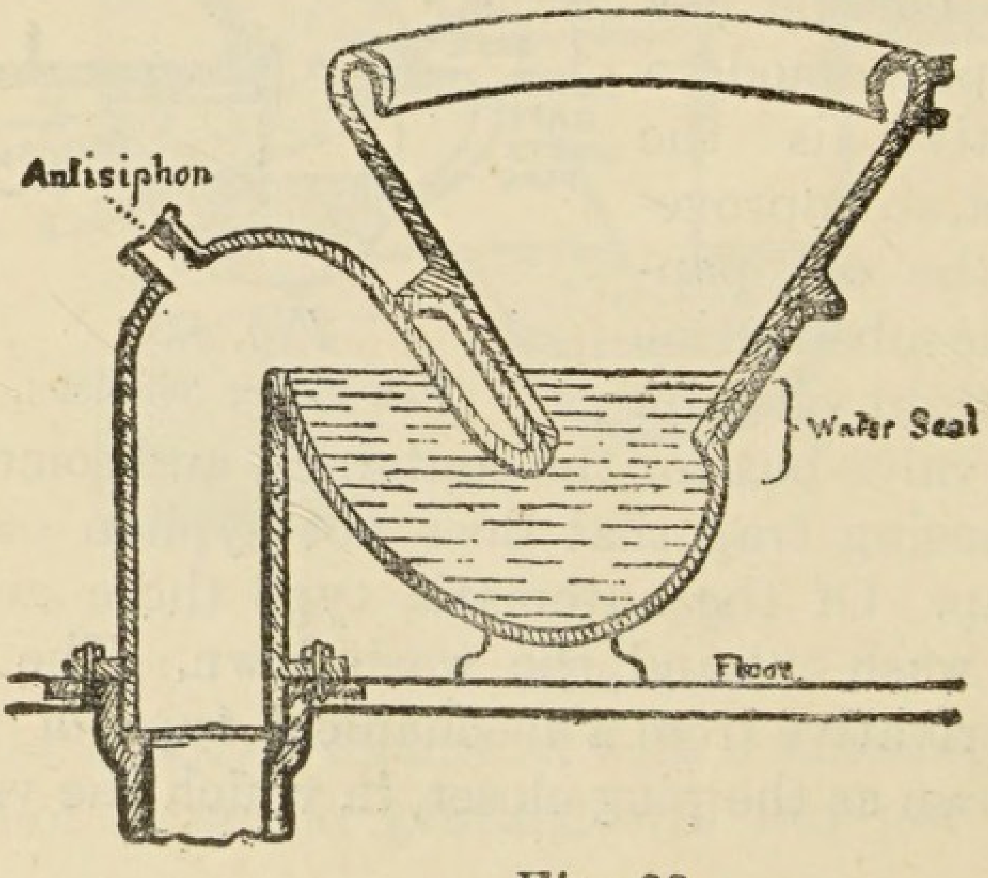


Fig. 61.
Wash-out closet.

Wash-out basins unless they possess an additional under-wash, are not so readily flushed as wash-down and valve-closets, as the double bend retards the force of the water.

A good pattern of wash-down or of valve-closet is to be preferred; the disadvantage of the former is noisiness,



Wash-down closet.

Fig. 62.

and of the latter the additional expense of the mechanical parts, which are liable to get out of order. The choice of pattern therefore, is a matter of refinement, and the wash-down answers all the requirements of health, provided that the basin is so shaped as to hold sufficient water, and not to become soiled, is self-cleansing, and possesses a flushing rim for the purpose of distributing the flow of water over its entire surface. The simplest method of providing for a leakage, or an accidental stoppage of a closet-trap, or bath-waste, and consequent over-flow, is by a metal tray or safe, or an impervious flooring below, sloped so as to drain through a pipe discharging into the open air.

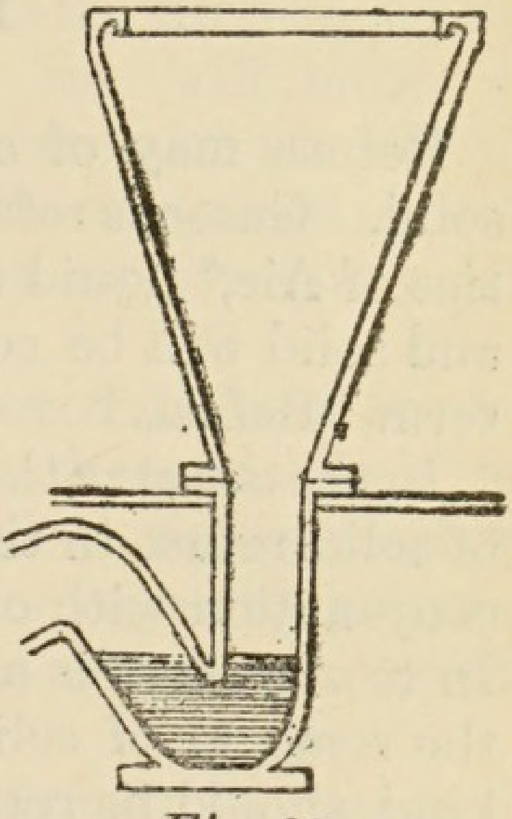


Fig. 63.
Long hopper.
(obsolete).

Whereas all surface pipes supplying pure water should run inside the house in order to protect them from frost, all drainage pipes should run outside, in order to reduce to a minimum any risk that might be incurred by defects.

Waste-pipes from sinks, lavatory basins, and baths should be trapped at or near the inflow within the house, and be open at the outflow outside, discharging over or near, a water-trapped inlet into the drain. They are thus doubly protected.

As to pipes carrying unsoiled water, rain-water pipes require no traps, but simply to be open at the head and at the foot, both openings being outside the building. Cistern overflow pipes should simply discharge into the open air and be cut off short a few inches outside the wall, remote from all gaseous emanations.

Refuse Disposal.

Refuse may of course be either gaseous, liquid or solid. Gaseous refuse has been treated under "Impurities of Air," liquid under the heading of "Drainage," and solid will be considered here under the common term "Refuse."

In the country there is no great difficulty in disposing of solid refuse in the garden, or on the soil, either in conjunction with or apart from earth and ash closets. In towns there is a considerably greater difficulty in the removal of solid refuse. All refuse of whatever kind, should be retained as short a time as possible in the neighbourhood of dwelling houses. It is for this reason that in large towns the *water carriage system* of excreta removal, by which the excreta are at once carried away with the slop and waste waters in drains and sewers, to a distance, is to be preferred to mixing them with the solid refuse, a system known as the *conservancy* or *dry* system, by which they are retained for a shorter or longer period on the dwelling premises, on account of the slowness and cumbersomeness of road carriage, compared with water carriage.

As the dust, ashes, sweepings, waste food, and other waste materials have to accumulate for a certain time on dwelling premises, they should be stored, not in large brick or wooden dustbins of the fixed kind, but in metal bins, preferably galvanized iron, which should not be larger than can be conveniently carried, when full. In an ordinary house this size will mean a capacity that will hold the accumulation of a week or less, certainly not more, as this is the recognised period beyond which decomposing refuse cannot safely be permitted to remain.

In some towns the refuse is removed twice a week, and in others daily. Burning on a domestic scale is the method that should be resorted to for rendering innocuous waste food of an animal or vegetable nature, otherwise such substances may become a great nuisance, especially in hot weather.

In large cities where the quantities to be disposed of are great, and nuisances may arise from sorting the refuse, utilising its constituent parts, or disposing of it upon the land, furnaces are erected to burn it. This process reduces its bulk to about one third and produces a very hard material, useful for making up roads, or for building purposes, or which may be ground and made into mortar or concrete.

Decoration and Furniture.

This subject more properly belongs to domestic economy, but a few points may be mentioned as of hygienic importance.

Rough flock papers are apt to catch the dust, and for the covering of walls smooth papers or paint are preferable. Varnished papers that can be washed, though perhaps inartistic for dwelling rooms, may be used with advantage in other parts of the house. For cleanliness sake old papers should not be allowed to remain on walls over which it is intended to hang new. The size used for pasting should be fresh and pure, and in the patterns of papers arsenical colours should be avoided. Drapery harbours the dust and should only be used in moderation for the purposes of decoration. Carpets necessarily have dirt and dust trodden into them. They should therefore be so laid that they can easily be taken up and beaten, and the floor washed. A bed-room should not be over-loaded with furniture. Beds should always stand out well from the wall, so that air can freely circulate around them. They should never be pushed into alcoves, nor be enclosed by drapery. In addition to periodical cleansing and dusting, the surface of the furniture should be cleaned daily. Organic matter in living rooms tends to adhere very intimately to the surface of objects, and hence not only are daily dusting and rubbing as well as hourly ventilation necessary, but also airing, and this of a kind that would be better known as perflation. That is to say that the wind should be allowed to blow through a living room in a thorough manner by opening the doors and windows for at least an hour once a day. One hour's perflation is more purifying than ordinary ventilation for the remaining twenty-three hours of the day.

CHAPTER X.

Prevention of Infectious Diseases.

The ultimate and most complete object of hygiene is the cultivation of health to the most vigorous condition compatible with the fullest exercise of the mental and bodily faculties. When the most active training of the body and mind is not brought into play for producing this effect the observance of the ordinary rules conducive to health succeed in maintaining an average health. When only preventive measures are practised they act in preventing actual ill-health, sickness or disease, so far as they are preventible, and especially those diseases known as communicable.

Parasites and Germs.

Communicable diseases include all those caused by parasites, which may be classified as external and internal, animal and vegetable.

External Animal Parasites are those of which the more common are mosquitos, midges, flies, bugs, lice, pimple mites and itch mites. (See figures 21 to 24).

Internal Animal Parasites are those of which the more common infest the internal passages of the body. There are various free parasites in the bowels causing diarrhœa and dysentery ; the fixed parasites such as the tape-worm, round-worm and whip-worms produce the symptoms of worm diseases or helminthiasis; in the tissues are found liver-flukes, and bladder-worms or hydatids, also trichinæ, the muscle-worms causing a disease resembling rheumatism and known as trichinosis; and, in the blood, moving organisms producing certain diseases of tropical climates. (See also figures 44, 45, and 46.)

Fig. 64.
Round worm.
(1-third natural length).

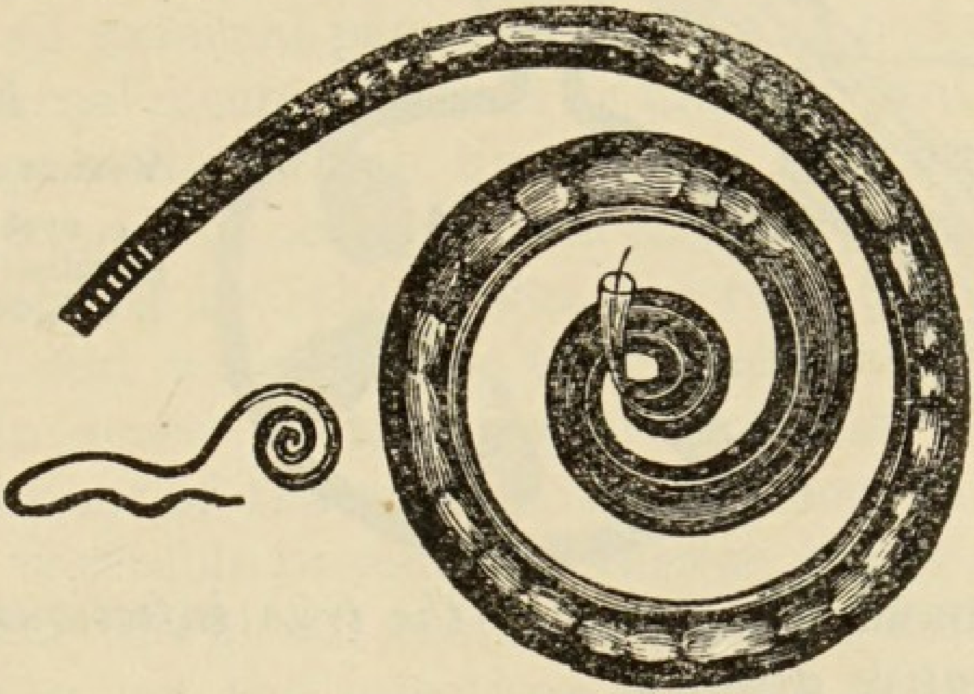


Fig. 65.
Thread worm.
(Natural size and magnified.)

External Vegetable Parasites, are those of which the most common are the fungi of ring-worm, favus, and warts, producing skin diseases. (See figures 25 and 26).

Internal Vegetable Parasites are those of which the more common that infest the passages of the body are the several forms of yeast found in the stomach, the fungus of thrush, and the fungi of some of the less common diseases; and in the blood and the tissues

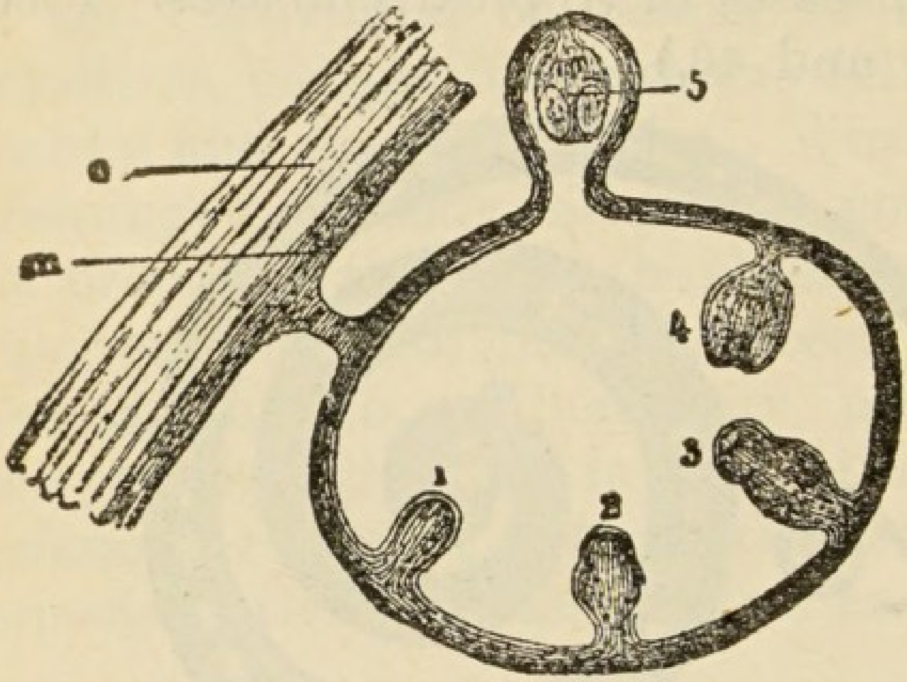


Fig. 66.
Vesicle of hydatid cyst.
c, cyst membrane; m, germinal membrane; 1, 2, 3, 4, 5, developing tœnia.

are found *the germs of the true infectious zymotic or fermentive diseases.*

The Infectious Diseases and their Modes of Attack, and Manners of Spreading.

Sometimes communicable diseases are sub-divided as contagious and infectious, the former spreading by contagion, and the latter by infection, but, as contagion and infection are more or less synonymous terms, some confusion has in consequence arisen. The original idea was that some diseases were spread by contact, and others without direct contact, but as many are spread by both means it is extremely difficult to differentiate them thus, although in legal and popular parlance all the external parasitic diseases, and some internal ones that spread only by inoculation, are still called contagious.

The divers modes in which diseases make their attack or are spread, are better understood in detail. But, generalising, all external parasites reach the body by obviously external means of direct or indirect contact. All internal parasites which live in the alimentary canal, are, as are also those internal animal parasites that make their way into the tissues, as a rule, taken in with the food and water; those that reach the blood may also gain access in this manner, or they may enter by abrasions of the surface, or by inoculation. The internal vegetable parasites, however, that reach the tissues and the blood, gain admission in various ways, that is to say the infectious diseases to which they give rise are not all acquired, nor do they all spread, in the same manner.

Infectious Diseases may be spread and taken into the body by means of (1) air, (2) water or food, (3) inoculation or abrasion of the surface.

Class 3 embraces those usually received through a wound or inoculation as gangrene, erysipelas, puerperal fever and blood poisonings generally. By the same means also are spread cow-pox, hydrophobia, glanders, splenic fever, tetanus, or lock-jaw, and other diseases of animals, and sometimes small-pox, tuberculosis or consumption, and leprosy.

Those usually spread by food or water, that is ingested, are ague, malaria, dysentery, diarrhœa, English and Asiatic cholera, typhoid fever, and sometimes also (by milk), scarlet fever and diphtheria.

Those diseases usually spread by the air, that is to say inhaled, are specially prone to spread from person to person, being the most infectious, and include typhus, relapsing, pneumonic, and scarlet fevers (and sometimes typhoid), chicken-pox, measles, German measles, influenza, whooping cough, membraneous croup, diphtheria, small pox, erysipelas, Asiatic and English cholera, diarrhœa and dysentery, and almost always malarial fevers and ague ; these last two are not directly communicable from one person to another.

Mode of Resistance of the Body.—It is well known that one attack of some of the infectious diseases will for years in some cases, for months only in others, protect the person against a subsequent attack, will in fact produce what is known medically as "immunity" against the particular disease for a longer or shorter time. This immunity has been regarded as being brought about by several means, several observers having put forward different theories. In order to make a difficult subject as far as practicable understood, the most probable of these theories, more or less confirmed by recent experiments, may be shortly described.

In the blood, in addition to the red and the white corpuscles already mentioned, there are certain large white corpuscles known as *leucocytes.* Whenever a wound is made or a part is irritated or inflamed, whether the irritation be caused by mechanical or chemical means, or by germs, the leucocytes increase in number. They are capable of movement, of throwing out processes, and of absorbing and digesting microscopic particles, much in the same way as that elementary form of animal life known as the amœba, found in pond water, and recognised as one of the simplest minute particles of living protoplasm. These leucocytes, in addition to having the power of enveloping and digesting minute particles, have also the power of secreting, or causing the tissues in their neighbourhood to secrete, substances that either kill or render harmless living microscopic organisms foreign to the body.

When the infected germs, having gained admission to the body, attack the tissues, the irritation caused by their presence or by their secretions, calls forth an army of defending leucocytes that devour by envelopment and digestion some of the germs, and by their secretion paralyse others. The secretion produced by the leucocytes and tissues also acts as an antidote to the poisonous secretion of the germs, and hence those remedies which are produced for injection into the tissues, as in diphtheria and other diseases, for the purposes of curing them, are known as anti-toxins. As the victory in the battle between germs and their poisons, and leucocytes and their antidotes will be to the strong, it explains how important it is to maintain the health of the body so that when attacked it may produce strong and healthy leucocytes for the fight. As a general outline this explains a principle but it must not be supposed that health is an infallible defence against infection; it may be that the white corpuscles, the tissues, the blood, or the system generally, even in the most healthy family or individual, lack some peculiar characteristic necessary for defence, and hence we have the differences that families and individuals possess in "susceptibility," or likelihood to attack from disease. There are one or two particular diseases which the maintenance of perfect health will not ward off. Typhoid fever generally attacks robust young adults, and the large majority of persons, and probably all children even in the best of health, lack the particular characteristic that might render them insusceptible to small-pox, and this is why in the absence of natural immunity, an artificial form, vaccination, is resorted to to ward off this loathsome and fatal disease.

Dangerous Infectious Diseases. — The dangerous infectious diseases that are scheduled in the Infectious Disease Notification Act of 1889, and must be notified to the Medical Officer of Health of the district in which they occur, are small-pox, scarlatina, or scarlet fever, diphtheria, membraneous croup, typhus fever, typhoid, or enteric, fever, continued fever, relapsing fever, puerperal fever, erysipelas, and cholera, and in some places also measles, whooping cough, and infantile diarrhœa are added.

Small-pox is a most infectious fever, the germs of which are probably conveyed in the scabs to a greater distance in the air than those of any other disease. It is spread by personal contact, by the clothing, and by the air, probably in all stages of the disease, but mostly so during the scabbing stage. An attack of the disease is preceded for two or three days by shivering, perhaps vomiting, by persistent pain in the back, and a rising temperature, until, about the fourteenth day after infection, the rash appears like shots under the skin, especially on the forehead and face near the margin of the hair. These shots become pocks containing fluid during the following week, then the fluid matter gradually turns yellow and the scabs form during the next week, when the dangerous secondary fever due to the inflammation and the poisonous putrifying fluid matter sets in. The scabs begin to fall off about the fourteenth day from the beginning of the disease or one month from infection. This is the course of the disease in an unvaccinated person. In a vaccinated person it is modified in varying degrees, and more resembles cow pox, sometimes only presenting one or two vesicles or pocks.

Cow-pox is only rarely acquired naturally by man, and then occurs in the milker who has handled a cow affected with the disease. It is produced artificially by vaccination, and was introduced for this purpose by Jenner, who found that milkers that had acquired the disease from the cow never took small-pox. It has been shown that the value of vaccination depends upon its thoroughness, at least four separate marks being necessary to most efficiently protect. It is very unwise to be vaccinated with less than four marks, as it produces false confidence, and brings a valuable life saving operation into disrepute. The vaccination marks, until they are healed should be kept clean and free from friction, a simple piece of clean linen renewed every day or two being, combined with care, sufficient for the purpose. The slight operation consists merely in scratching spots on the surface of the skin, over which the lymph is spread, and entails no more risk, and perhaps less, than an ordinary scratch, provided the subject be in a good state of health. About the age of twelve a child should be re-vaccinated, and in time of threatening epidemic it is wise for all those who value their health and lives to adopt the same precaution.

To explain what cow-pox is, and why it protects against small-pox, it should be stated that it actually is small-pox that has passed through the cow, and that the effect of this passage has been to rob it of its power of infection through the air, and to render it so mild that it hardly, if at all, appears to disturb the health. Yet it introduces into the system a lymph, which calls forth the power of the leucocytes and the tissues to resist the attack of the germs of the more virulent form of the disease, small-pox.

That it really is small-pox derived from man is shown by a number of facts; now that the prevalence of small-pox is so much lessened by vaccination, cow-pox in the cow is extremely rare, while formerly the disease was much more common in cows, being mainly found on their teats and udders, which became infected by the scabby hands of a convalescent milker, but bulls did not get the disease. In the last few years experimenters, some of whom in former years were doubtful, have succeeded in a number of instances in actually inoculating calves with human small-pox and producing cow-pox, and the lymph so produced has been successfully used for vaccination. In further confirmation of the fact that this disease can be so modified, Pasteur has made it true of many diseases, so that when they are transferred from man to animals, or from one animal to another, they may be modified in various directions, and above all be rendered less virulent.

Scarlet Fever or Scarlatina, the former the English, the latter the Latin term for the same disease, is also highly infectious. The infection is spread by the exhalations and especially by the peeling from the skin, and may be carried by clothes and other objects with which it comes into contact. The disease generally commences about two or three days after infection, and the symptoms are shivering, fever, sometimes vomiting, a scarlet rash and a sore throat more or less severe. The fever and the rash subside during the following three or four days, and in a mild case the patient would appear quite well again, but should be seriously cautioned against this deceptive condition, as exposure to chill may induce kidney disease. From the tenth to the fourteenth day peeling may be expected to commence, although it may be delayed to the third week and sometimes later, and last from one to three or four weeks, during the whole of which time the patient is still infectious.

Diphtheria and Membraneous Croup, may be regarded as the same disease. It is communicated by the infected secretions or the membranes that form principally in the mouth and nose. The secretions may be passed out with the breath, or in the act of kissing, or on drinking utensils, or on clothing or bedding, or even through coughing may be projected into a room, and the dried material may cling to the floor and furniture, remaining infectious for a great length of time. It is extremely important, therefore, to collect these secretions and to burn the rags used for wiping the mouth and nose. The disease sets in very rapidly after infection, and membranes may be formed within a day or two. It is especially apt to attack those suffering from sore throat, and when it extends into the air passages may necessitate an operation to prevent suffocation. The patient's strength is rapidly exhausted and a fatal fainting is likely to set in. With recovery kidney disease may develop, or paralysis, local or general, may take place. In all cases where diphtheria is suspected it is wise to have the secretion submitted to examination, as it is possible, within twenty-four hours, to find the specific germ, if present.

Typhus Fever is highly infectious through the exhalations, but thanks to the diminution of gross overcrowding, to fresh air and cleanliness, it has become comparatively rare in most of our towns although it is occasionally introduced into our sea-ports. It is only infectious to a very short distance, so that plenty of space and fresh air being allowed, it only spreads to those in close contact. From the fourth day to the beginning of the second week a rash appears as dusky red spots; at the end of the second week the disease rapidly abates and by the end of the third week convalescence is usually established.

Typhoid, or Enteric Fever is infectious in a somewhat modified sense as applied to the four diseases we have already mentioned which spread most readily through the air, and infect the room and surroundings. But typhoid fever, if strict personal cleanliness be observed, is far less likely to so spread, the infection leaving the body, principally, if not solely, in the stools and urine. Hence, it is extremely important to treat the excreta with some powerful disinfectant, such as carbolic acid or corrosive sublimate, before disposing of them. It can be readily understood how typhoid, cholera, and diarrhœa of various types, being diseases that principally affect the bowels, are spread by the excreta coming into contact with water or milk, the hands, or soiled linen. The disease takes two or three weeks to declare itself, and then in a typical case, commences insidiously with a continuous wavering fever, stools like pea-soup, and a stupid or unconscious condition of mind. It is often an extremely difficult disease to recognise in its early stages. In the course of the disease in addition to the danger of excessive rise of temperature, there is a great danger of the bowels being perforated by ulceration, and no solid food or unnecessary movement should on any account be allowed until convalescence sets in, which may be in from five to ten weeks. There is a form of fever known as *continued fever*, which may either be a very mild attack of typhus, of typhoid or of simple fever. It should be treated as suspicious until a definite opinion is reached.

Relapsing Fever, sometimes also known as famine fever, is of rare occurrence.

Puerperal Fever, a dangerous disease communicable to women after childbirth, is mainly preventible by most scrupulous personal cleanliness and the destruction or most careful disinfection of infected articles. It is spread by means of septic germs which cause blood poisoning in the same way as other diseases, including erysipelas, due to the same cause.

Measles prevails most commonly amongst children from two to five years of age. About fourteen days after infection it develops symptoms like a cold in the head, with increasing fever and a dusky red mottled rash appears about the fourth day, lasting until about the seventh, when the fever gradually declines, and the disease terminates by the shedding of branny scales from the skin, which may continue to the second or even the third week. It is infectious from the first, before the rash sets in, and the infection lasts until into the third week of the disease at least.

Whooping Cough is highly infectious through the breath. The "whoop" takes from ten to fourteen days to develop. Like measles, its danger is in the possible lung complications that may set in. In a favourable case the patient recovers in from three to six weeks.

Chicken-pox is not dangerous, but is apt to leave scars. It is highly infectious, and in the duration of its stages is somewhat similar to small-pox. Great care should be taken not to regard modified small-pox as chicken-pox, an accident that has often happened with very ill results.

German Measles is a mild affection, resembling both measles and scarlatina, but distinguished from both. It must be treated as an infectious fever, and lasts from two to three weeks.

Mumps is another mild affection, causing great discomfort and enlargement of the glands of the jaw, lasting three or four weeks.

Ophthalmia is a disease of the eyes spread by the germs in the secretion, through the towels and handkerchiefs used. It is especially prone to spread in schools.

Another disease, *Consumption* or *Tuberculosis*, and especially consumption of the lungs, or phthisis, must be mentioned, although it does not run such an acute course as the preceding. This is undoubtedly spread through the secretions from the air passages, and therefore great care should be taken with the expectoration of a consumptive patient. When this dries, the germs that it contains, which are very tenacious of life, are likely to spread about the floor and furniture of the rooms and to be carried in the air and inhaled by others. The expectoration should be caught in a spittoon or bottle containing a strong disinfectant, the handkerchiefs should be boiled or burnt, and no healthy person should sleep with a consumptive patient.

Isolation of Infected Patients.

Formerly much less attention was paid to the separation of those suffering from infectious diseases from healthy persons, and especially amongst children, with very sad results to health and life. It is extremely important to bear in mind that, with regard to most of the infectious diseases that attack children, the longer they are staved off and the older the child grows without catching them, the less likely is he to be attacked, and if attacked the less likely to succumb. When a person is attacked, undoubtedly the best course is immediate removal to an infectious hospital, as not only will this remove the danger from the family, but it will also secure isolation from the rest of the community and ensure the best nursing. If this course cannot be adopted, the patient should be removed to a room at the top of the house, and all the furniture and draperies that possibly can be dispensed with should be removed from the room. Free ventilation should be allowed, and if a fire be kept burning it will cause all openings in the room, especially the door, to be inlets and not outlets. In addition, the door should be completely covered on the outside by a sheet kept constantly moist with a solution of carbolic acid. The nurse should change her clothes on leaving the room, which no one else should be allowed to enter. In fact, it is best to isolate the whole of the top floor and devote it to nursing purposes, leaving the window on the staircase constantly open night and day, and providing on the landing a convenient table upon which all the necessary things brought up may be deposited.

Duration of Infection.

This is usually held to be from six to eight weeks in whooping-cough, scarlet fever and diphtheria, from four to eight weeks in typhoid fever, from three to four weeks in typhus fever, measles and small pox, from two to four weeks in mumps and German measles, and from two to three weeks in chicken-pox. The periods may extend beyond those mentioned and great care should be taken to ensure that the patient is free from infection before associating with others. In those diseases, such as small-pox, scarlet fever, measles, or chicken-pox, in which peeling takes place, or scab or scurf are cast off, care should to be taken to see that they have all come away, and the patient should take a series of baths before being released from isolation.

All children in an infected family or house should be carefully excluded from school until the probability of conveying infection is passed. The periods of exclusion have been variously estimated, but the Medical Officers of Schools' Association have fixed the following periods as those during which children should be excluded, dating from the time of complete disinfection in the case of those who have recovered from the disease, or of exposure to infection in the case of those who have been in contact with infected persons; diphtheria twelve days, scarlet fever fourteen days, measles sixteen days, chicken-pox, German measles and small-pox eighteen days, whooping cough twenty-one days, mumps twenty-four days.

Disinfection after infectious Diseases.

This is best performed by the officers of the Sanitary Authority, or other persons expert in the methods required. After those diseases that are spread through the air, it is necessary to disinfect not only the bedding and clothing, but also the whole of the contents of the room and the surfaces of the room or rooms infected. All those articles that are washable should be boiled for twenty minutes in a copper. If stained, the stains should be washed out previously in a cold solution of carbolic acid or corrosive sublimate. Boiling water is a most powerful disinfectant. The unwashable articles should be conveyed to a disinfecting chamber in which to be subjected to steam under pressure. It is essential that all the objects in the room that can be submitted to moist heat, the most powerful disinfectant, either in the form of boiling water or steam, that we possess, be first removed for the purpose—the room is then ready for fumigation. All brass or metal surfaces having been greased with vaseline, the windows are closed, and the chinks are pasted up, the fireplace is similarly closed up with a screen or brown paper, and the joints pasted over. Either chlorine gas or sulphurous acid gas may be used for fumigation. The latter is more easy and simple to produce, and it is equally efficacious, provided that the air of the room is moist. To render the air of the room moist, take a large sized wooden bucket, and fill it two-thirds full of fresh quicklime—if the room is extra large, two of these may be required. Place the bucket in the middle of the room. To produce the fumigant, place also in the middle of the room a small metal foot-bath, or wooden washtub, and pour into it water to the depth of a few inches. In the centre of this place some bricks, and upon the bricks a fair-sized baking tin or a tin dish, in which put 1lb. of broken sulphur for every 1,000 cubic feet in the room, and pour over it a little spirits of wine. The object of the water in the bath or tub is to prevent any danger of fire that might arise from the sulphur boiling over when burning. Now pour two or three pints of water over the quicklime, and in a few minutes it will begin to throw off volumes of steam ; then light the spirits of wine and the sulphur, and it will commence to burn and give off sulphurous acid gas ; retire from the room, close the door, and paste up the cracks all round securely with paper, and close the keyhole. Leave the room in this condition for eight or ten hours. Upon first opening the door of the room, at the end of this time, it is advisable to enter with a wet cloth over the mouth and nose. The doors, fireplace, and windows may be thrown wide open and the room allowed to air, until it is possible to enter it with comfort; afterwards the furniture and surfaces should be cleansed. The cleansing is best done by well washing all the wood and paint work with soap, soda, and hot water, stripping the walls of the paper and burning it, and washing the ceiling. This stripping and cleansing is a most important part of the process. Recently formic aldehyde, produced by a special apparatus, has been recommended as a disinfectant, and a spray of perchloride of mercury solution has been recommended for spraying the surfaces in substitution for or in addition to fumigation.

Disinfectants.

It will have been noticed that it is possible to accomplish the disinfection of a room after infectious disease without using any chemical disinfectants, except those necessary for fumigation (which possibly may also be dispensed with if the stripping and cleansing are thoroughly done, and air and sunlight allowed full play), and that moist heat in the form of boiling water and steam, and general cleansing have been relied upon. Unfortunately the term disinfectant has been very much abused, and allowed to include odoriferous substances, deodorisers, and antiseptics, or preservatives, with true germicides that actually kill germs, the latter being the only true form of disinfectants. Of these the most powerful are corrosive sublimate, used 1 part in 1,000, and carbonic acid, used 1 part in 20. There are also a number of disinfectants under various patent names which contain the tar bases mixed with alkalies making powerful soluble disinfectant soaps in a liquid form. As a practical fact it may be added that we have in constant use an excellent disinfectant—soap—and especially those forms, such as the soft soaps, which contain an excess of alkali. The alkalies in strong soap not only kill many germs, but also tend to dissolve the outer coating of many of their spores or eggs. They also wash away the greasy materials that frequently protect germs from the action of the natural disinfectants, sunlight and oxygen, and are at all times valuable purifiers.

There is no doubt that one of the great reasons of the healthiness of the Anglo-Saxon race is its firm belief in the gospel of soap.

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