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TEXT-BOOK OF HYGIENE

FOR TEACHERS

BY

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PREFACE.

THE success of *School Hygiene*, which was published in the early days of the medical inspection of school children, leads one to believe that a book containing the same matter brought up to date, together with an increased amount of physiological detail, would meet a real demand from students who have to start the study of the subject without any special training in physiology.

In the present volume the matter from *School Hygiene* has been entirely rearranged and partly rewritten. The schemes of medical inspection outlined herein, as well as the views expressed upon various details of the work, are the result of experience in initiating the work in the West Riding of Yorkshire, the Urban District of Handsworth (now part of greater Birmingham), and the County of Hampshire.

Thanks are due to a large number of authors of books and papers on the subject, far too numerous to mention separately, and to the many readers of *School Hygiene* who have written me making valuable suggestions for improvement.

ROBERT ARTHUR LYSTER.

THE CASTLE, WINCHESTER,
March 19, 1912.

EXTRACTS FROM THE MEMORANDUM

ON

MEDICAL INSPECTION OF CHILDREN

UNDER SECTION 13 OF THE EDUCATION (ADMINISTRATIVE PROVISIONS) ACT, 1907.

[*Issued by the Board of Education, November* 1907.]

The Board are convinced that the work of medical inspection cannot be properly accomplished by medical men without assistance. The teacher, the school nurse (where such exists), and the parents or guardians of the child must heartily co-operate with the school medical officer. In whatever way the system be organised, its success will depend, immediately and ultimately, upon the cordial sympathy and assistance of the teachers. . . . .

From what has been said it will be clear that the fundamental principle of Section 13 of the new Act is the medical examination and supervision not only of children known, or suspected, to be weakly or ailing, but of all children in the elementary schools, with a view to adapting and modifying the system of education to the needs and capacities of the child, securing the early detection of unsuspected defects, checking incipient maladies at their onset, and furnishing the facts which will guide Education Authorities in relation to physical and mental development during school life. . . .

It cannot be doubted that a large proportion of the common diseases and physical unfitness in this country can be substantially diminished by effective public health administration, combined with the teaching of hygiene and a realisation by teachers, parents, and children of its vital importance. . . . .

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INTRODUCTORY.

Health at School.

The Hygiene of School Life is of paramount importance in connection with the subjects of Political Economy and the prosperity of the nation. It must be taken into consideration by all those who are in any way connected with the education of the young, and especially by the teacher, if real success is to be achieved. Its importance is equal to that of the hygiene of the nursery, and its responsibilities are even greater. Undoubtedly, both subjects have been very much neglected in the past by all classes of the community, but recent events show clearly that an increased amount of official and public attention is being directed to the improvement of the health of the children.

Vast amounts of public money are being wasted in education because the children are not in the necessary physical condition to assimilate the instruction they are given. Sir John Gorst says: "The children are underfed, stunted, and suffering from a large percentage of preventable diseases. To make these poor little creatures learn multiplication tables and do sums is as cruel as forcing an underfed horse to work." Another source of waste and the cause of much mental injury is the forced teaching of unsuitable subjects. The training of the average teacher is not calculated to supply adequate instruction upon such subjects as hygiene and general health, and it is disheartening to find as compulsory subjects those which

are not likely to be of any particular or essential use in instructing the ordinary Elementary school child and which leave the teacher still ignorant of knowledge that should be considered vital and important.

Sound, common-sense *elementary* instruction in health subjects by medical men engaged in public health work should be given to all teachers during their training. Attempts to teach such subjects by persons not fully trained may, in some instances, be merely useless, while in others they may occasionally be actually dangerous. When all teachers receive sound instruction of this kind it will be possible to hope for the systematic teaching of the principles of hygiene in our Elementary schools.

Instruction in Care of Infants, Hygiene, and Temperance.

Very little definite instruction upon these subjects is being given, and it appears to be left to the option of the teacher as to whether such subjects should or should not be included among some lessons on nature study. When, therefore, the teacher has little or no interest in them, the children get no instruction. Of course, the reason alleged is that the time-table is already overloaded, but the reply to such an excuse should be that none of the subjects in the time-table can compare with these as regards permanent usefulness in after-life. It is apparently not realised by those who frame such time-tables that a child leaving school ignorant of the rules of a healthy life, without any information as to the relative values of foods, and entirely uninstructed concerning the vital functions, should be regarded as grossly uneducated.

Radical changes in the instruction given to girls eleven years of age and upwards are necessary. At present girls leave school ignorant of simple and economical rules of preparing food, general hygiene and ventilation, of house-

wifery, and the rearing and feeding of infants and children, and of practically all subjects that will be of vital importance to them during their lives. There is little opportunity for them to learn such subjects at home, because their mothers are equally ignorant. In the Memorandum on "The Teaching of Infant Care and Management in Public Elementary Schools," issued in November 1910, Sir Robert Morant says :—

"If girls and women could be taught how to take care of infants we might hope to diminish not only the high rate of infant mortality, but also the large amount of unnecessary ill-health and physical suffering caused by neglect in infancy and childhood. Education is concerned with the bodies as well as the minds of the scholars, and a practical knowledge of the common conditions which affect health and physical efficiency is as necessary a part of the purposes of a school education as intellectual attainment. Some amount of such teaching ought certainly to be provided for girls by the Local Education Authority, and this being the case, it is necessary to consider carefully what form exactly it should take, and in what way it should be connected up with the general work of the school.

The ultimate aim of a State system of education for girls in the public Elementary schools should be to equip them in the best possible way for the duties which will fall to them in after life. What is commonly called book-learning has in past years been too much regarded as the supreme purpose of our Elementary schools, and it is beginning to be widely realised that teaching given in these schools might with advantage be made more practical in certain directions, and that it might, especially in the case of the elder girls, be more definitely directed towards arousing interest in, and increasing the knowledge of, domestic hygiene, including infant care.

Few of these girls have mothers who are in a position to give them an efficient training in home management, and the home conditions must often render it very difficult for this to be done. It is thus desirable to consider in what way this subject may be most appropriately and usefully taught at the school in order to supplement or correct the inadequate or inaccurate knowledge of domestic matters acquired in the home: remembering always that the training should be of a two-fold nature, namely, a training in domesticity and a training in infant care, and that it must be designed not to replace but to stimulate and encourage teaching by the mother in the home.

"It is the earnest hope of the Board in issuing this Memorandum that it may serve to arouse a keen interest in the subject amongst many who have not yet realised the opportunities and responsibilities of the Elementary Schools in this direction, and that it may also give useful guidance and direction to the many devoted workers who are already seeking to offer the great benefits of this early training to some of the elder girls in our Elementary schools."

Early Injuries to the Body.

It is during the dawn of life that lasting mental impressions are made, and the body so affected that the framework and delicate machinery of the future man is made or marred. These impressions may lead the child on to happiness and health or to unhappiness and disease. The form of the body, the shape of the limbs, the development of the organs, the cultivation of the senses, may be easily interfered with during childhood. How many infants are killed every week by improper feeding! How many curved spines are due to a wrong position of sitting in school! How many eyes have been

injured by small print, fine stitches, bad lighting, or holding the book at a wrong distance! How many lives are ruined by the effects of preventable disease caused by bad ventilation or the absence or inadequacy of medical supervision and inspection!

It is important to point out that considerable improvement in the health of the children could be produced without the expenditure of any great amount of money. In fact, many of the improvements cost nothing at all. At most schools, for instance, open-air teaching is possible on many days during the year, and requires only the enthusiasm of the teacher, supported by the sympathetic consideration of the Education Committee, to introduce it as an almost every-day occurrence during the summer. The alterations in the school teaching and time-table would, similarly, cost nothing, but the abolition of fine work for children under seven, and the introduction of sound teaching of hygiene, cookery, and other subjects of vital importance to the children when they have left school, would result in a considerable improvement in the physical condition of the race.

Most schools are provided with *means* for ventilation which, if used thoroughly and intelligently, would keep the rooms fairly well ventilated. Owing, however, to the carelessness and lack of interest on the part of the teachers it is common to find the atmosphere in the rooms unnecessarily foul. By stimulating the interest of the teachers and by improving their training in these important subjects it would be possible to make the schools much healthier.

Similarly, the attendance of children of five years and under means the addition of considerable and unnecessary risks to those inevitably associated with schools, particularly in connection with injury to sight and the possibility of damage or death from some infectious disease.

Infantile Mortality.

The alarming mortality among infants and children is strikingly illustrated by Farr, who follows the progress of 1,000,000 children. Out of a million, nearly 150,000 die during the first year of life. At the end of the second year nearly 210,000 are dead. There are only about 730,000 survivors at the end of five years, and these are reduced to 700,000 during the following five years. At the end of fifteen years the total number of deaths has amounted to almost 310,000.

There is no doubt whatever that these figures could be enormously reduced by greater attention to the teaching of hygiene. For instance, although thorough instruction in health subjects and perfect hygiene surroundings would not directly affect the infants under five years of age, yet the ultimate effects would undoubtedly result in the future diminution of this extraordinary death rate. This desirable result would be brought about chiefly by first effecting an improvement in the physique of the children at present at school: these will be the fathers and mothers of the next generation, and their children will not only share in this physical improvement but will also be more carefully reared if the instructions received at school have been given in such a way as to produce a lasting impression.

The explanation of the failure at present is that we have lost sight of the essentials of education. Surely the most essential part of education should be a knowledge of the care of the body, the simple means of maintaining health, the avoidance of ill-health and disease, and the care of children. It is only by improving educational methods and making people really interested in themselves and their children that improvement in infantile mortality can be brought about. Improvement in sanitary conditions in towns and the surroundings of people can never bring about more

than a very slight decrease in infantile mortality. It is often stated that people cannot be made temperate by Act of Parliament. It is much more true to say that people cannot be made healthy by Act of Parliament or by beneficent by-laws of towns. Many people put into sanitary houses amid the best of surroundings will live in a most disgusting way, and the health of infants reared by them is very little better than in the worst slum of a town.

Non-essential subjects are being piled into the already overloaded time-table, and when it is suggested that the essential subjects of the health and the care of the children should be taught the teachers exclaim: "How can we find time for them?" The only way will be to prune severely and cut down the present list of subjects and restrict ourselves to essentials.

The good lady's contention that she ought to be considered an expert in the care of children because she had already buried fourteen of her own might be paralleled by the present-day "educational experts" who, in proof of their knowledge and of the success of their system, might claim:—

(1) That a large percentage of children are permanently injured and handicapped for life by the present school conditions;

(2) That most children leave school in appalling ignorance of such essential matters as the care of their own health and the proper care of children; and

(3) That the average child leaves school with a smattering of a variety of non-essential subjects which it forgets altogether soon after its school life is finished.

The teaching of hygiene must be on sound practical lines. At present there is an absurd lack of appreciation of the

necessity for knowledge to be available and applicable to every-day life. If hygiene is properly taught in schools the constant opportunity to use such knowledge would prevent it being forgotten. Can we say as much of the present educational equipments of the average elementary school child?

Theory of "Survival of the Fittest."

It is sometimes asserted by apparently intelligent people that this infantile mortality is a good thing; that it weeds out from the masses the weak, the delicate, and the diseased, and leaves behind the stronger and better developed of the population; that it eliminates the unhealthy, and is a benefit to the rest of mankind; and that it therefore gives a teacher a better material to work upon.

Fallacies involved.

The argument is unsound. Leaving out of the question the morality of the result, there might be something to be said for it if the unhealthy conditions acted injuriously upon the weakly members of the community alone. But it is certain that the unhealthy surroundings at home and at school, and improper feeding and treatment during infancy and childhood, not only serve to kill off those who start life hampered with either actual disease or weak constitutions, but also lower the vitality and the resisting power of those who were originally perfectly healthy, and these, if they survive so long, grow up into men or women of indifferent physique. These injured children, moreover, are exceedingly poor material for the teacher and can never compete intellectually or physically with their more fortunate schoolfellows. Another result of these constitutional injuries that are received during infancy is that such children offer very small resistance to epidemic diseases. Schools in districts where the physical standard

of the children is low are most likely to be nearly emptied during any severe epidemic. The death rate at such times and among such children is always abnormally high.

Suggested Remedies.

The question that naturally arises is, What can be done to stop this dreadful slaughter of the innocents and this enormous depreciation of national physique? The only hope appears to be in the direction of the schools. First the surroundings of the child when at school should be hygienically perfect. This will, at all events, help it to appreciate part of the value of its instruction on such matters. What impression is likely to be made on a child when the teacher gives a lesson on ventilation in an overcrowded stuffy class-room? Is such a child likely to advocate the open bedroom window at home? The health of the child is undoubtedly improved by perfect school hygiene.

Next is the proper training of all teachers in sound hygienic principles and the care and feeding of infants, so that every one of them will be able to give his or her class correct instruction. Both boys and girls should receive this instruction. School impressions often last throughout life, but the feminine mind is notoriously conservative and there is always the possibility of a girl, in after-life, managing her home and rearing her children on precisely the same lines as her mother did before her. Boys, on the other hand, if hygienic truths are sufficiently impressed upon them, are much more likely, when they get homes of their own, to see that such principles are carried out with regard to their house and their children. The effect would therefore be a tendency towards a substantial improvement in the national physique.

As a matter of fact great changes would be quickly

produced in many of the homes if the children were properly instructed in cleanliness and general hygiene while at school. Improved cleanliness at home naturally follows when personal tidiness and cleanliness are insisted upon at school. "Slums" can only be prevented by eliminating the slum-maker. So long as the "slum-maker" continues to flourish, any collection of houses can be turned into a slum. The "housing problem" is not so simple as some well-meaning enthusiasts would have us believe. It seems almost incredible to believe that there is at present no systematic teaching of hygiene in the elementary schools in this country. The teaching of hygiene is made compulsory by education laws in America and by a decree of Parliament in Sweden. Also, in Denmark, Holland, and Italy hygiene is systematically taught.

In fact a considerable revision of our elementary school "education" is urgently necessary, particularly for girls. No one can say that the present system has not been given a fair trial. Thirty years have elapsed since compulsory education was introduced, but it has not proved to be an unqualified success. As a writer in the *British Medical Journal* says: "Under the head of knowledge of common phenomena of the external world Nature study is nearly always taken. Week after week children pull to pieces flowers, or are taught about the germination of seeds; no doubt this is useful and interesting by way of cultivating a child's artistic tendencies and of exercising its memory in remembering scientific names of the parts of a plant. But to the children of London and other great towns, who seldom have the happiness of seeing a flower, it can only be regarded as waste of time, since this teaching is given at the expense of such vitally important subjects as mental, moral, and physical hygiene.

"The present generation of mothers have all passed

through the school curriculum, and their school training should be reflected in the upbringing of their children. As a matter of fact the grossest ignorance of matters bearing on daily life is manifested. It is well recognised that the cause of most of the degradation among the people is rather ignorance than poverty. Many a family has enough money to spend, but the women do not know how to expend it wisely. They are ignorant of the properties of food, of economical housekeeping, and of the management of a family. They may leave school able to read and write, and recite Tennyson, and sing glees, and pick flowers to pieces; but they have not learnt the degradation of sending their children to school in ragged clothes, with dirty skins, heads swarming with vermin, and often, in consequence, a mass of sores, with which hands and faces become inoculated." Such an indictment should surely be sufficiently powerful to stir even English public opinion. Also in all matters of personal hygiene there exists the greatest ignorance. Take the teeth for example. Practically all the poorer classes give no attention whatever to these important structures, neither towards preventing decay nor arresting it. No man or woman among them dreams of ever cleaning teeth or having a tooth stopped. The usual procedure is to wait until the tooth is badly decayed, and then, if it becomes very painful, to get it extracted. The importance of the care of the teeth is dealt with elsewhere, and so it is only necessary here to state that it is a subject intimately associated with the well-being and physical fitness of the race.

The chief aim of our elementary teaching should be to produce in the children a desire to lead clean wholesome lives and to possess vigorous healthy bodies. The instruction given should be of such a nature as will enable them to satisfy so desirable an ambition.

Children Under Five.

The attendance of children under five years of age appears to be undesirable, as its educational value appears to be very doubtful, while, on the other hand, it involves unnecessary and serious risk to health. The exclusion of these children from school was very ably advocated by Dr. Newsholme in 1902, and again in 1907, but, unfortunately, it is still quite common in many schools to find them in attendance. In the Education Code of 1905, a memorandum by Mr. Morant states that there is a mass of evidence to prove that a child who does not attend school before six years of age or more will in general compare favourably at a later age with a child whose attendance began at an earlier age. There appears to be little doubt that the admission of these children has been permitted partly on account of parents who find it convenient to get rid of them, and partly on account of teachers who desire to increase the school attendance.

The educational uselessness of school attendance under five years of age appears to have been abundantly confirmed by official documents issued by the Board of Education. In addition to the one already quoted, there are others stating that teaching, either in the ordinary way or by means of kindergarten occupations, is undesirable for children under five, and that to attempt formal teaching will almost inevitably mean for some of the children either restraint or over-stimulation. Whatever training is advantageous for children under five is not the kind of training that could best be given in a school. If the home is satisfactory, then such training can be most effectively acquired there, while if unsatisfactory, the necessary care is best obtained by the provision of crèches in charge of nurses.

On the other hand, there is no doubt whatever that writing and reading for children under five, or even under

six years of age, is dangerous, and likely to cause permanent injury to the partly-developed eye. Damage done at this age is never recovered from.

Dangers from too Early Attendance at School.

(1) The dangers of excessive restraint on the one hand, or over-stimulation on the other, have already been referred to.

(2) The possible damage to eyesight by attempting to do near and fine work, such as reading from books and writing on slates or paper, is now so well known that it should only need mention here.

(3) It appears to be undesirable that children under five should run the risk of injury from breathing the polluted atmosphere of the ordinary schoolroom. There is no doubt that the atmosphere of the average schoolroom is much fouler than that of the average house, and probably children under five, or even under six or seven years of age, are in many instances permanently injured by this exposure to injurious surroundings.

(4) The experience of every school medical officer is that most of his trouble with regard to the spread of infectious disease is started by these young children. After the age of six the susceptibility to measles and whooping cough rapidly declines, as well as the fatality among those affected. Similarly in the case of diphtheria and scarlet fever the fatality among those affected declines after the age of five. There is evidently, therefore, great advantage to be obtained by postponing the attendance until over five or six years of age. The presence of these susceptible infants means a very considerable increase in the likelihood of a very serious outbreak of infectious disease among the scholars. It is a matter of common knowledge that attendance at school increases the risk of infectious diseases being imported

into homes, and Dr. Newsholme has pointed out that if children were not admitted to school until over five years of age the results would be that—

(*a*) Fewer families would become infected, and

(*b*) The children of these families still uninfected would become infected on the average at a higher age, with the result that fewer deaths would occur.

The only valid reason that can be urged with regard to the attendance of these children at school is the fact that if the mother goes out to work there is the difficulty in the minding of these children, and that older children would be kept at home to attend to them. In many districts, however, the proportion of the women going out to work is not large, and the above reasons lose a great deal of their strength.

In other countries the age of compulsion for school attendance does not begin until the child is either six or seven years old, and England appears to be almost alone in allowing children to attend school before the ages when compulsory attendance begins.

Medical Inspection in Schools.

In this country the general work of medical inspection in schools began with the passing of the Education (Administrative Provisions) Act, 1907. In the same year a Medical Department of the Board of Education was established and Dr. George Newman, a well-known Medical Officer of Health, was appointed Chief Medical Officer. This appointment was followed by the issue of a Memorandum on Medical Inspection which placed the subject on the firm basis of general public health.

PART I.

THE SCHOOL.

CHAPTER I.

THE SITE OF THE SCHOOL.

It must be clearly understood that schools are provided for that part of the population which is peculiarly susceptible to the influence of bad hygienic surroundings, and it is therefore especially necessary that the site, the building, and the general conditions of a school should be as nearly perfect as possible. But is this rule usually followed? Unfortunately sites are often chosen which would certainly never be selected for private residences, and, as a matter of fact, are undesirable from many points of view.

In selecting a site the chief points to carefully examine are:—

(1) The conditions as to natural drainage, and the ordinary level of the ground water.
(2) The nature of the soil and subsoil.
(3) The aspect and elevation.
(4) The surroundings.

The importance of the first two conditions can be made clear by considering the kinds of soil, the usual arrangement of soils and rocks, and the ground air and ground water.

Soil.

A subdivision of the soil into **surface soil** and **subsoil** is generally recognised, and is convenient. The upper layer

is composed partly of inorganic materials from the subsoil below and partly of organic matter of animal and vegetable origin. This layer swarms with bacteria of various kinds. Some of these are known as nitrifying bacteria and are of the utmost importance, inasmuch as they convert waste nitrogenous material into salts of ammonium and ultimately into nitrites and nitrates. The subsoil is purely inorganic and contains no bacteria. It is formed by the gradual breaking up of the **rock** below. The term rock is of wide significance. It includes granite, slate, sandstone, clay, limestone, chalk, etc. The soil of every locality should therefore be merely the decayed upper surface of the rocks beneath, together with decayed and decaying animal and vegetable matter, but the action of rain and other forces causes the removal of material to a greater or less distance from its source, so that in many instances a soil derived from one rock is laid upon a totally different kind of rock.

Another convenient and important classification of soils is obtained by their action in preventing or allowing the percolation of water through them. Soils which allow water to pass readily through them are called **porous** or pervious, while those which prevent the passage of water are called **impervious**. Porous soils include sand, gravel, chalk, sandstone. The commonest impervious soil is clay, which, although it allows practically no water to pass through it, absorbs water and remains damp for long periods.

Ground Water.

In most districts there is a layer of porous soil on the surface. Below this, at variable depths, is an impervious layer. The rain falling on the surface soil will percolate downwards until it reaches the impervious layer, on the

surface of which it will form an underground river. This collection of water, or underground river, resting on an impervious layer is called ground water. It is in constant movement, always flowing towards the nearest stream or towards the sea.

The level of this ground water is the depth of the water in shallow wells in the neighbourhood. This level is liable to fluctuation, being raised, for instance, by a heavy rainfall. It may be lowered by deepening and clearing out neighbouring watercourses, or by making fresh channels, whereby the rapidity of its flow may be increased. For a healthy site the level of the ground water should be more than 10 feet below the surface of the ground.

Ground Air.

The permeable soil, above the level of the ground water, contains quantities of air, varying according to the nature of the soil. All soils contain air, and the actual percentage depends upon the looseness, or otherwise, with which its particles are packed together. The porous soils such as gravels, sands, and sandstones can hold considerable volumes of air, even up to 50 per cent.

The composition of ground air varies according to the nature of the soil and the depth below the surface. It differs from ordinary air in the following particulars:

(1) *It contains a much larger percentage of carbon dioxide.* The amount varies from ·2 per cent. to 8 per cent., the latter figure representing the proportion in the ground air from gravelly soils at a depth of about 10 feet. This carbon dioxide is produced in two ways. Part is formed by the oxygen in the air combining with carbon derived from various animal or vegetable sources, and a further quantity is produced, by the action

of putrefactive micro-organisms, from the oxygen of organic substances and of nitrates in the soil.

(2) *It contains less oxygen than ordinary air.* This is due to the fact that part of the oxygen is used in producing carbon dioxide.

(3) *It contains a greater quantity of organic and other gases.* Marsh gas may be present as a result of the decomposition of certain organic substances. Occasionally sulphuretted hydrogen is found in ground air.

(4) It may contain great numbers of bacteria.

The amount of nitrogen in ground air is about the same as in ordinary air. It is an undoubted fact that if large quantities of this air gain access to a house or a school it is liable to produce serious injury to health. The presence of ground air in houses in towns is, for instance, probably one of the chief predisposing causes of diphtheria.

Movements of Ground Air.

The subterranean atmosphere is in continual movement. These movements are produced chiefly in four ways. These are :—

(1) Any variation in the level of the ground water will cause movement of the ground air above it. Thus a heavy rainfall will be followed by a sudden rise in the level of the ground water and this will force out large quantities of ground air.

(2) The outside air and the earth are nearly always at different temperatures. When these differences are greatest the widest range of movements of the ground air will occur. In autumn and winter, for instance, the soil is warmer than the air, and the ground air will therefore escape into the

atmosphere, and the colder atmospheric air will enter the pores of the soil.

(3) The above result is most marked when a small area of ground is covered by a house or school, and especially when the surface of the soil outside the house is ice-bound or macadamised, as it is in large towns. Under such circumstances,

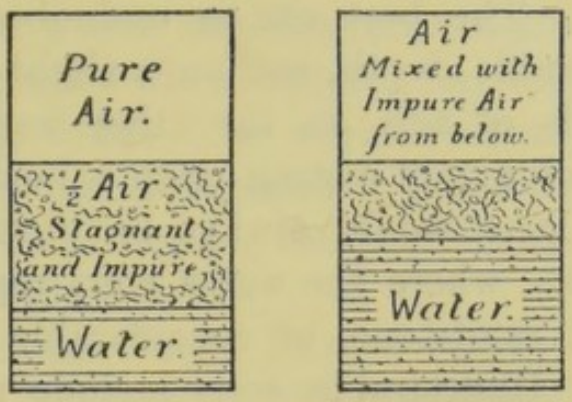


Fig. 1.

when the temperature inside the house is very much higher than that outside, the aspirating effect of fires, chimneys, and ventilation outlets will tend to draw large volumes of ground air from the soil unless the site is covered with a substantial layer of concrete. In towns the ground air is usually mixed with coal gas, and cases are recorded where the inhabitants of the house have been poisoned by air thus drawn from the soil.

(4) Small movements of ground air are also produced by variations in the barometric pressure: on the days of low pressure the ground air escapes from the soil. Other factors include the action of wind in sucking out the air from the soil, as well as in forcing air into the strata which are opposed to its path.

The upper layers of the earth may therefore be compared to a huge lung alternately expelling and taking in air.

Influence of Soil on Health.

1. **Damp.**—The dryness or otherwise of a site depends mainly upon the rapidity with which the rain water can run off or through the soil, together with the depth of the ground water. The best site is undoubtedly a gravelly soil of considerable depth, and on a slight slope. One of the worst kinds of site, on the other hand, would be a shallow layer of gravel resting upon a horizontal layer of clay: such a layer would always be water-logged. Impermeable rocks, where the water runs readily away, and also chalk and sandstone, of considerable depth, are dry and healthy. Undesirable soils include marl and clay, which are damp; peat soils, which contain a large amount of organic matter; and made soils.

It has been shown conclusively that an intimate connection exists between damp soil and all lung diseases, and it is extremely probable that damp is an important factor in the production of rheumatism, catarrh, neuralgia, throat affections (including diphtheria), and also favours the spread of measles and whooping cough. At Ely and Salisbury, for instance, the death rate due to consumption was reduced by fifty per cent. by efficient drainage of the soil, and a consequent lowering of the level of the ground water. It has already been stated that no site can be considered satisfactory where the level of the ground water is within 10 feet of the surface. If the soil is damp, the entire site below the foundations should be drained by laying unglazed agricultural pipes, with open joints, at the bottom of trenches filled with stones or gravel.

2. **Made Soils.**—Excavations made for the purpose of removing gravel, clay, sand, etc., are usually filled after-

wards with all kinds of rubbish. Such rubbish is sure to contain more or less organic matter, and this will exist in a state of putrefaction for years, rendering impure the air around and inside the building. Such sites should always be avoided, if possible, and should, at all events, not be built upon within five years after the excavation has been completely filled in. Even then the layer of concrete extending over the whole site, desirable in all cases, becomes an absolute necessity when building on such soil.

3. **Warmth of Soils.**—The warmth of any soil depends upon its nature and its dryness. Schübler has classified the various soils, as regards composition, in order of merit for warmth as follows:—

Sand with some lime	100	Clayey earth	68
Pure sand	96	Pure clay	67
Light clay	77	Fine chalk	62
Gypsum	72	Humus	49
Heavy clay	71		

If the soil is damp the evaporation from its surface keeps its temperature continuously much lower than that of the air above. Consequently a damp site is always a cold one.

4. Diseases associated with Soils.—Occasionally the actual bacteria which produce certain diseases are found in the soil. Thus the bacilli of tetanus (lockjaw), malignant œdema, and anthrax have been often demonstrated in soil. Also the close connection that exists between damp soils and certain diseases such as consumption, rheumatism, etc., has already been mentioned. In certain other diseases, although the specific germ may be either unknown or has not been actually found in soils, the relation between particular states of soil and prevalence of the disease has been clearly made out. Some observers, for instance, have noticed a relation between the height of the ground water

and epidemic outbreaks of typhoid fever and cholera. Epidemic summer diarrhœa, so fatal among children, has been conclusively shown to be associated with soils soaked with sewage or polluted in other ways. There also appears to be a relationship between epidemics of diphtheria and the fluctuations of the level of the ground water. Similarly yellow fever is associated with certain soil conditions. Malaria exists only where the soil is damp and marshy and capable of holding shallow pools of stagnant water. Thorough drainage of the soil, removal of jungle and dense vegetation, and tree planting have been successfully used to make malarious districts healthy.

Aspect and Elevation.

In choosing the site the questions of exposure to sun and to east or north winds should be considered. All rooms

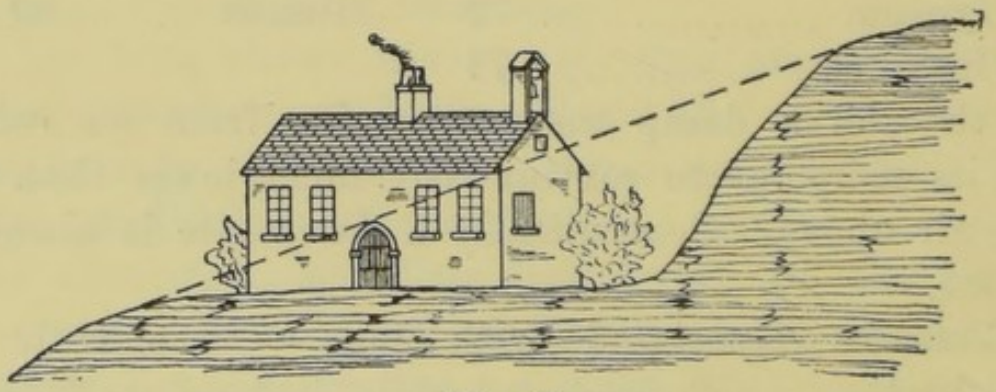


Fig. 2

THE DOTTED LINE SHOWS ORIGINAL OUTLINE OF HILL.

as far as possible should be exposed to direct sunlight some time during the day. Direct sunlight is probably Nature's most powerful disinfectant. Abundance of light is secured by selecting a southerly or south-westerly aspect. Hollows, whether on high or low land, should be avoided. The foot of a hill is undesirable. If it is proposed to place a school upon the side of a hill, the ground must not be dug out so that the cliff rises immediately behind. The

excavated soil should be used to raise the site so as to leave a trench between the building and the cliff (see Fig. 3).

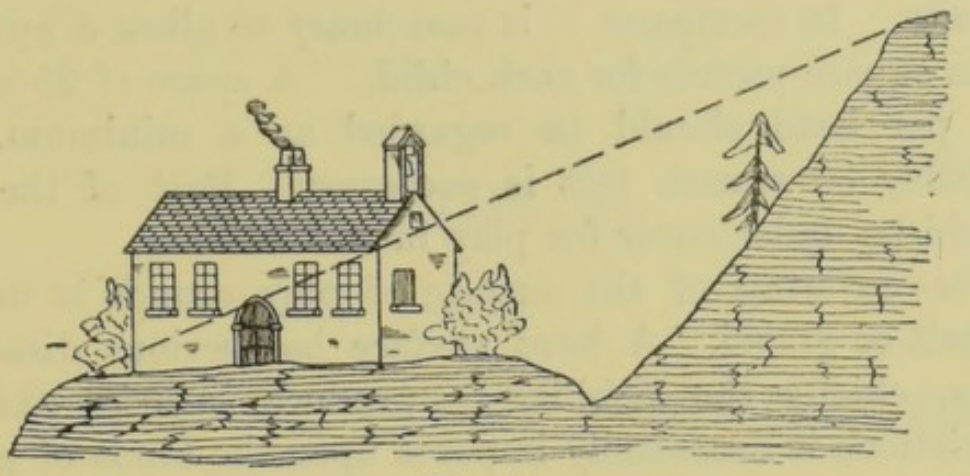


Fig. 3.

THE DOTTED LINE SHOWS ORIGINAL OUTLINE OF HILL.

The soil should never rise immediately upwards from the building so as to allow superficial drainage or soakage to take place towards the foundations. There should be room for the free play of air on all sides.

Surroundings.

The building should not be situated near brickyards or any offensive works. It should be sheltered from cold winds as far as possible. Trees may afford valuable shelter, not only from cold winds but from fogs, but they must not be too close to the building, lest they impede the free circulation of air. They are best situated on the north and east sides. Everything which tends to allow stagnation of air in or around the school is to be avoided; for this reason high walls and lofty buildings should be as far away as possible. A line drawn from the foot of the school building to the top of the nearest wall or building should make an angle with the horizontal of not more than 30°. In order to avoid dust and noise the building should stand as far back from the street as possible.

THE PLAYGROUND.

The playground necessarily forms a large proportion of the site. In Germany it is customary to allow a space of three square metres for each child. A space of 25 square feet per head should be regarded as a minimum, and probably 30 square feet is necessary. Part of the area should be under cover for play in wet weather.

The covering of the surface of playgrounds is usually asphalt or gravel. A hard surface has serious disadvantages, chiefly the liability to produce injuries and the restrictions it necessarily imposes upon the kinds of games and exercises that are possible. If part of the area is covered with turf it is a great advantage.

Open sheds, and trees planted in suitable positions, add greatly to the conveniences for open air teaching, and should always be borne in mind by those responsible for the erection of the school.

CHAPTER II.

THE CONSTRUCTION OF THE BUILDING.

In building a school all the usual rules that are followed in erecting a healthy modern house should be observed. The surface soil is removed and the whole site is then covered with a layer of concrete at least six inches thick and extending six inches beyond the footings of the outside walls. Under the walls the concrete should be at least eighteen inches deep. The object of this layer of concrete is to prevent the passage of moisture and ground air from the ground beneath into the building.

The walls are provided with damp-proof courses in order to prevent the possibility of moisture rising up from the foundations. The floors are best made of wood blocks laid upon concrete. Such floors are durable, clean, and noiseless, and are superior to all others. Where wood blocks are not used the floors should be constructed of narrow planks of close-grained wood such as oak or pitch-pine, and the edges should be "tongued and grooved" so as to fit one into the other.

The junction of the wainscot with the floor should everywhere be completed by means of a rounded insertion which serves to cut off the usual corners into which dust so often collects. The substitution of glazed bricks for wooden wainscoting is in many ways an improvement.

Internal Wall Surfaces.

Unless it is proposed to cover the walls with smooth impervious material, which may be periodically cleaned or painted, it is best to leave the walls uncovered by either plaster, paint, or paper, but it is necessary to use impervious hard bricks set in cement if this course is adopted. Such wall surfaces can be easily kept clean and are very satisfactory. Glazed bricks or enamelled tiles are still more impervious and give excellent results.

If the walls are plastered, a durable, smooth, non-porous variety should be selected. The plaster is then usually coloured by some colour wash, but more permanent and satisfactory results are obtained by painting and varnishing the walls. The aim should be to produce a surface that will be almost non-absorbent and which can be readily cleaned. Ordinary non-painted plaster absorbs moisture and organic matters. Analysis of the plaster of a hospital ward has shown the presence of 46 per cent. of organic matter. In such cases there is probably a continuous fermentation going on, giving rise to ill-health. Whitewashing and colour-washing does not remove or destroy such accumulations, but merely covers it all over with a layer that *looks* clean. When such surfaces require cleansing they should be carefully washed, and some disinfectant should be added to the new colouring matter.

Cornices, string courses, and projections of every kind upon which dust can gather should be ruthlessly prohibited on the walls or in any part of the room. The tops of the doors and windows should be levelled off, and indeed all kinds of irregularities taken away; even raised thresholds should be avoided: everything that will interfere with a clean sweep is wrong and must not be permitted on any account. Woodwork where visible should be stained and varnished.

Colour of Walls.

There are two points to be considered in connection with the selection of the colour for the wall. It is important to choose such a colour as will not tax the eye, and at the same time the colour must be such as will not absorb light to any appreciable extent. Thus, red colours absorb a large amount of light; yellows absorb the least amount of light but produce greater fatigue and nervousness than the other colours; while greens stand next to yellows in their absorption of light and are markedly restful to the eye. As a rule the best results are obtained by adopting a light greenish gray, with a dull surface. The wall should be painted, so that it may be washed.

Basements.

There should be a basement under the whole building if possible. If the basement has two-thirds of its height above the ground level, and has no direct communication with the rooms above, it may be used for cloak-rooms. The floor should be of good asphalt or cemented concrete. Under no circumstance should such rooms be used for teaching purposes. Part of the accommodation here will be taken up by the heating apparatus, and by store-rooms. The furnace-room should be shut off from the remainder of the floor by stout iron doors which serve to isolate this part in case of fire.

Cloak-rooms and Lavatories.

Special rooms must be available for such purposes, although it is unlikely that the demand for a cloak-room for each class-room will be met yet. They should be entered from well lighted and ventilated lobbies, and not from any room used for teaching. Basements may be used, but only when no other space is available. They must be heated

and ventilated so as to dry any wet clothes and prevent damp or smell from entering the school. Lavatory fittings should not be placed in cloak-rooms. The practice of using parts of corridors as cloak-rooms is bad, not only because it disfigures the building, but also on account of the smell of damp clothes in wet weather.

Cloak-rooms should be well lighted from the end, and gangways at least four feet wide should be made between the hanging rails. Pegs for hats and cloaks should be

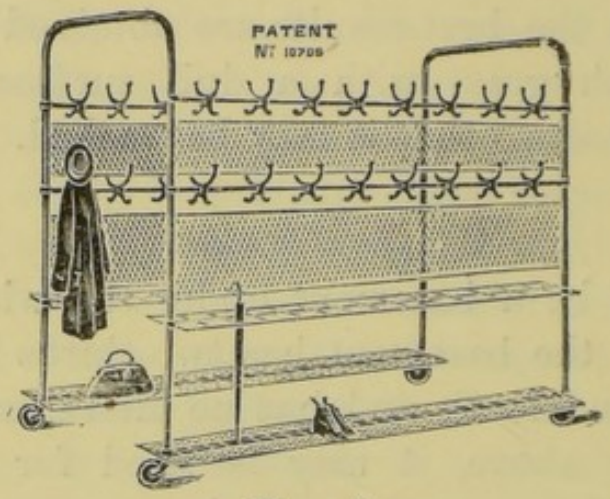


Fig. 4.

Metal Cloak-room Fittings.

numbered, placed not less than twelve inches apart, and not one above another. The floors should be of asphalt or cemented concrete, and the walls of glazed brick or tile. Glazed partitions should be used as far as possible.

The best plan for arranging the clothes is by means of metal ranges—usually steel coated with aluminium—so made that there is a free circulation of air around the clothing, thereby ensuring rapid drying (see Fig. 4). The methods that are usually adopted do not allow such free circulation as is desirable. The usual plan is either to fix a wide shelf round the room with double coat hooks underneath, fifteen inches apart, or to form a series of

compartments by vertical partitions, placed ten inches apart, with coat hooks fixed on each side. Additional

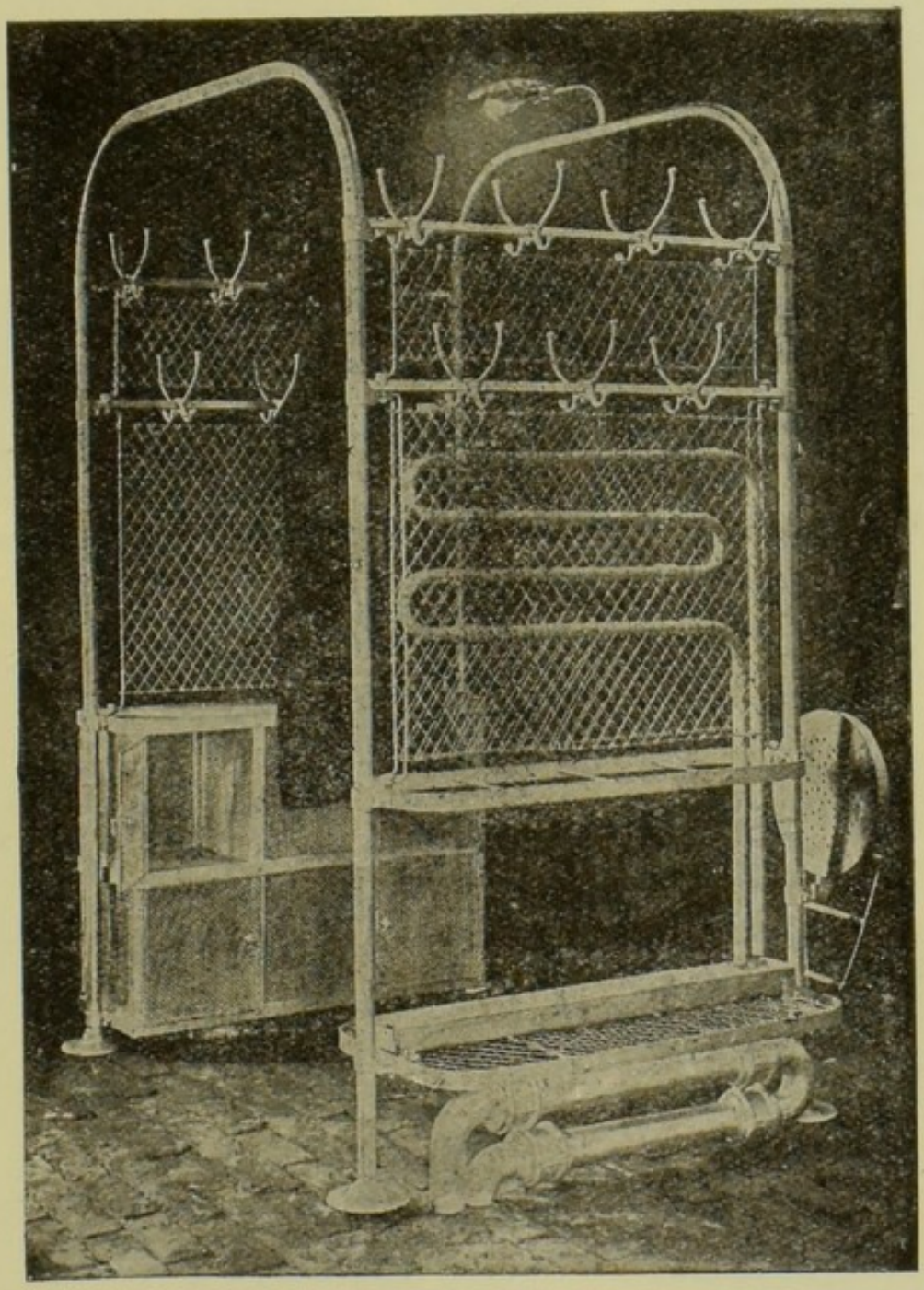


Fig. 5.

METAL CLOAK-ROOM FITTINGS.

accommodation may be provided by fixing small shelves between the vertical partitions. The latter method appears

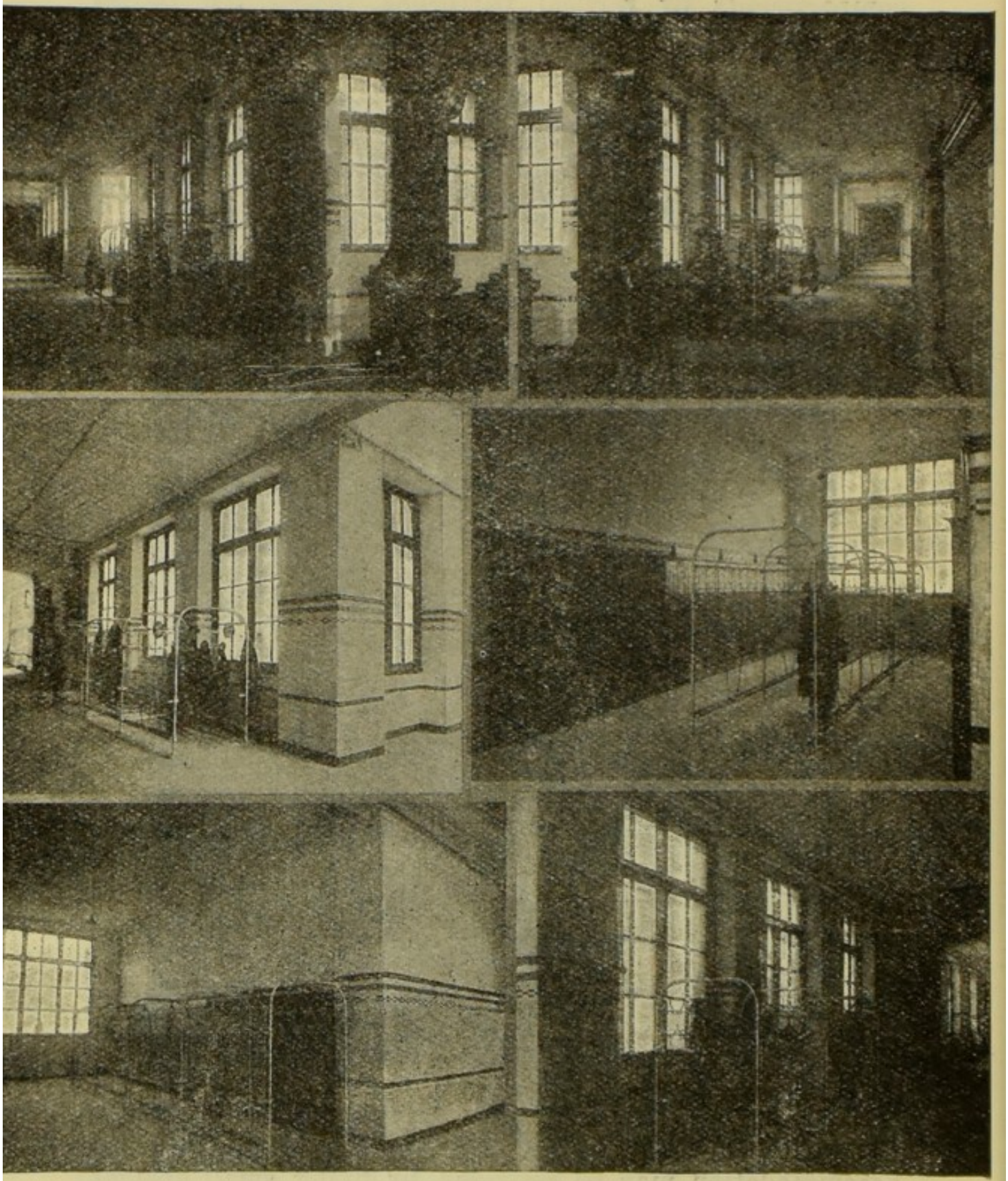


Fig. 6.

Cloak-room Accommodation,

attractive, but it is unsatisfactory on account of the obstruction to the free circulation of air, resulting in delay to the drying process.

Entrances.

There should be a sufficient number of external doors to allow the school to be completely emptied in less than three minutes, and the doors should be wider than the stairs or passages leading to them. No school should have less than two entrances, and in mixed or dual schools there should be separate entrances for boys and girls. Where external doors have outside steps there should be a landing between door and steps. In all cases external doors should open outwards.

Staircases.

These should not be less than four feet and not more than six feet wide, and must not have more than fourteen steps to a flight. Where possible they should be constructed with solid walls on both sides of the flight, and every staircase must have at least one external wall. They must be of fire-resisting materials, such as iron and slate, or steel and lead, and well lighted in every part. In schools of more than 150 scholars with upstair rooms there must be at least two staircases. In fact, two staircases should be considered to be the minimum in all cases. In mixed schools one staircase should be used by boys and another by girls.

Numerous cases of children falling over banisters have led many authorities to insist that there should be no balustrade, but that the staircase should have walls on both sides. This arrangement may be considered less ornamental, but it is undoubtedly safer. On each side of

the staircase a double handrail should be fixed, the lower rail being at a level suitable for smaller children, and a higher one for the taller scholars.

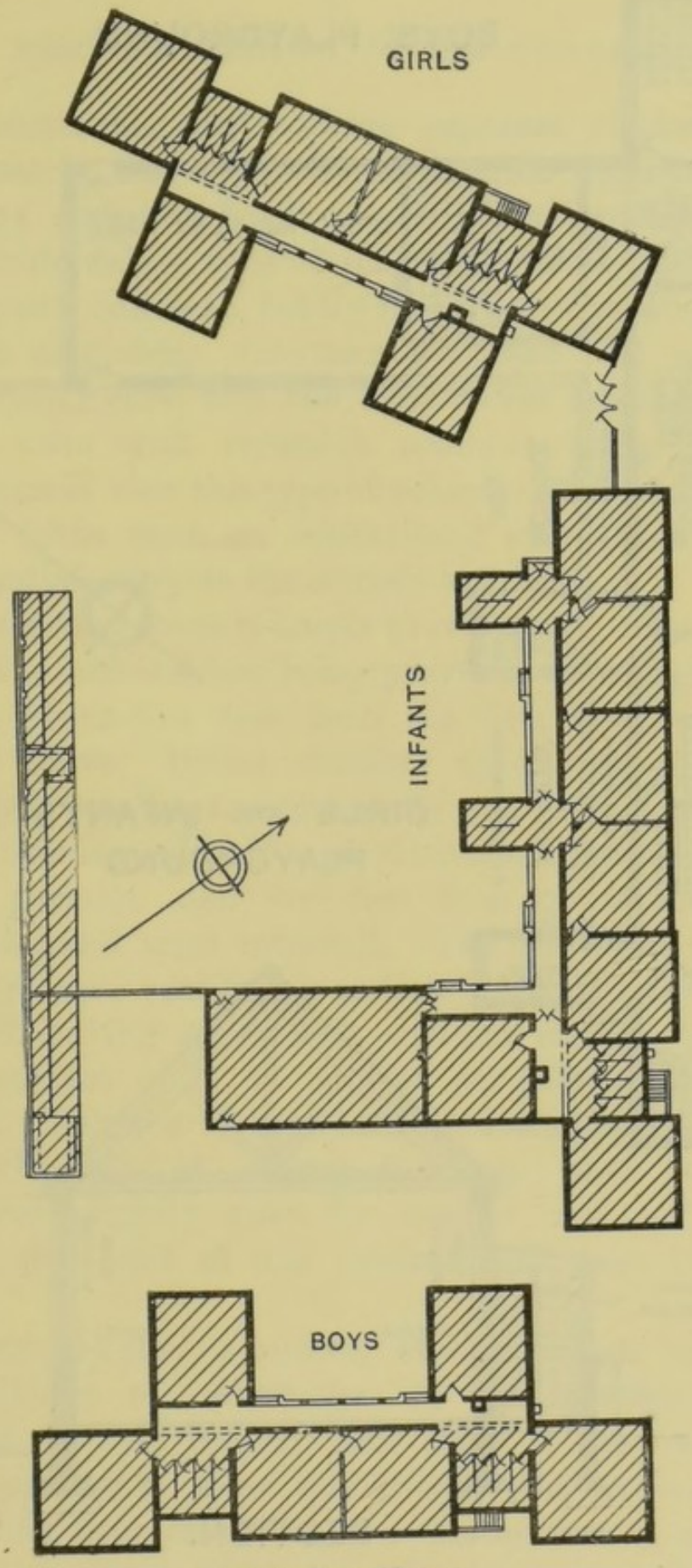
It is advisable that each staircase should be broken by a square or oblong landing, not only as affording a temporary rest for the muscles, but also as guarding against accidents.

The width of the steps (or treads) should be not less than eleven inches, and the height of one step above another (risers) should be six inches.

General Plan.

In order to secure proper organisation and supervision the various rooms should be grouped compactly and conveniently. The usual modern plan is that of a central hall, round which the other rooms are ranged, and from which they are entered by doors, the upper portions of which are glazed. If an upper storey is necessary the staircases and corridors should be on view from the central hall. Passages and corridors should be avoided as far as possible. Where unavoidable, they must be large, airy, and well lighted, and constructed of fire-resisting materials. In many cases there appears to be an inability to realise the importance of wide halls or corridors. Main corridors should be at least ten feet wide, but need not be more. Occasionally one meets schools with abnormally wide halls and corridors, simply representing waste of valuable space which might have been economically included in the school-rooms.

The objection to the central hall type of school is that adequate ventilation by natural means is extremely difficult. In fact it is owing to this difficulty and the common adoption of the central hall type that mechanical ventilation has been forced upon school authorities, thereby



Ground Plan of School.

Fig. 7.

THE STAFFORDSHIRE TYPE OF ELEMENTARY SCHOOL.

GROUND PLAN SHOWING RELATIVE ARRANGEMENT OF THE THREE DEPARTMENTS.

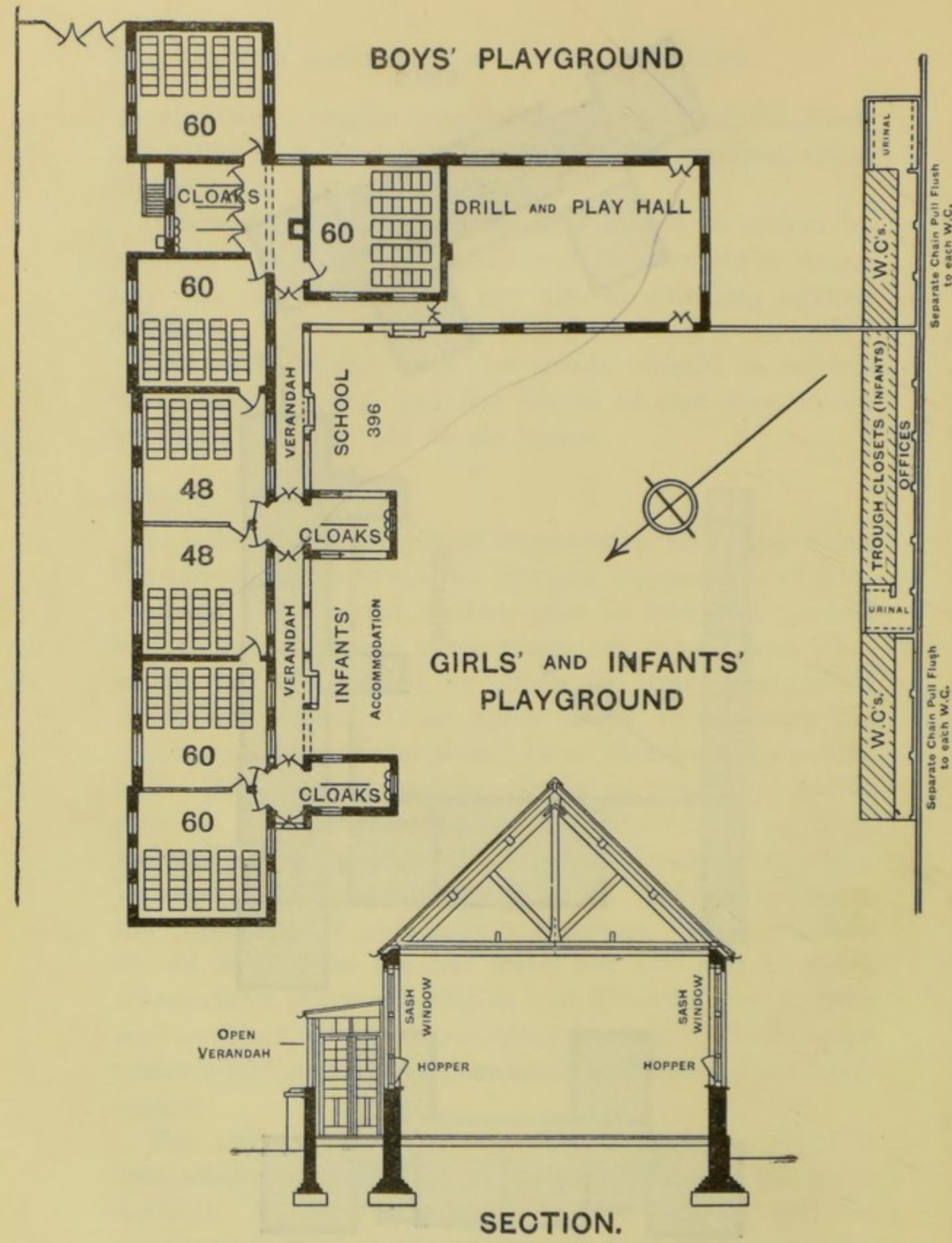


Fig. 8.

THE STAFFORDSHIRE TYPE OF ELEMENTARY SCHOOL. GROUND PLAN OF INFANTS SCHOOL, WITH DRILL AND PLAY HALL. ALSO SECTION OF CLASS-ROOM.

greatly increasing the working expenses of the schools. Unfortunately this type of building has come to be regarded as essential from an educational point of view. In the Staffordshire type of school, proposed by Dr. Reid, the difficulty has been boldly faced, and the central hall has been abolished. One semi-detached hall serves for three departments, and the class-rooms are designed in pavilion form with verandah communication. From a health point of view this type of school makes an important advance, while from an educational standpoint it is at least as satisfactory as the central hall type

In this school there is ample provision for cross window ventilation, each window being provided with large hopper openings about five feet from the floor level, and sash openings above. Under ordinary conditions of weather the hoppers are kept permanently and fully open, while the sash openings allow for additional ventilation so far as weather permits, and for free flushing of the rooms during play and meal intervals. The heating is provided by low pressure ventilating radiators, each department of the school having an entirely distinct circuit. A mean heating surface of 17 to 20 feet per 1000 cubic feet is provided. The cost of such schools, excluding the cost of site, works out at about £10 per head for large schools and slightly more for smaller ones. The average cost per head of the central hall type of school is £15.

Dr. Reid has made a number of experiments comparing the possibility of ventilation in the pavilion schools with that in the central hall type. The results of these experiments show conclusively the superiority of the pavilion type of school, the atmosphere in a central hall type of school, without mechanical ventilation, being at least four times as impure after 1½ hours occupation

as that of the pavilion school collected on the same day and under similar circumstances.

All corridors should receive direct light from windows at each end and, if necessary, must be lighted from the adjoining class-rooms by windows fitted with clear ribbed glass. Ground glass is very unsatisfactory, as it absorbs a large percentage of the light.

The Class-room.

The best shape for the class-room is that of a rectangle with the greater sides about one-fifth longer than the smaller sides. The pupils should sit facing one of the shorter sides, *i.e.* with the long sides of the room on their right and left. Light is admitted on the left side. The necessary size is determined from certain factors. There should be 15 feet of floor space and 200 cubic feet of air space provided for each scholar.

[The Board of Education give 120 cubic feet per head for London elementary schools, and 100 cubic feet per head for provincial schools, and 18 square feet for every scholar in secondary schools.]

One of the commonest and most dangerous fallacies is that a smaller air space per head is required for primary schools than for secondary schools. Other factors to be considered are the distance for which the light admitted on the left will prove effective (this limits the width of the room to 25 feet); the distance at which the scholars with normal eyes can see writing on the blackboard; and the distance at which the words of the teacher are still clearly audible. The latter factors limit the length of the room to about 30 feet.

We thus arrive at the dimensions 30 feet by 25 feet. These give a floor space of 750 square feet, and allowing

13 feet for the height we have a room containing 9750 cubic feet of air. This will accommodate 48 scholars if the allowance of 15 square feet of floor space and 200 cubic feet of air space is considered to be sufficient. This is a very large class for one teacher, and, in practice, a class of 40 pupils should be considered a maximum.

CHAPTER III.

LIGHTING AND HEATING.

SECTION I.—LIGHTING.

The continued increase in short sight among children may be ascribed without hesitation partly to deficient and faulty illumination of school-rooms. In order to understand the principles of perfect lighting it is best to consider under what natural circumstances reading can be best accomplished. The most perfect ease in reading or writing, or in doing any fine work which imposes a certain strain upon the eyes, is obtained in the open air on a dull day. Under such circumstances there is ample light, but it is so well diffused that it appears to come from no point in particular and therefore casts no shadow. This represents the ideal conditions. It is imitated in artificial lighting by concealed electric lights, the light from which is reflected to the ceiling and thence, well diffused, to all parts of the room. One of the most important rules is that the light should never fall directly upon the eyes. Illumination of the paper or object, with shading or protection of the eyes, is the aim of good lighting. Such is attained in the lighting of billiard tables, or by reading-lamps.

Windows.

Every part of a school-room should be fully lighted. The area of window glass must not be less than one-fifth the area of the floor in rooms used for teaching, and in other rooms not less than one-eighth; so that a school-room 30 feet by 25 feet should have a window area of not less than 150 square feet. At least half the glass area of every window must be made to open for ventilation and for cleaning. In rooms used for teaching the windows should have square heads, be as near the ceiling as possible, and of white glass only. There should be no wall space between the ceiling and the window. As a general rule one-third of the total light admitted by a window is furnished by the upper fourth. The height from the floor to the bottom of the window should be four feet in order to prevent reflections from the top of the desks, and so that the light should not be on a level with the eyes of the pupils. Provision for cross ventilation should be made. A convenient arrangement of windows is to have the lower portion fitted as double-hung sashes and the upper as a fanlight hung at the bottom to fall inwards. Another good plan is to arrange below the sashes a hopper opening that cannot be closed. If the top of the window does not open, or if the window does not reach up to the ceiling, there will be a layer of foul air continually occupying the upper part of the room.

The light should, as far as possible, be admitted from the left side of the scholars; but when a left light is impossible, a right light is next best, in which case the window sills should not be very low. The objection to a light from the right is that it casts a shadow from the pen over the writing. The worst light is that which comes directly from the front of the scholar. This is very dazzling and is injurious to the eyes. Light from the back throws a shadow over

the work of the scholars, and is unpleasant and injurious to the teacher. Moreover, such a position decreases the power of the teacher of overlooking the scholars. The number of panes of glass to each window should be not more than four. The best plan is to have one pane for the upper sash and one for the lower. Such windows are more easily cleaned, and give more light than those with more panes.

Abundant light is absolutely necessary, and it should be arranged to strike the desk at a considerable angle. A "dim religious" light is opposed to healthiness of mind, and tends to develop that hysterical state greatly admired and so much promoted by some schools of religious thought. It depresses a healthy mind, and impedes the vigorous action of brain matter. Light goes with knowledge, and assists to develop mental power. A dim light probably impedes the formation of the habit of private judgment, and leads the person under its influence to lean upon somebody else: to follow the lead of the teacher in blind obedience; but it does not tend to health. That which does not produce a perfect state of bodily health, or impedes its growth, cannot be good for any body of people, and this applies to children much more than adults. Lighting should be provided on a scale suitable for dull days: the mere passing of a dark cloud over the sun may decrease the illumination in a room by 66 per cent.

Light should be diffused as equally as possible through the room: dark corners and dark ends should be got rid of by opening windows in the blank walls, or putting in skylights if the walls are not outside walls.

Amount of Illumination.

To test the sufficiency of illumination in a room the light upon the desk placed in the most unfavourable position

should be examined. It is usual to compare the illumination at any place with that afforded by a standard candle placed one metre away. This is called a candle metre. The illumination upon the desk in the darkest part of the room should be at least fifty candle metres. If it is below the standard the eyes of the pupil will be subjected to an undue amount of strain.

Windows with Obstructed Sky Line.

Unfortunately many school buildings have some windows which give a poor light because the neighbouring walls and houses obstruct the sky line. Under such circumstances it is necessary to deflect the light into the room by means of special contrivances such as ribbed glass, or glass prisms.

A series of tests on the diffusion of light through ribbed and prismatic glasses were made by C. L. Norton at Massachusetts. The ribbed glass giving the best results was plane on one side and had twenty-one ribs to the inch on the other. The ribs should be set horizontally. Its cost is not excessive. It is claimed that for average-sized school-rooms with obstructed sky line the illumination can be increased, on dull days, by more than fifty per cent. if the upper sash is glazed with ribbed glass.

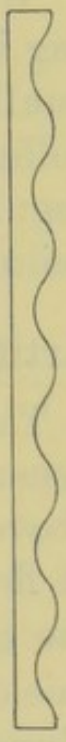


Fig. 9. Ribbed Glass.

Lighting by prisms is also very satisfactory in those cases where the windows open upon narrow streets or dark courts. Panes are made with projecting prisms on one side, the angles of the prisms varying for different cases. By refraction and reflection the light from the sky above is directed into the room. The most satisfactory method of using these prisms is so to arrange the angle that the light is

deflected to the white ceiling, thereby affording an ideal light

The space between the windows should be as narrow as possible. Wide spaces produce bands of light and dark shadows which strain the eyes. The best arrangement is to use cast-iron mullions between the windows, so that brickwork is altogether unnecessary in these positions.

In many schools the windows are seldom cleaned. Small panes should be avoided on account of the increased tendency to become dirty, as well as affording less light. Regular cleaning of the windows is as important as the scrubbing of the floors.

Blinds.

When the direct rays of a bright summer sun are pouring into a room the light may become dazzling. Direct sunlight should never fall upon a desk. Opaque shades, rolling from the *bottom*, should then be used in order to regulate the amount of light. The light entering near the ceiling is then evenly diffused.

Artificial Lighting.

The incandescent electric light is by far the best. As a general rule, three 16 candle-power lamps, placed eight feet above the floor, will be required for every 100 square feet of floor space. The glowing film itself, if visible, injures the eye, and some shield is therefore necessary. Most shields, ground glass for instance, greatly decrease the illumination. Shaw, of New York University, strongly recommends the adoption of the Holophane glass globe. This globe increases the effectiveness of the lighting at all points below the horizontal. They should be used as close to the ceiling as possible. Gas has the great disadvantage of giving a considerable amount of impurities to the air,

as well as using up the oxygen. One cubic foot of gas will, in burning, consume the entire oxygen of eight cubic feet of air, and also give to the air about half its volume of carbon dioxide as well as compounds of sulphur, which are par-

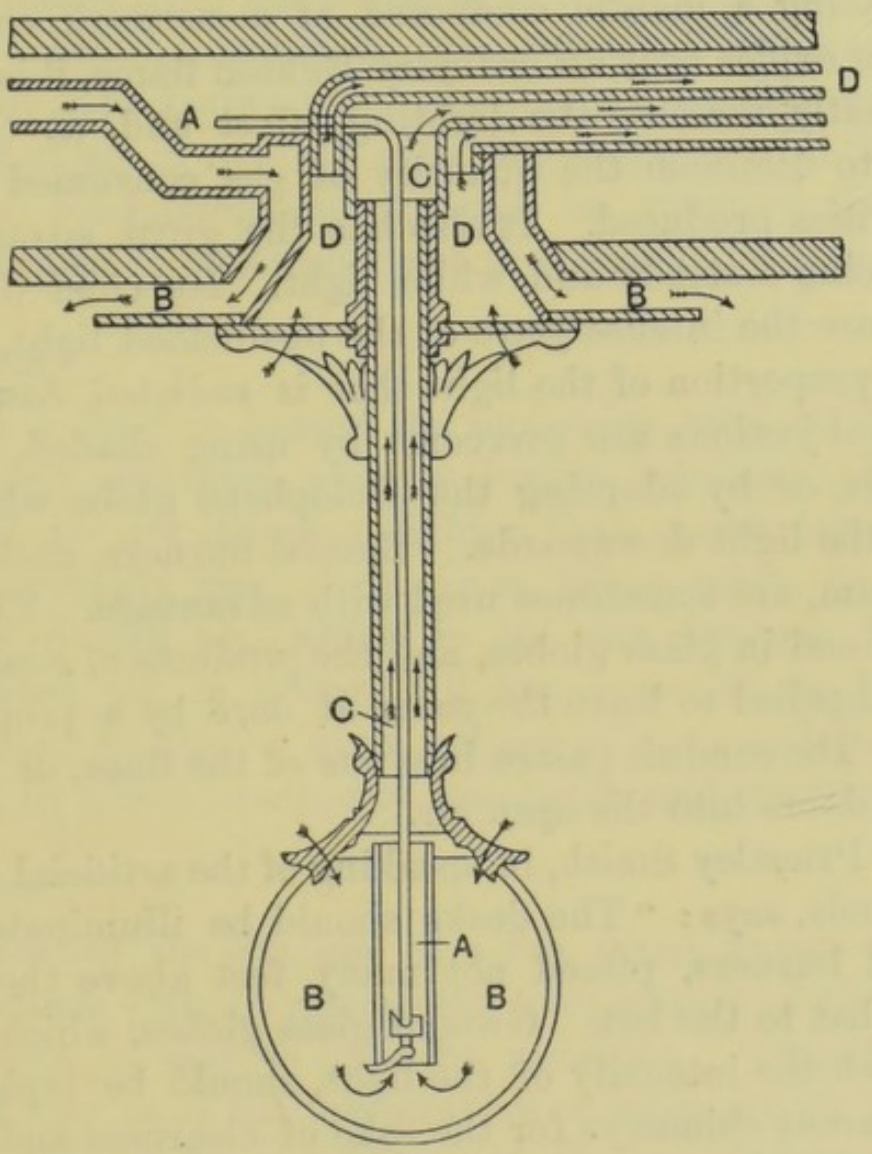


Fig. 10.

WENHAM'S GAS-BURNER.

A, Burner and gas pipe.
B, Inlets into room and globe for fresh air, as shown by the arrows.
C, Outlet for products of combustion.
D, Outlet for foul air from room.

ticularly injurious. An ordinary batswing burner, of 16 candle-power, consumes $5\frac{1}{2}$ cubic feet of gas per hour, and is estimated to produce, in that time, 2·8 cubic feet of CO_2,

and 7·3 cubic feet of water vapour, thereby polluting the air to about the same extent as would be produced by the process of respiration of five adults. By using Welsbach incandescent burners, in which incandescence is produced by placing a mantle composed of a network containing certain oxides over an ordinary Bunsen flame, it is possible to greatly increase the lighting effect and, at the same time, to diminish the quantity of gas consumed and the impurities produced. It also has the great advantage of producing a steady and white light. Its chief disadvantages are the intense glare of the unshielded light, and the small proportion of the light that is radiated downwards. These objections are overcome by using shaded inverted burners, or by adopting the Holophane globe which diffuses the light downwards. Special burners, such as the Wenham, are sometimes used with advantage. The flame is enclosed in glass globes, and the products of combustion are compelled to leave the room at once by a proper conduit. The conduit passes into one of the flues, or directly out of doors into the open air.

Mr. Priestley Smith, in speaking of the artificial lighting of schools, says: "The desks should be illuminated by a row of burners, placed not many feet above them, and somewhat to the left. Ground glass globes, which greatly diminish the intensity of the light, should be replaced by transparent chimneys for the sake of clearness and steadiness, and reflectors may be added with great advantage."

SECTION II.—HEATING.

The heating of the school is, or should be, closely associated with its ventilation, and the subject will therefore be constantly alluded to in considering the question of ventilation. Heat tends to pass from warmer to colder

bodies in three ways—by conduction, by convection, and by radiation.

Conduction.

Heat passes from hot particles to cooler particles in contact with them by means of conduction. The passage of heat along solid bodies takes place solely by this method. Particles of air in contact with hot surfaces also become heated by conduction, and can pass on some of the heat thus obtained to other particles in a similar manner.

Convection.

When a fluid is heated its molecules tend to become more widely separated, and its density decreases. Heated layers of air are therefore lighter than cooler layers and will accordingly rise, their place being taken by equal volumes of cool air, which in its turn becomes heated. The heated air, in rising, will lose some of its heat by conduction, so that a given volume of air may be quickly warmed by a combination of convection and conduction.

Radiation.

The heat of the sun, and of a fire, which warms objects at a distance without raising the temperature of the intervening air, is said to pass by radiation. Objects thus warmed may raise the temperature of adjacent air by conduction, and of large volumes of air by conduction and convection.

For school purposes we may consider the following methods as available for heating:—

I. Open Fires.

This is the most popular method of heating in this country, but it cannot be recommended as the sole source

of heat for schools. They have the following disadvantages:—

(1) They are very wasteful. Between 10 and 20 per cent. of the actual amount of heat that is produced is really used in warming the room, the 80 or 90 per cent. being wasted largely by the rush of heated air up the chimney. To prevent as much of this loss as possible the opening into the flue should be narrow and adjustable; also the grate should be made with as little metal work and as much fireclay as possible. The bars beneath should be so close together as to allow small ash only to pass, and the bars in front should be narrow so as not to obstruct radiation. The back of the grate should slope over the fire to deflect the heat into the room. The space under the fire should be shut off so as to allow no air to pass. In order to increase radiation the fireplace should be brought into the room as much as possible. The heat is also economised by building fireplaces against *inside* walls only.

(2) Open fireplaces heat a room very unequally. On cold days one side of a room feels comfortably warm, while the side farthest away from the fire is very chilly.

(3) They create a large amount of dust and ashes, and require a large amount of attention in stoking and cleaning.

On the other hand the open fireplace possesses very important advantages, namely, the cheerful appearance and the efficient aid that it gives to ventilation.

No system of warming can ever give such pleasant effects as those of an open fire. Nearly the whole of its heat is in the radiant form, and as a result the walls and furniture of a room are kept at a higher temperature than the air. Under such circumstances the body is surrounded with comparatively cool air, which is much more healthy to breathe than hot air, but the neighbouring objects, such

as walls and furniture, are warmer. The result is that the body loses far less heat, by the process of radiation, than it does in a room filled with warm air but where the walls are cold. In a room heated by hot water pipes or warmed air, the walls not being heated in the same proportion, although the air may feel warm, the walls will remain cold, so that the heat of the body passes rapidly by radiation to the walls, and gives rise to a chill.

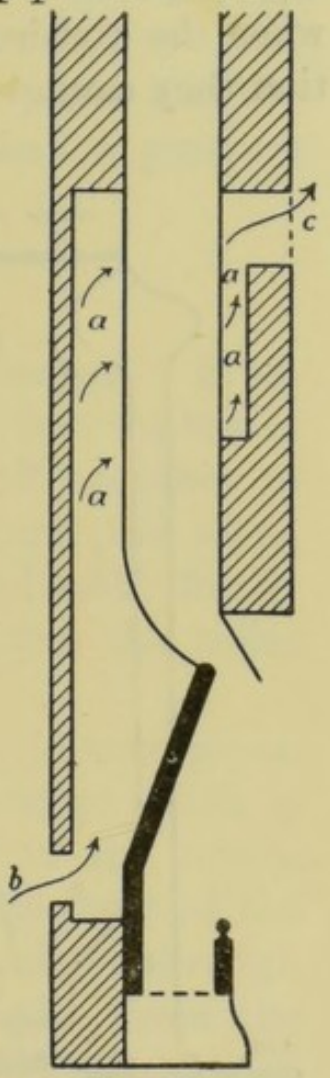


Fig. 11.
THE GALTON GRATE.
a, Hot-air chamber surrounding flue; *b*, opening for fresh air; *c*, inlet into room.

Ventilating Grates.

If open fireplaces are used they should always be of the Galton type in order to introduce a constant supply of warm fresh air. At the back of these grates, and surrounding the lower part of the flue, is an air chamber communicating on the one hand with the outer air, and on the other with the room. Fresh air enters the air chamber from outside, becomes warmed by contact with the hot back of the grate and the heated sides of the flue, and enters the room by openings placed either between the mantel-piece and the ceiling or just below the mantel-shelf.

II. Stoves.

These have certain advantages over open fires, being more economical, cleaner, and more uniform sources of heat. Moreover the best forms of stoves require very little attention. On the other hand they dry the air, giving rise to unpleasant sensations, and may actually cause a smell of

burning owing to the charring of the dust and organic matter in the air. Another unpleasant feature is the tendency of cast-iron stoves to give off carbon monoxide, a highly poisonous gas, to the air. This only takes place when the cast-iron is red-hot. For the purpose of ventilation they cannot compare with open fires.

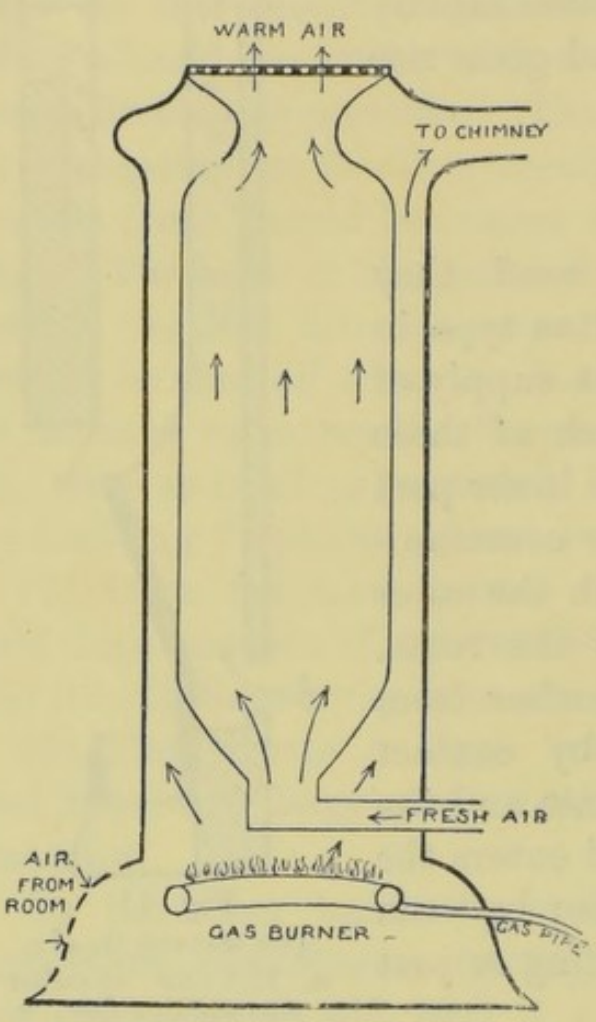


Fig. 12.

VENTILATING STOVE.

III. Gas Fires or Stoves.

These are rarely used for school purposes except for small rooms which are occupied occasionally. The advantages claimed for them are that they are clean, easily regulated, and economical when the room is required at intervals only. It is important to remember that no stove of any kind is permissible unless it is fitted with a proper flue to carry off the products of the combustion.

Ventilating Stoves.

The most satisfactory form of stove is the ventilating stove, which deserves much more general use. There are several varieties, but the principle is clearly shown in the accompanying diagram. Fresh air enters the room from outside and is warmed on the way by passing through a tube or chamber which is heated by

a gas flame (Bunsen burners). The air which is vitiated by the combustion of the gas is led either into the chimney or directly outside.

IV. Hot-Water Pipes.

The heating of buildings by hot water pipes may be accomplished in one of two ways; viz. by the low pressure system or the high pressure system.

Low Pressure System.

The water is heated in a boiler in the basement. From the top of the boiler runs a cast-iron pipe, four inches in diameter, vertically upwards. This gives off branches to all the rooms. Each branch pipe goes round the room, and then returns by bending back under itself, finally uniting with the main return pipe which enters the boiler at the bottom.

There is a continual circulation of water in such pipes, because the outgoing one is filled with hot water which is lighter than the comparatively cool water in the return pipe, such conditions being maintained by the heat of the boiler and the cooling of the water as it circulates through the pipes in the various rooms. A feed pipe from the cistern enters the return pipe and makes good any leakage or waste from evaporation. An escape for air or steam is provided at the highest point. The average temperature at which such pipes are maintained is generally between 160° and 180° F. The pressure in the boiler only exceeds the atmospheric pressure by the pressure due to the weight of a column of water whose height is the vertical distance between the boiler and the highest point of the system.

Roughly speaking, it is usually found that about 12 feet of the 4-inch pipe are required for each 1000 cubic feet in a room in order to maintain a temperature of 65° F.

High Pressure System.

When water is heated while it is exposed to the ordinary atmospheric pressure it boils at 212° F. If the steam is prevented from escaping the pressure inside the closed vessel will be increased and the water will not boil until a higher temperature is reached. The greater the pressure upon the water the higher is the temperature at which it boils. The following table gives the boiling-point of water at different pressures:—

Pressure (in atmospheres).	Boiling Point.
1	212° F.
1·4	230° F.
1·96	248° F.
2·67	266° F.
4·7	302° F.
9·9	356° F.
15·4	392° F.
27·5	446° F.

The high pressure system is composed of a single, continuous, closed pipe, made of $\frac{1}{2}$-inch wrought iron, and with $\frac{7}{8}$-inch internal diameter. From $\frac{1}{6}$ to $\frac{1}{12}$ of the entire length of the pipe is arranged as a coil in the furnace in the basement. The pipe is completely filled with water. From the coil in the furnace the pipe proceeds vertically, and goes round each room in turn and returns to the bottom of the coil.

The water is usually heated to 300° F. (representing about four or five atmospheres pressure). At the top of the system are fixed wider tubes, called expansion tubes, partly filled with air. These allow for the expansion

of the water by the heat. About eight feet of this piping is equivalent, in its heating power, to 12 feet of the low

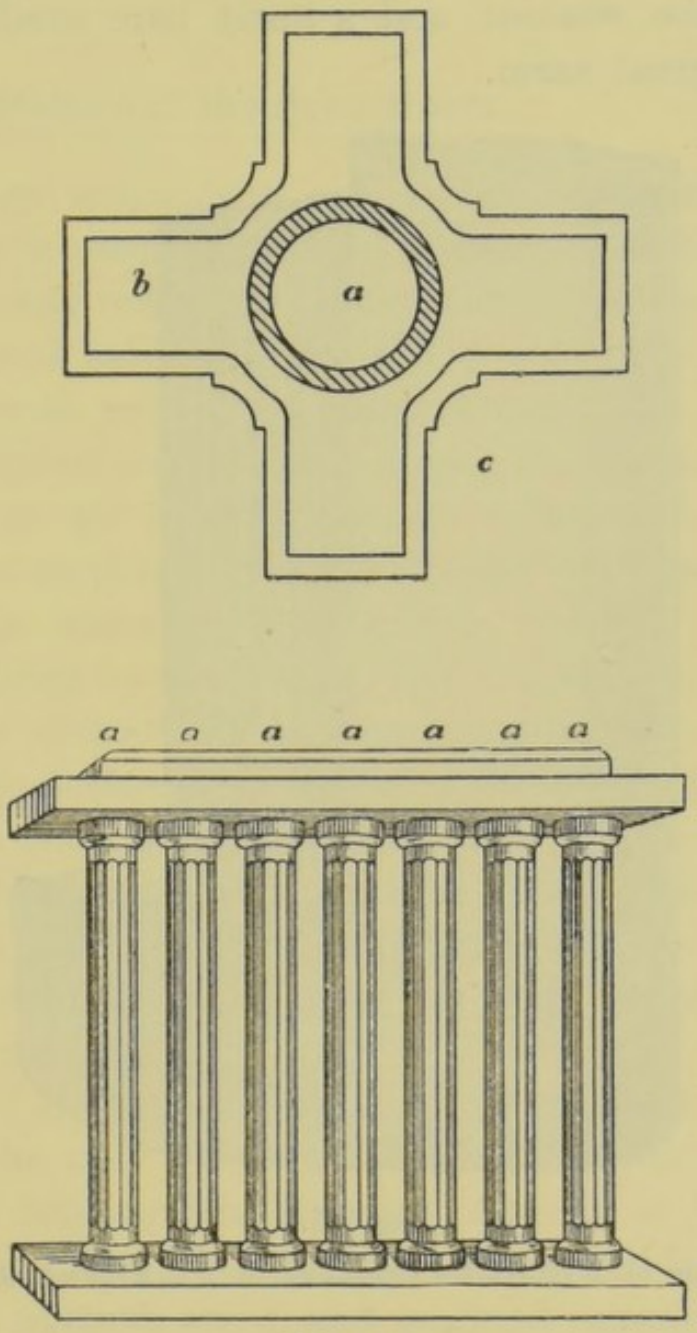


Fig. 13.

WENHAM AND WATERS' HOT-WATER COIL.

pressure piping. As a rule the results given by the system are not so satisfactory as those obtained by the low pressure system, owing to its liability to over-heat the air.

Moreover, unless the furnace receives constant attention the temperature of the pipes may alter very suddenly. As regards the danger from the high pressure the part in the furnace is the weakest, and a burst here would probably not do any great harm.

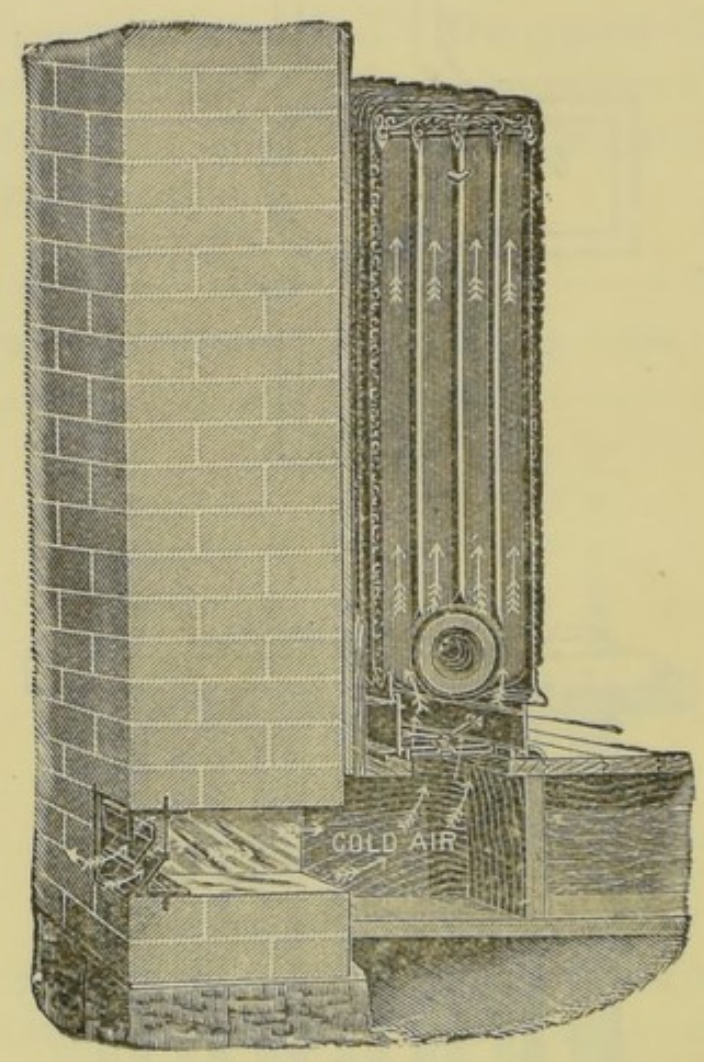


Fig. 14.

SECTION OF A RADIATOR INTRODUCING WARM FRESH AIR.

No system of hot water or steam pipes is admissible unless proper inlets and outlets are provided for ventilation.

A convenient method is to substitute for the 4-inch pipes and coils radiators composed of hollow columns connected below with an opening in the wall through which

air enters and, after passing through the radiator, is discharged into the room fresh and warm, as shown in Figs. 13 and 14.

The Temperature of the Schoolroom.

In a large majority of schools the temperature is kept too high in winter. The best temperature is 60° F. or just below, but any temperature between 56° F. and 60° F. may be considered satisfactory. Every schoolroom should be furnished with two or three thermometers.

The temperature of a schoolroom should not be allowed to fall below 45° F. at any time, night or day, while the school is in session. If the walls get quite cold there is a difficulty in warming them again; whilst if the room is well ventilated by perflation after the class has separated, thoroughly cleaned up at once, as it ought to be, and the heating apparatus kept on at a lower temperature, the room need never get quite cold. The children, under such circumstances, are comfortable as soon as they enter the room on a cold winter morning, instead of shivering and being quite unable to take in the teacher's meaning, as is too often now the case.

It should be hardly necessary to state that temperature must be the only guide as to whether it is necessary to commence heating the school. Also it is important to bear in mind that after the Christmas holidays the rooms should be opened, aired, and warmed several days before they are required.

Comparison of the Various Systems of Heating.

The following summary is given by Carnelley in his report to the Dundee School Board:—

Open Fires.

Advantages.

(1) More cheerful.
(2) First cost much less than hot-pipe systems.
(3) Keeps air fresher than hot pipes, owing to draft up chimney.
(4) So far as the Dundee schools are concerned, the temperature in the open fire schools was higher than those heated by other systems.
(5) The rooms of these schools will probably need painting less frequently than those heated by other systems.

Disadvantages.

(1) Greater labour in service.
(2) Slightly greater annual cost than stoves or steam-pipes or large hot-water pipes.
(3) Unequal distribution of heat.
(4) Air more highly charged with micro-organisms.

Stoves.

Advantages.

(1) Smallest first cost.
(2) Least annual cost.
(3) Probably more effective heaters than open fires.

Disadvantages.

(1) Greater labour in service.
(2) Require more attention than open fires.
(3) More liable to smoke than open fires.
(4) More liable to get out of repair than open fires.

Hot Pipes.

Advantages.

(1) Less labour in service than either open fires or stoves.
(2) The class is not disturbed as in the case of mending open fires and stoves.
(3) More equal distribution of heat.
(4) Air less charged with micro-organisms than when open fires are used.
(5) On the whole the annual cost is probably *slightly* less than with open fires, but more than with stoves.

Disadvantages.

(1) Not so cheerful as open fires.
(2) First cost much more than in the case of open fires or stoves.
(3) Air not so fresh as with open fires.

Comparison of Hot-pipe Schools.

(1) Small high-pressure pipes are cheaper in first cost than large low-pressure pipes.
(2) In those schools examined the air was better in rooms heated by small high-pressure pipes than in those heated by large low-pressure pipes.
(3) It takes longer to get up the heat with large than with small pipes.
(4) Small pipes are less obtrusive in rooms.

CHAPTER IV.

VENTILATION.

"One of the most important subjects connected with health at school is that which deals with overcrowding. '*Too many children in the school*' is the impression which is upon the mind of every lover of fresh air as soon as he sets foot in a school the pupils of which have been assembled for an hour or two and have remained in the room all the time. One seldom goes into any school in the middle of working-time, especially in cold weather, without being struck with the fact that the air is too impure for perfect health. The impurity arises from overcrowding connected with a want of ventilation. These two subjects are mixed up very much together; one school with a hundred boys or girls in it may have a much purer air than another of the same size with only fifty, because in the one case the products of respiration are rapidly removed, and in the other in a great measure retained. The question of floor space is an important one, but not nearly so important as that of ventilation."—(*Carpenter.*) It is important to remember that the question of floor space or cubic space per head in no way affects the question of the quantity of fresh air per hour that it is necessary to provide. The effect of a large area of floor space is simply to delay the time when the air would become poisonous. Cubic as well as floor space is a delusion in various ways; one room ten

feet high will ventilate better than another fifteen or even twenty, because in the one case the windows are carried up to the ceiling, and in the other there is seven or eight feet of wall between the top of the window and the ceiling itself. The age of the children will be a factor in the case, though not so great as is often represented; for a child of six or seven requires nearly as much fresh air as one double that age.

THE ATMOSPHERE.

Ordinary fresh air has the following percentage composition:—

Nitrogen (including Argon 1%)	79
Oxygen	20·96
Carbon Dioxide	·04
	100·00

There are also variable quantities of water vapour organic matter, ozone, oxides of nitrogen and sulphur, and sulphuretted hydrogen in the air; the first substance being usually present, and the others in air under certain conditions only. There are also suspended particles in the air, composed of inorganic and organic materials, and various bacteria.

Expired Air.

Air that is breathed out of the lungs differs materially from ordinary air in its composition. Its percentage composition may be represented thus:—

Nitrogen (with Argon)	79
Oxygen	16
Carbon Dioxide ..	4·4
	99·4

This shows that expired air has less oxygen and more carbon dioxide than inspired air. It also is saturated with water vapour, is warmer, and contains a considerable quantity of organic impurities. This organic matter is usually regarded as the most injurious of the impurities produced by respiration, although some recent investigations are said to negative this statement. There is at present no reasonable ground to consider that the injurious effects of bad ventilation are not due to the organic constituents of expired air.

School Air.

The air in a schoolroom therefore will differ from ordinary air in many particulars which may be thus enumerated:—

(1) There will be more than ·04 per cent. of carbon dioxide present in the air. Most of this excess of carbon dioxide will have been produced by respiration, but part may have been evolved as a product of the combustion of coal, coal gas, or lamps.

(2) Organic matter from the lungs and skin will be present. This is probably the chief source of the offensive odour so obvious to anyone entering a badly ventilated room from the outer air.

(3) There will be a decrease in the amount of oxygen, resulting in a lowering of the vitality.

(4) A large increase in the quantity of water vapour will take place. This causes discomfort and interferes with the proper evaporation of moisture from the surfaces of the body.

(5) The temperature is higher. This increases the discomfort caused by the excess of water vapour in the air.

(6) Decomposition of organic matters upon the clothing

and the skin often occurs in schools, especially in poor districts, giving rise to offensive odours.

(7) An increase in the amount of dust, or suspended impurity, is common in schools. These particles of dust are of the most varied composition, some of the commonest being scales of skin, hair, fragments of wool, cotton, silk, soot, and common salt, and include many forms of bacterial life, and there may be disease germs present. Dust, of itself, is injurious, and for this reason the use of crayons, which adds considerably to the quantity of dust, is not to be recommended.

(8) There may be some special gaseous impurities present, such as carbon monoxide from coal gas, and oxides of sulphur, and other gases from the combustion of coal gas.

Carbon Dioxide.

The most constant of all these impurities is the carbon dioxide, and, as the estimation of the quantity of the gas is comparatively easy, it is usual to test the sufficiency or otherwise of ventilation by determining the percentage of this gas that is present. The method of estimation does not concern us here, but a simple test of the purity of the air is as follows:—Take a stoppered bottle with a capacity of 10½ oz. Fill it with the air to be tested by pumping through it by means of foot-bellows. Add ½ oz. of clear limewater, put in the stopper, and shake up. If the limewater is turned milky there is an excess of carbon dioxide present. This gives a very rough and ready test only. Systematic examinations of the air of schools at all times of the day by the Education Medical Officer should be regarded as essential; it is only by such tests that the ventilation of any school can be regarded as sufficient or otherwise.

One of the simpler but fairly exact methods of ascertaining the amount of carbon dioxide in the air in a school is by the use of Scurfield's apparatus. This consists of a cylindrical aspirator holding two pints of water, and a rack carrying seven tubes which are filled to a given height with a weak baryta solution coloured pink by phenolphthalein. One tube is connected to the aspirator for each estimation. The aspirator is furnished with a vertical gauge divided into tenths, each division representing 0·1 of the cubical contents of the aspirator.

To use it the aspirator is filled with water, and connected with one of the tubes. Then the air is drawn through the baryta solution until the pink colour disappears. The amount of air required to do this is measured by the aspirator. If the experiment is made first in the open air and repeated in the different rooms of the school it is obvious that strictly comparative results will be obtained. In the school there will be more carbon dioxide present and a proportionally smaller quantity of air will be necessary to remove the colour from the liquid. Assuming that the outside air contains ·04 per cent. of carbon dioxide, it is easy to calculate from the results of these experiments the amount of carbon dioxide in the air that has been tested.

Permissible quantity of Carbon Dioxide.

The amount of carbon dioxide in fresh air remains fairly constant at about ·04 per cent. Any excess over this amount is regarded as an impurity. Thus, if a sample of air was found to contain ·07 per cent. of carbon dioxide we should say that there was an impurity of ·03 per cent. of the gas. An impurity of ·02 per cent. is usually regarded as harmless, although a room containing this amount of impurity due to respiration smells slightly close

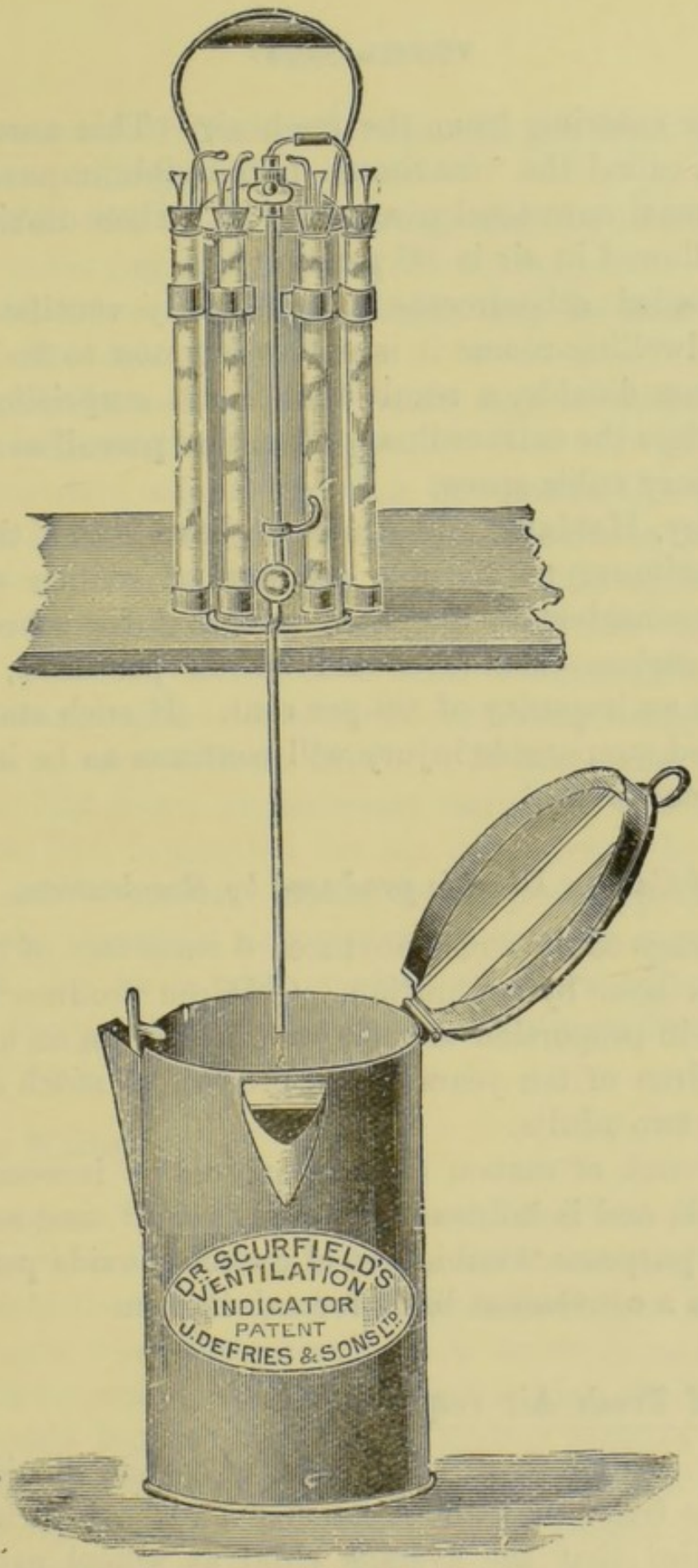


Fig. 15.

DR. SCURFIELD'S APPARATUS FOR DETERMINING THE AMOUNT OF CARBON DIOXIDE IN THE AIR IN A ROOM.

to anyone entering from the fresh air. This amount is, therefore, called the "maximum permissible impurity," so that the maximum total percentage of carbon dioxide that may be allowed in air is ·06 per cent.

In crowded schoolrooms and in badly ventilated and crowded dwelling-rooms it is not uncommon to find ·3 per cent. carbon dioxide, a result that is not surprising when one considers the extraordinary ideas that prevail as regards the necessary cubic space.

Carnelley, Haldane, and Anderson have stated that the above maximum permissible amount of carbon dioxide should be considerably increased, and that for schools the limit of carbon dioxide should be ·13 per cent., which represents an impurity of ·09 per cent. If such standards are adopted irreparable injury will continue to be inflicted upon the children.

Amount of Carbon Dioxide produced by Respiration.

The average adult at rest produces ·6 cubic feet of carbon dioxide per hour by respiration. Children produce larger quantities in proportion to their weight, and on an average three children of ten years of age produce as much carbon dioxide as two adults.

The amount of carbon dioxide expired is increased by active work, and is influenced by diet, weight, and sex, but for school purposes ·4 cubic feet of carbon dioxide per head per hour is a convenient basis for calculation.

Amount of Fresh Air required.

We may assume that ·02 per cent. of carbon dioxide can be added to fresh air without causing it to be injurious to health. Also that the average child at school produces ·4 cubic feet of carbon dioxide per hour. The calculation

of the amount of fresh air required per head per hour proceeds as follows:—

·02 cubic feet of carbon dioxide may be added to 100 cubic feet of fresh air;

∴ ·04 cubic feet of carbon dioxide may be added to 200 cubic feet of fresh air;

∴ ·4 cubic feet of carbon dioxide may be added to 2000 cubic feet of fresh air.

The standard adopted by law in some of the American States is 1800 cubic feet per hour. The above calculation shows that there should be supplied 2000 cubic feet of fresh air for each scholar per hour. If the cubic space allowed per head is 100 cubic feet, this amounts to completely changing the air of the room twenty times per hour, which is a very difficult matter. If the space per head which is laid down as necessary earlier in this book, viz. 200 cubic feet, is adopted the air will have to be changed ten times in the hour. Apart from special appliances for ventilation the air in a room usually changes once an hour through the walls and crevices of doors and windows, leaving the problem at changing the air nine times in the hour, or once every seven minutes.

Organic Matter.

The organic impurity in air is estimated with much more difficulty than the carbon dioxide, and it is therefore usual to estimate the quantity of carbon dioxide that is present, and to infer from these results how much organic matter must have accompanied the carbon dioxide. This is generally reliable because the organic matter appears to be an invariable accompaniment of the carbon dioxide produced by respiration, and so the quantity of carbon dioxide in the air of a room may be taken as a fair index of its purity.

The *detection* of the organic matter is comparatively

simple. If a large amount of the air is drawn through some distilled water the organic impurities are retained by the water, and, if kept a short time, quickly decompose and evolve a very offensive smell. Or the air may be drawn through strong sulphuric acid, which chars the organic matter and becomes brown. Still another method is to draw the air through water rendered pink by acidified permanganate of potash. Organic matter soon removes the bright pink colour.

Effects of Bad Ventilation.

Living in a badly ventilated room for a few hours produces drowsiness and headache, a sense of oppression and discomfort, slowing of the heart's action, and quickening of respiration, and interferes greatly with the efficiency of the teacher and the scholars. The power of concentration on the part of the scholars is also greatly decreased. Un fortunately the evil does not stop here. A lowering of the vitality results, and there is an increased tendency to contract diseases of all kinds. Under such conditions consumption very often occurs, and infectious diseases, when once started, spread very rapidly. Anaemia, loss of appetite, and impairment of nutrition commonly result from bad ventilation. A striking illustration of the relationship between foul air and consumption is given by the following statistics contained in the report of the Army Sanitary Commission. Foot Guards had been allowed 331 cubic feet of space per man in their barracks, and the death-rate from consumption among them amounted to 13·8 per 1000; while the Horse Guards, with a cubic space of 572 feet per man, showed a mortality of only 7·3 per 1000. On increasing the cubic space per head there was a very marked diminution of the mortality from all causes. Under the greatly improved conditions the death-rate from

consumption in the Army at the present time is slightly below that of the male civil population at the same age, whereas fifty years ago it was in notable excess of that amount. The frequent occurrence of the disease in animals kept in confinement serves as another illustration of the relationship that undoubtedly exists between consumption and the breathing of a vitiated atmosphere.

Hamer says, "The evidence which has accumulated in recent years as to the dissemination of certain diseases, particularly diphtheria, scarlet fever, and measles, in school class-rooms, is quite conclusive as to the risk incurred by bringing together a number of children within a confined space, unless the most thorough precautionary measures are undertaken with a view to the detection and exclusion of sufferers from the maladies referred to." As a matter of fact the absolute exclusion of every one of these cases is not possible at present, and probably never will be. But the risk of contagion would be greatly decreased if the ventilation of our schools were brought up to a higher standard. Improved ventilation would not only effect this by simple dilution, but would also result in an improved physical condition of the children, so that they would not be so liable to contract any disease. Shutting up children in badly ventilated rooms brings about a bodily condition which offers little or no resistance to invasion by the micro-organisms of disease.

Extreme cases, such as are illustrated by the incident of the Black Hole of Calcutta, show that when the products of respiration are breathed in a concentrated condition rapid poisoning results. At Calcutta 146 persons were imprisoned in a room about 18 feet square, and with only two small windows. In the morning there were 123 dead and, of the 23 who were living, several afterwards died of putrid fever, the effects of the organic poison they had

inhaled. A similar catastrophe befell the steerage passengers of the *Londonderry* who, in 1848, were shut down in the cabin during a storm. Among those who recovered from the immediate ill-effects many suffered from fever and mal-nutrition. Such extreme cases are not likely to occur in schools and are mentioned simply in order to illustrate the fact that we have to deal with a poisonous pollution of the air.

Methods of Ventilation.

The efficient ventilation of schools is undoubtedly one of the most important problems of the hour. In a great number of the older schools the question of ventilation does not appear to have been considered in any way, while in the more modern ones elaborate installations have been fixed at a great cost without any corresponding satisfaction.

The methods of ventilation may be divided into two kinds—the natural and the artificial. By **natural ventilation** we mean any method that depends upon the natural forces which set air in motion, and does not involve the use of any mechanical means for the renewal of the air. **Artificial ventilation,** on the other hand, depends upon the use of pumps, fans, bellows, etc.

NATURAL VENTILATION.

Two properties of gases play a very important part in the theory of ventilation; these are (1) diffusion, and (2) changes in the density of the air produced by heat.

Diffusion is the property of gases to mix thoroughly and completely even against gravity, *i.e.* a heavy gas will diffuse upwards and completely mix with a lighter gas, and a light gas will diffuse downwards and mix with a heavier one.

For instance, if in Fig. 22 the upper jar is filled with coal gas, which is a light gas, and the lower jar with air, which is a comparatively heavy one, then, on removing the plates between them and allowing them to diffuse about half an hour, the lower jar will be found to contain just as much coal gas as the upper jar, and both may be lighted. Of course, if the heavy gas is placed above the light one, the mixing will take place more rapidly. The same result would be obtained, after a longer time, if a partition of some porous substance, such as unglazed earthenware, were placed between the jars. It is found that the lighter a gas is the faster it diffuses, and that if a light gas is on one side of a porous partition and a heavier gas on the other, then the light gas will diffuse through into the heavy one faster than the heavy gas will diffuse into the light one.

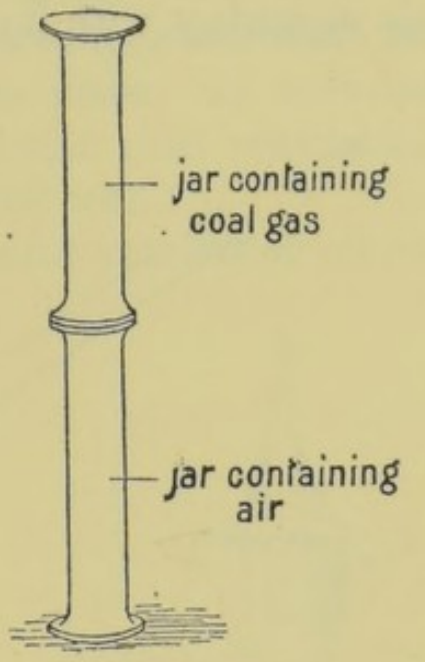


Fig. 16.
DIFFUSION.

Now in an ordinary room the air is warmer and, as we shall see, lighter than the cold air outside. Diffusion outwards, therefore, will take place at a greater rate than diffusion inwards, and fresh air will enter the room not only as the result of this process of diffusion, but also in order to equalise the pressure inside and outside the room. Diffusion through the walls of a room is greatly interfered with by the paper, plaster, and paint with which the walls are covered. As an example of the power of diffusion as a ventilating force it is said that in the case of a cubical room with brick walls, contents 3000 cubic feet, and difference of temperature between the

inside and outside air being 35° Fahr., the air would be completely changed in one hour by diffusion alone.

Changes in Density of Air.

When air is heated it expands. For this reason a pint of cold air will weigh heavier than a pint of hot air. Hot air therefore rises and cold air will take its place. This is exactly how **winds** are produced. The surface of part of the earth becomes heated by the sun; this warms the air in contact with it and causes it to expand and rise; the

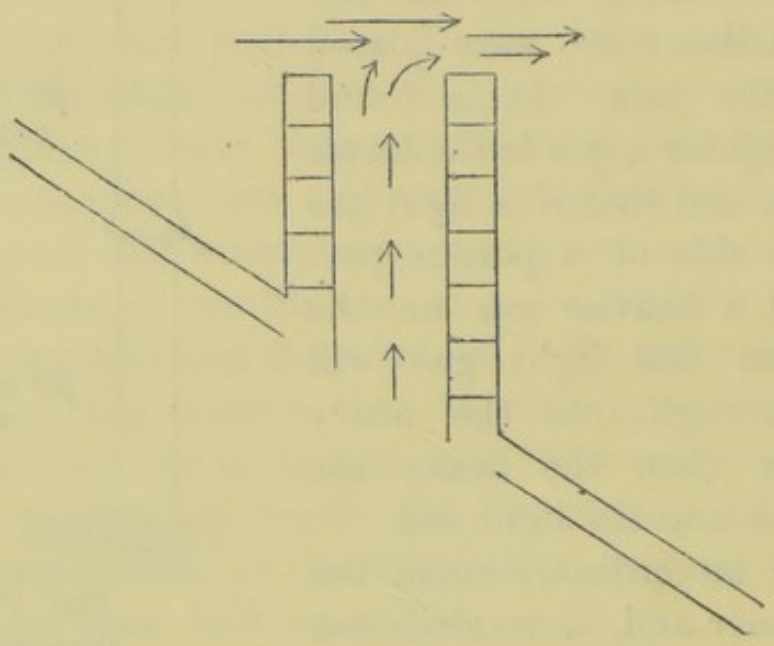


Fig. 17.

Aspirating Effect of Chimney.

colder surrounding air then rushes in to take its place and a wind is produced.

The application of this to ventilation is easy. Foul air —being a product of respiration and combustion—is always hotter than the fresh air, and so it will rise, and if an opening is provided, it will escape. Fresh air will then enter through any opening to take its place. For the same

reason the hot air over a fire goes up the chimney, and is replaced by fresh and colder air entering by windows, door, keyholes, and cracks.

Wind, as a ventilating agent, may act in two ways :—

(1) By perflation, *i.e.* by blowing through a room when the doors and windows are open.

(2) By aspiration. This is illustrated by the draught up a chimney when there is no fire below. The wind blowing over the top of the chimney lessens the pressure of air in the chimney, producing an up-draught, while fresh air is drawn into the room to take its place. In crowded courts surrounded by higher buildings this ventilating action of the wind is greatly interfered with.

There are a number of appliances for ventilation which make use of this aspirating effect of the wind. Boyle's ventilators and Banner's cowls are two forms which are widely used.

Boyle's *Air-pump Ventilator* has fixed openings on different sides. (See Fig. 18.) The wind, blowing from almost any direction, passes through some of the openings and out of the opposite ones. In doing so, air is extracted from the tube or air-exit over which the ventilator is placed.

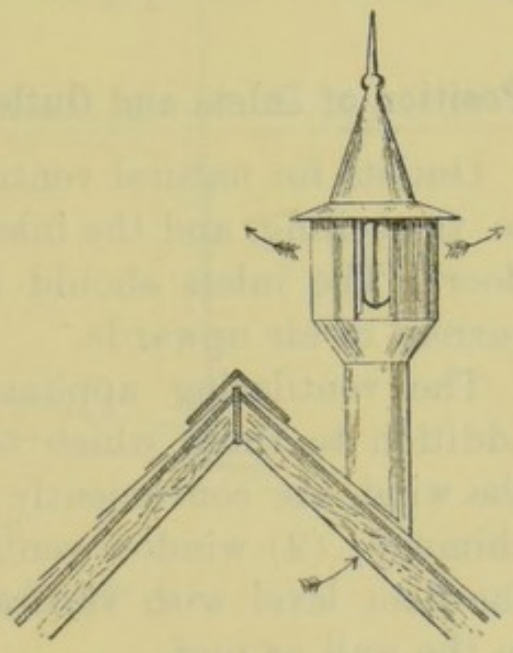


Fig. 18.

Boyle's Air Pump Ventilator

Banner's Cowl sets itself, by means of a wind vane, so that the opening is always directed to face the wind.

OPENINGS FOR VENTILATION.

Outlets for foul air and inlets for fresh air must both be provided. It is a common practice to provide the outlet only and to make no provision for the entrance of fresh air. In order to provide the necessary 2000 cubic feet of fresh air per hour an opening of 16 square inches must be provided, assuming the air to enter the room at an average velocity of 5 feet per second. An outlet of the same or larger size is necessary. In a class-room for 48 scholars the inlets should therefore have a minimum total area of $5\frac{1}{3}$ square feet and the outlets the same or rather more. The ventilation inlet opening recommended by the Board of Education is certainly inadequate, and betrays an entire ignorance of the subject.

Position of Inlets and Outlets.

Outlets for natural ventilation are usually provided close to the ceiling, and the inlets at about five feet above the floor. The inlets should be so arranged as to direct the current of air upwards.

The ventilating appliances for natural ventilation, in addition to those which take advantage of the action of the wind, are conveniently divided in four groups, (1) the chimney; (2) window ventilation; (3) openings at or near the floor level with vertical tubes or shafts; (4) openings in the wall or roof.

The Chimney.

The chimney, if present, acts as an excellent and most efficient outlet. If a fire is burning in the grate the action is to rush air out of the room at a great rate, and when there is no fire the chimney is still a valuable outlet.

Window Ventilation.

(*a*) The simplest and most obvious method of ventilation is that of open windows; and in warm weather it is undoubtedly the best. In cold weather, however, it is very liable to produce draughts.

(*b*) The upper part of the window can be made to work

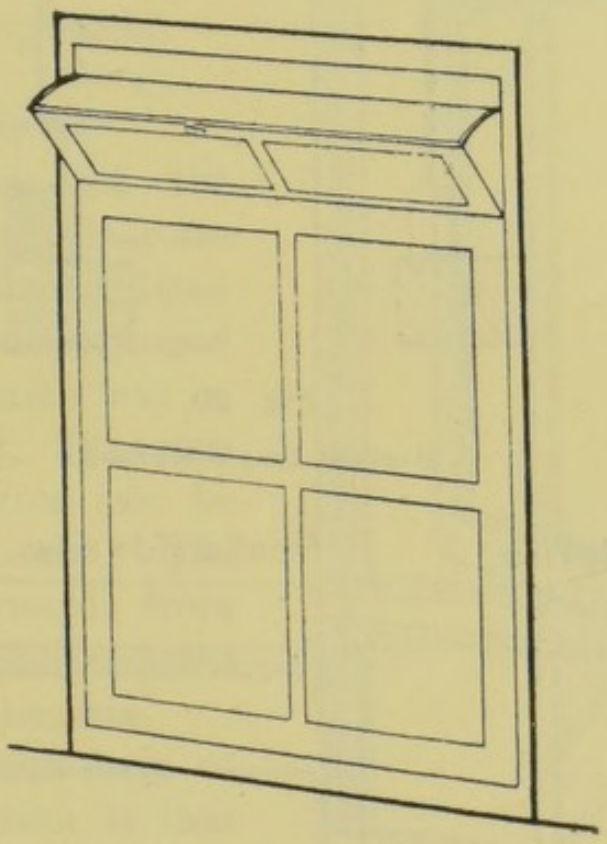


Fig. 19.

HINGED TOP TO WINDOW.

on a hinge so that the top moves into the room. Triangular pieces of glass or wood should be placed at the sides to prevent down draught. The current of fresh air will then be directed upwards, as is the case with all efficient ventilators. Similar hopper openings can be arranged 6 feet from the floor and may act as inlets or outlets.

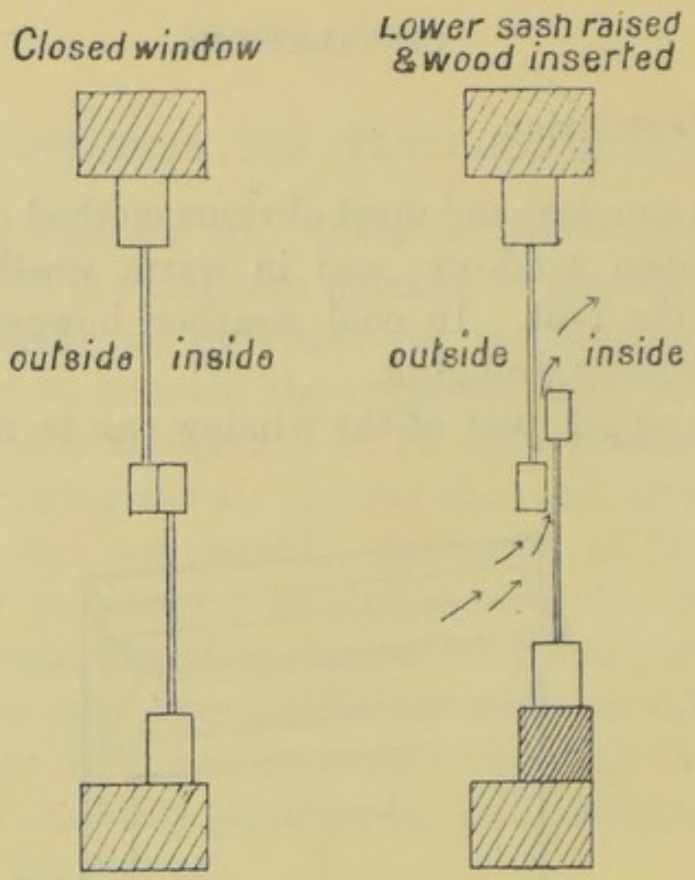


Fig. 20.

HINCKES BIRD'S METHOD.

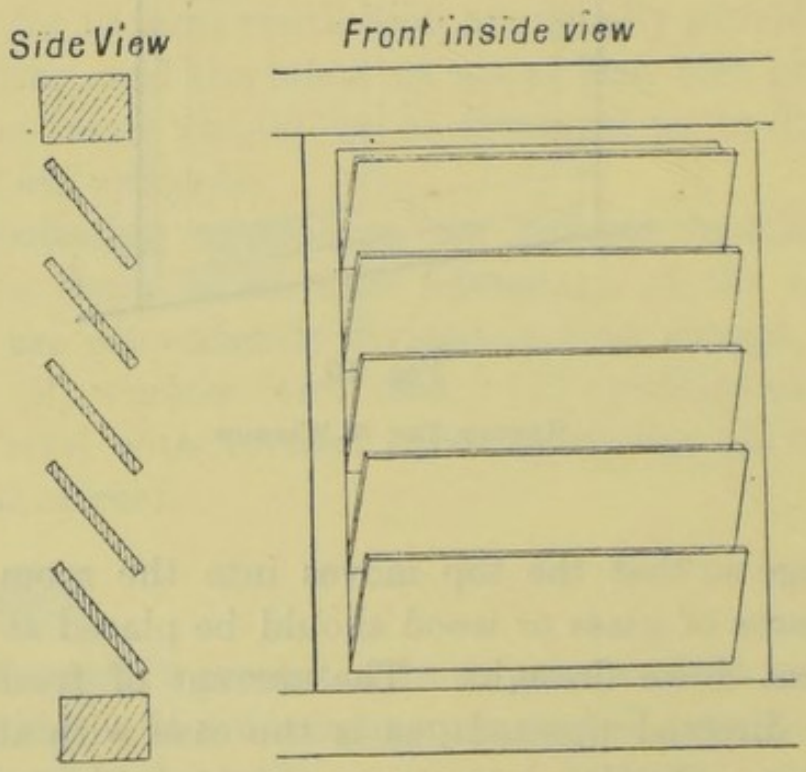


Fig. 21.

LOUVRE VENTILATOR.

(*c*) A very simple and excellent method of window ventilation is that suggested by **Hinckes Bird**. The lower sash is raised, and a block of wood is accurately fitted in the opening below so as to completely close it. Fresh air enters between the two sashes and is directed upwards.

(*d*) *Louvre Ventilator.*

One or more of the ordinary panes of glass are removed and the space fitted with strips of glass arranged in exactly the same way as a Venetian blind. The space between the strips can be adjusted by cords. The strips slant upwards from the outside, and direct the current of air upwards.

(*e*) An excellent form of window ventilation is that of the Chaddock Window (Fig. 22). The ease of manipulation is remarkable, and the results obtained are extremely satisfactory.

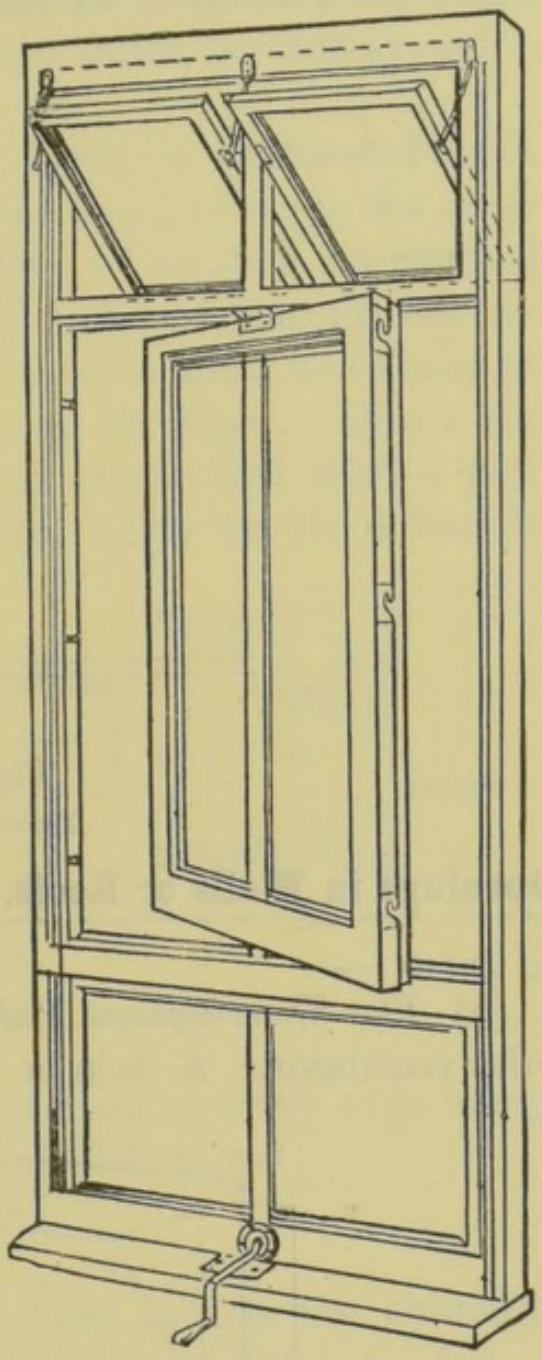


Fig. 22.
THE CHADDOCK WINDOW.

Openings near Floor with Vertical Shafts:—

Tobin's Tubes. The air enters from the outside through an opening in the wall at the floor level; it is then directed upwards by the vertical shaft or tube about six feet high.

At the top the tube is fitted with a valve by means of which the amount of air coming in may be regulated.

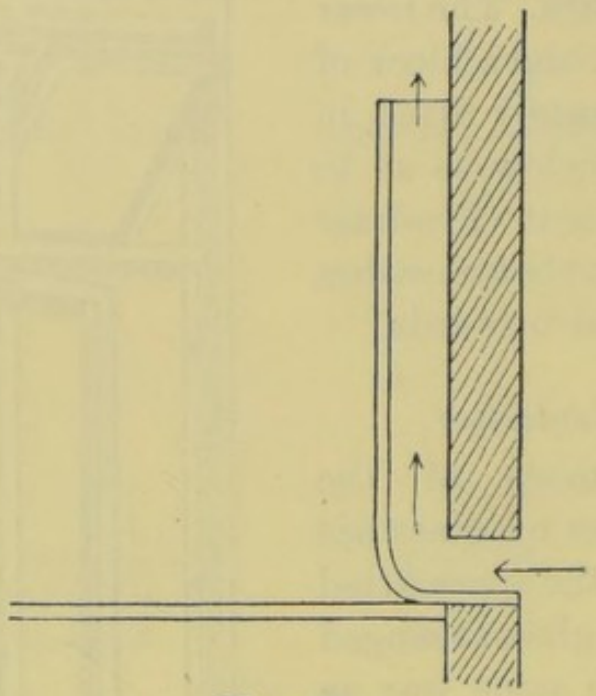


Fig. 23.
TOBIN'S TUBE.

Openings in Walls or Roofs.

I. *Inlets:—*

(*a*) *The Sherringham Valve* is a simple and a very good inlet ventilator. A hole is made in the wall about seven

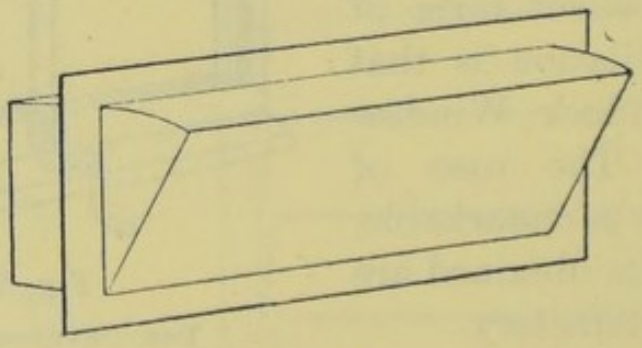


Fig. 24.
SHERRINGHAM VALVE.

or eight feet from the floor. Into this is fitted an iron box, with a grating on the outside and a hopper valve on the inside. The air passes from the outside through the

grating and into the room through the valve, the size of which may be regulated by a pulley. The inside aperture of the ventilator is larger than the outer, so that draughts are not usually produced.

(*b*) *Ellison's Bricks.* Each brick is perforated with conical holes, the apex of the cone being towards the outer air, so that the incoming current of air has its channel continuously increased in size, thereby causing its velocity to be decreased. The action of these conical holes may be very simply illustrated by a cone of paper. Direct the large opening towards a lighted candle and send a puff of breath down the small opening. The candle is hardly

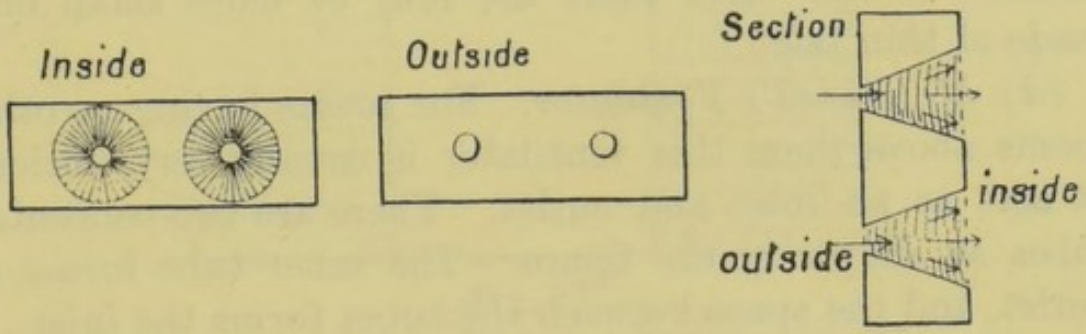


Fig. 25.

Ellison's Air Bricks.

affected. If the cone is now reversed and the experiment repeated the candle will at once be blown out.

II. *Outlets:*—

(*a*) The chief outlet, as we have said, is the **chimney.** When a fire is burning, from 5,000 to 25,000 cubic feet of air pass up the chimney per hour.

(*b*) *Arnott's Valve* is an outlet made to be fixed in the wall so as to open into the chimney. It consists of an iron box with a light metal valve capable of swinging towards the chimney, but not into the room. The foul air can therefore pass up the chimney, but the smoke cannot pass

into the room. An objectionable feature of these ventilators is the clicking noise they make. Also, when in any way out of order, they admit smoke from the chimney. Fig. 27 shows an improved method. The outlet shaft is built alongside the chimney shaft and acts as an efficient outlet.

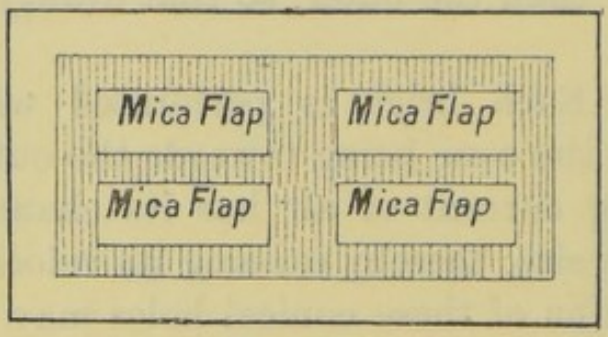


Fig. 26.
Boyle's Mica Flap Ventilator.

(*c*) *Boyle's Mica Flap Ventilator* is simply an improvement upon Arnott's valve. Instead of one valve there are four or more small ones made of thin talc.

(*d*) *McKinnell's Ventilator.* For rooms having no other rooms above them this ventilator is usually very efficient. It acts as an inlet and outlet. There are two concentric tubes as shown in the figure. The inner tube forms an outlet, and the space between the tubes forms the inlet.

Value of Natural Ventilation.

It is necessary to preface any remarks upon the subject with the statement that attempts to ventilate schools by natural ventilation are usually of the most crude and elementary description. When a building is to be ventilated by artificial means very careful calculations are made, and the whole system is fully planned and thought out from beginning to end; but with natural ventilation little or no trouble is taken, and there is usually no systematic attempt to deal with the difficulty. If the same serious efforts were devoted towards effecting efficient ventilation by natural means as are always given to the provision and maintenance of artificial ventilation, it is at all events possible that much more satisfactory results would be obtained.

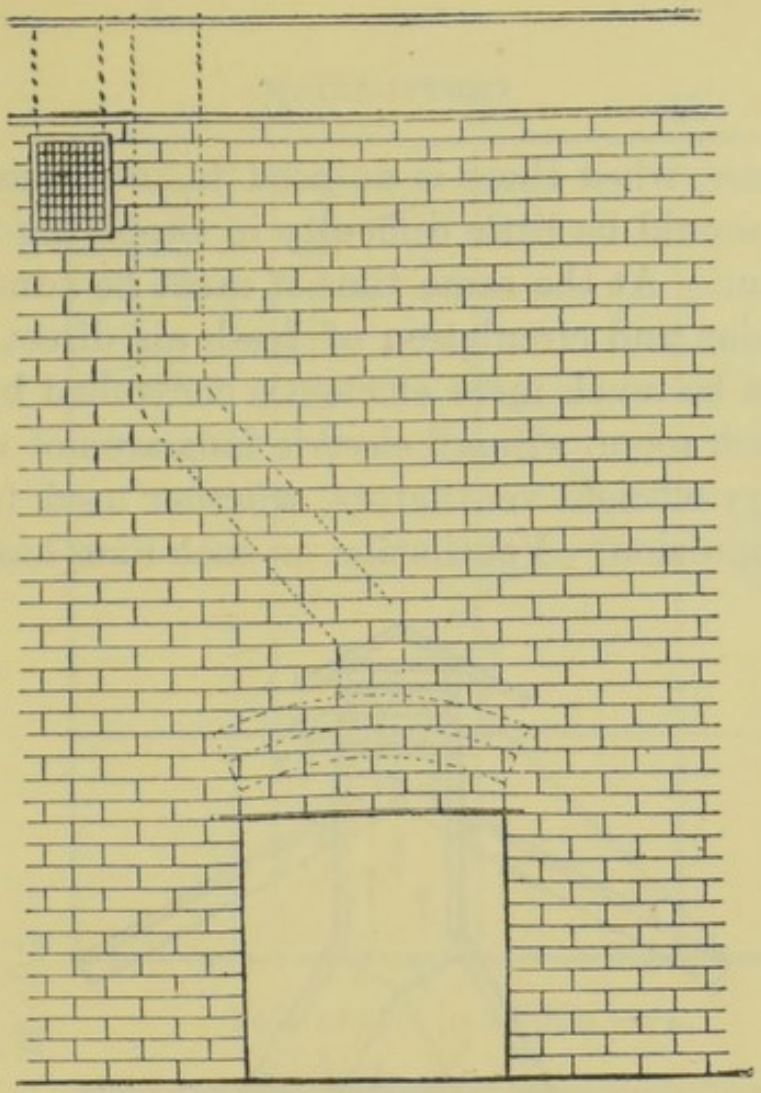


Fig. 27.

CHIMNEY BREAST AIR OUTLET.

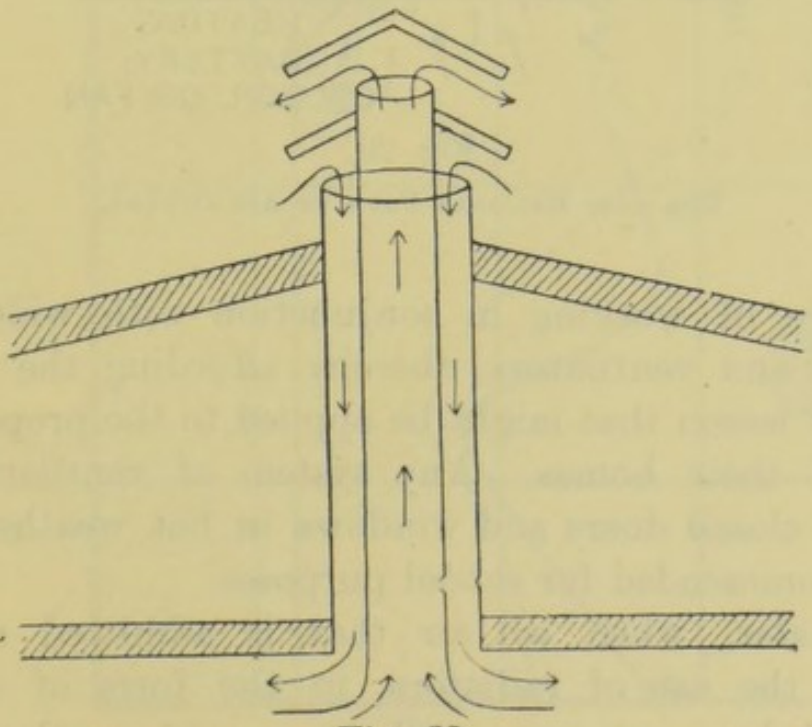


Fig. 28.

McKINNELL'S VENTILATOR.

In summer, when there is no need to introduce warmed air, there should be little difficulty in supplying the necessary amount. At the same time it must be admitted that the admission and circulation of fresh air direct from the outside can be much more efficiently controlled by separate fans for each room. Small electric fans are not very costly and are very efficient ventilators, whether used for extraction or propulsion. Ventilation on such lines has the great

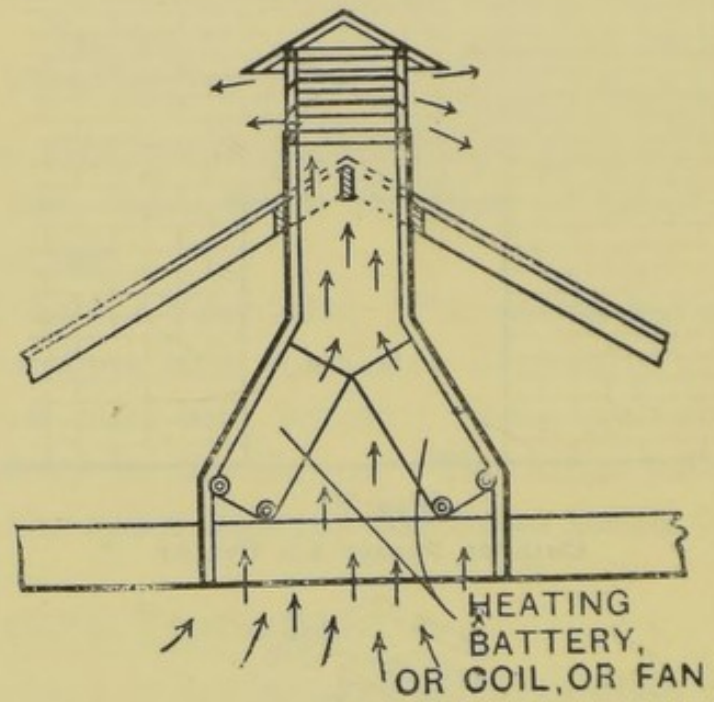


Fig. 29.

THE MOST RELIABLE FORM OF AIR OUTLET.

advantage of working in conjunction with widely open windows and ventilators, thereby affording the children an object lesson that might be applied to the proper ventilation of their homes. Any system of ventilation that demands closed doors and windows in hot weather is not to be recommended for school purposes.

In winter, when all air that is admitted must be warmed, the use of radiators, in the form of modified Tobin's tubes, act very well as a rule, or the various

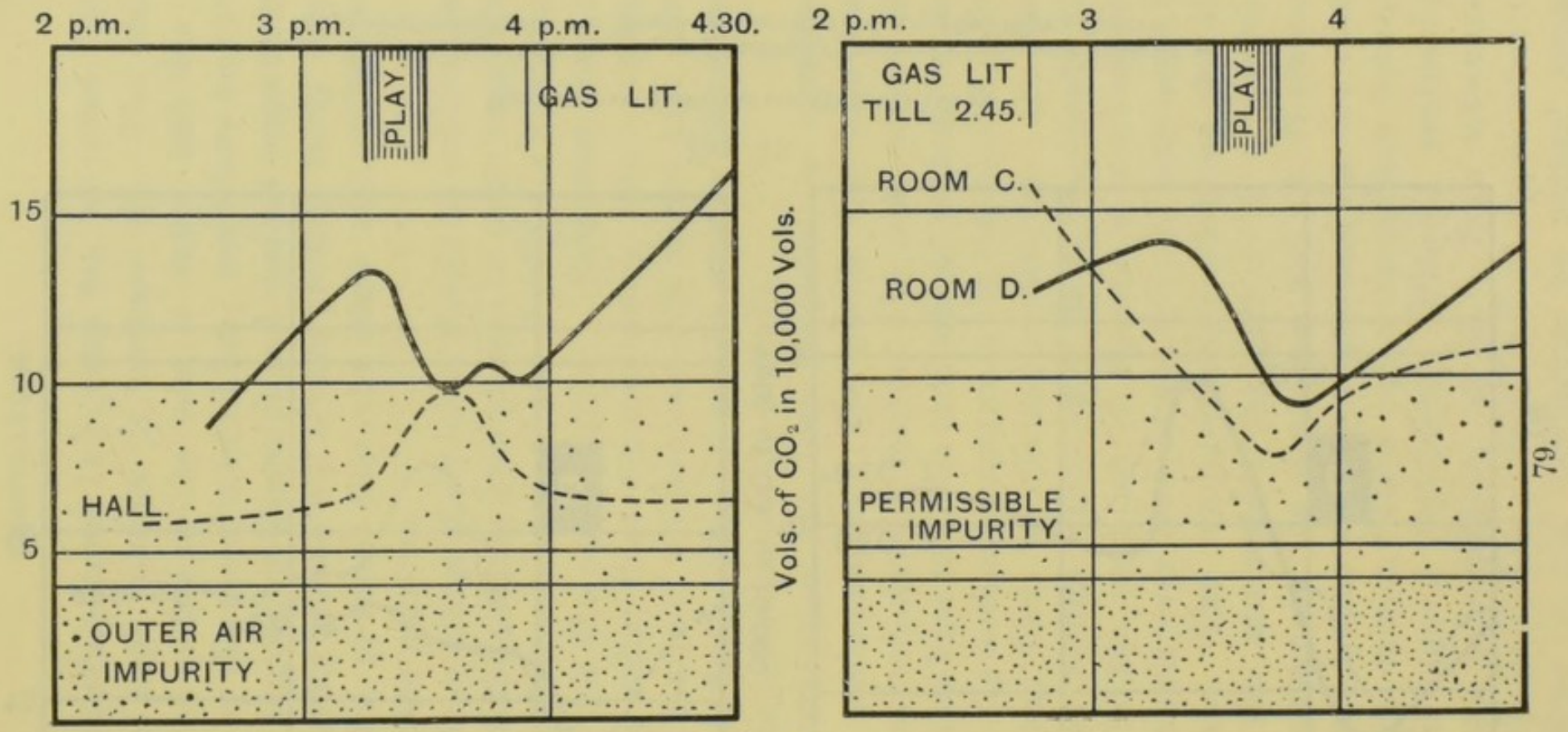


Fig. 30.

NATURAL VENTILATION.

These diagrams show the variation in the CO_2 due to perflation during recess.
Also effect of gas lights.—Dr. Kerr's Reports.

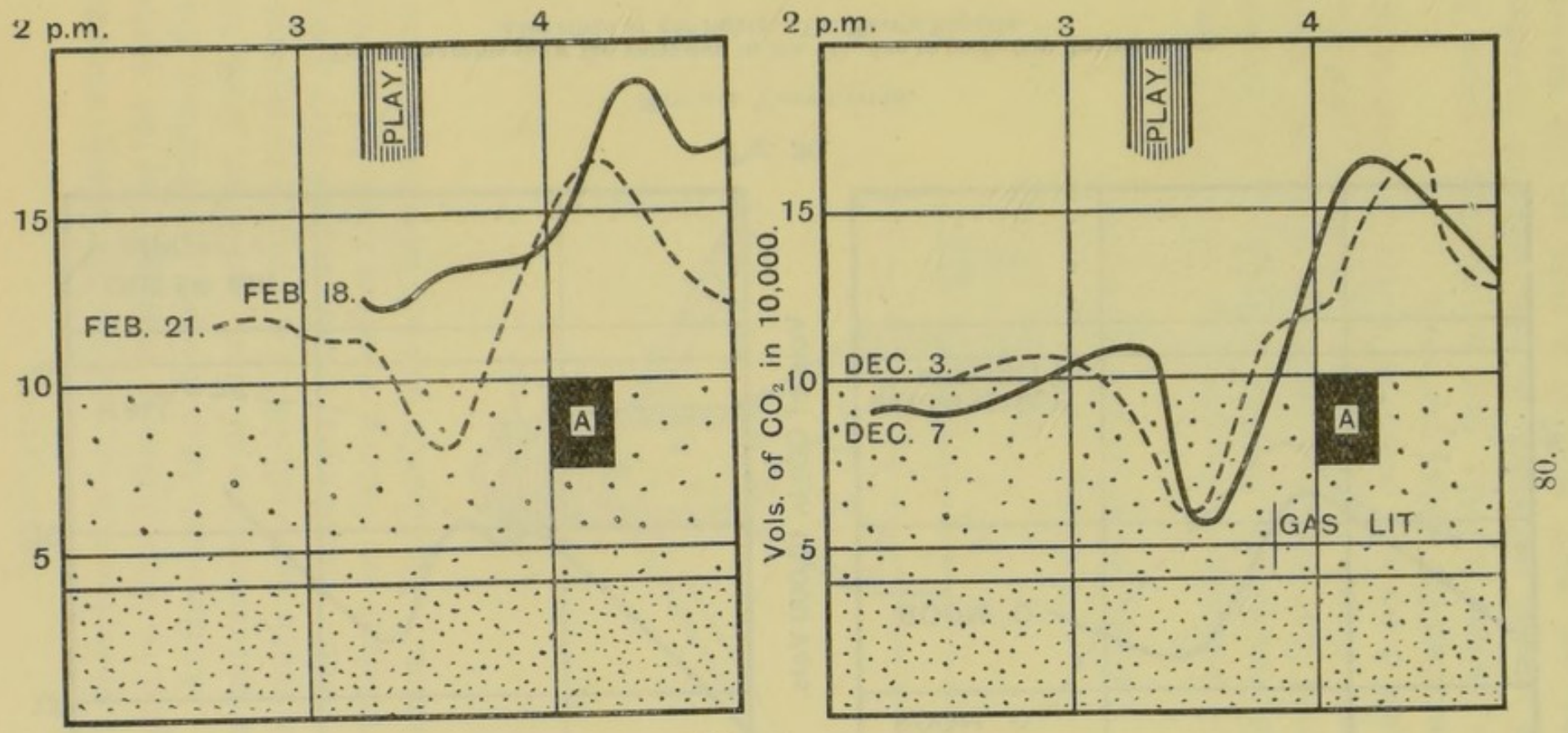


Fig. 31.

MECHANICAL VENTILATION (INSUFFICIENT).

These diagrams show how the CO_2 may suddenly increase when outer doors of an adjoining department are opened (at time marked A).—Dr. Kerr's Reports.

forms of ventilating stoves and grates can be relied upon to introduce large volumes of warmed air. The chief difficulty is the *control* of the inlet or outlet, and this is best secured by the use of a small fan; but where fans are too costly or impossible a careful and serious supervision of the ventilating scheme will always produce fairly satisfactory results, provided that the inlets and outlets are sufficient for the purpose.

The outside openings of air inlets should be not less than six feet above the outside ground level in order to prevent the entrance of an excessive amount of dust; or filters may be arranged for the same purpose. Extraction may be controlled by using flues communicating with a vertical shaft, in the centre of which a cast-iron smoke pipe, from the furnace, is fixed. This hot surface rarefies the vitiated air and causes a continuous up-draught.

Natural ventilation has been subjected to somewhat exaggerated condemnation. The results that have been obtained have undoubtedly merited the most severe disapproval; these have not been produced by natural ventilation, but, in the author's experience, by an almost entire absence of any form of efficient ventilators. Dr. Kerr has published results which show most graphically the superiority in the condition of the air in mechanically ventilated schools over that in the schools ventilated by natural means. The results possibly illustrate the difference in the atmosphere maintained by a carefully supervised system on the one hand, and an ill-planned and inadequate system with no supervision on the other. In Dr. Kerr's opinion "there is no comparison between artificial and natural ventilation. Natural ventilation, in fact, means no ventilation at all." Such statements are deplorable and show a total lack of appreciation of the possibilities of real ventilation by natural means.

Dr. Reid's experiments with the Staffordshire type of school show conclusively that excellent ventilation may be achieved by natural means, and experiments carried out by the author serve to show that if intelligent supervision is exercised over these methods the results are as good as those obtained by mechanical means, while the educational effect is greatly superior. On the other hand, Dr. Kerr admits that "the artificial systems mean that doors and windows must be shut, and that alone gives a feeling of 'closed-in-ness' to the people who work in the room."

ARTIFICIAL VENTILATION.

The methods of artificial ventilation depend either upon one of the following processes, or upon the two combined:—

1. Extraction processes, or vacuum methods, in which the vitiated air is forced out of the room, and fresh air enters mainly through inlets provided.
2. Propulsion processes, or plenum methods, in which the fresh air is forced into the room, and the foul air escapes through the usual outlets.

A combination of the two systems is usually advisable, but where one only is adopted the propulsion process is usually regarded as preferable, because the air can then be obtained from a known inlet, and can be warmed, filtered, and otherwise treated before it enters the rooms. If extraction is employed the sources of fresh air cannot be controlled so easily as in the case of propulsion, but it is possible that this method may be found eventually to be the more satisfactory.

Fans.

Fans are usually relied upon in all systems for the artificial ventilation of schools. The open-blade types of

fan are preferable, as they are easily kept in order and are economical. An electric fan ten feet in diameter, running at ninety revolutions per minute, and delivering 2,115,000 cubic feet of air per hour is used in the Bradford schools, and costs the astonishingly small sum of 1·3 pence per hour.

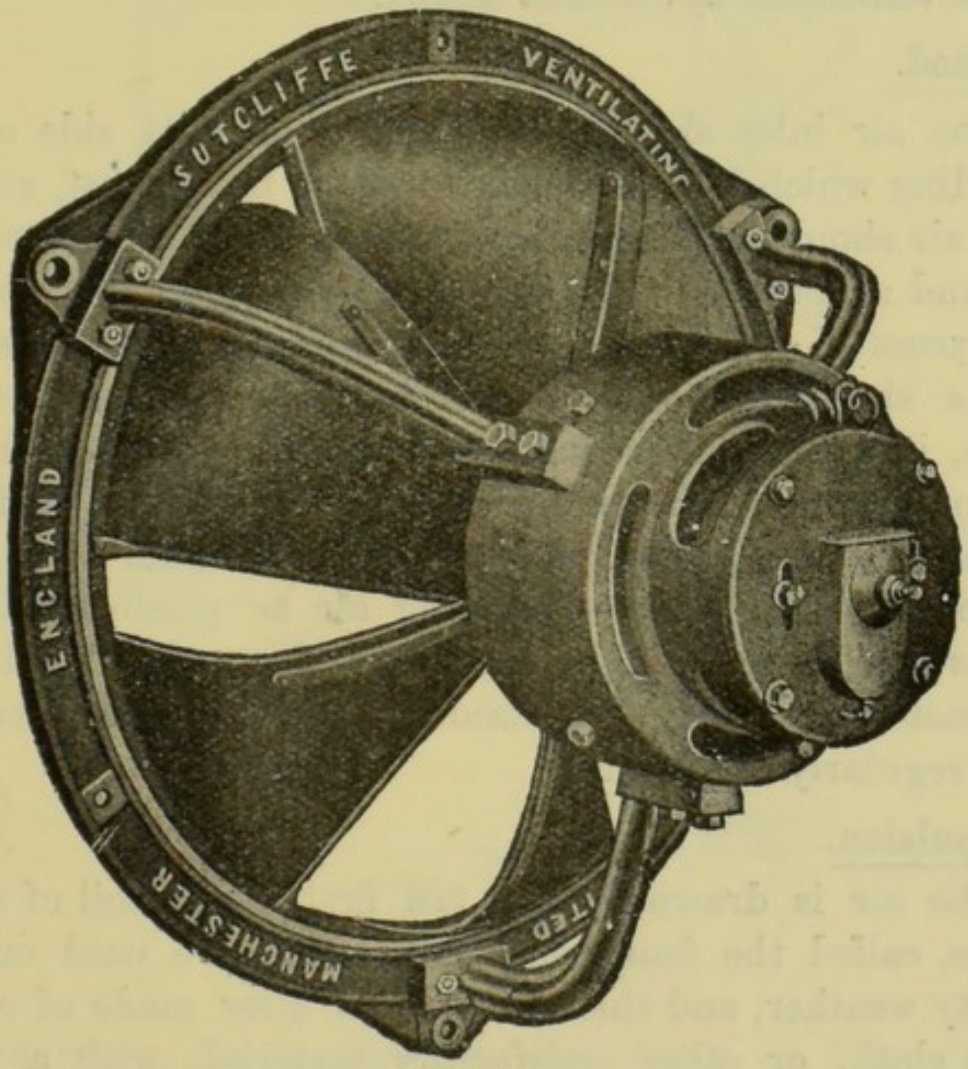


Fig. 32.

Combined Fan and Motor.

Fans may be driven by electric motors, by steam, or by a gas engine. Electricity should always be used where possible, as it possesses the combined advantages of being cheap, noiseless, and inodorous.

Cost.

The cost of fuel in schools ventilated by mechanical means should be less than in schools which rely upon natural methods. In Bradford the cost for fuel per ten square feet floor space is slightly over tenpence in mechanically ventilated schools, and nearly elevenpence halfpenny in those ventilated by natural means.

Method.

The air inlet should be arranged on that side of the building which is most likely to yield the purest supply. The air should be drawn from a point as high above the ground as possible. It should be of ample size, greatly in excess of its theoretical requirements. The main air-ducts should be very large, and not less than six feet high, in order that regular and thorough inspection may be maintained. They must be made with smooth surfaces; preferably lined with glazed bricks, in order to give as little resistance to the inflowing air as possible. If the ducts are lined with glazed bricks they must be cleaned at least once a year. Unglazed surfaces should be carefully and regularly limewashed.

Propulsion.

The air is drawn by the fan first over a coil of steam pipes, called the tempering coil, which are used only in frosty weather, and then through a filter made of coarse jute cloth, or other satisfactory material, with a water spray attached. A layer of coke between wire netting makes a satisfactory filter. Cheese cloth screens have also proved to be very efficient. The use of the water spray in warm weather probably makes the air too humid. It is necessary when the air is being warmed, and additional moisture should be supplied. The current of air then passes through the fan and along the main duct, from

which it enters the branch ducts which lead to the different parts of the building. At the entrances of branch ducts additional steam coils may be placed if it is desirable to keep one part of the building at a higher temperature than the rest, or to afford increased heat to provide for

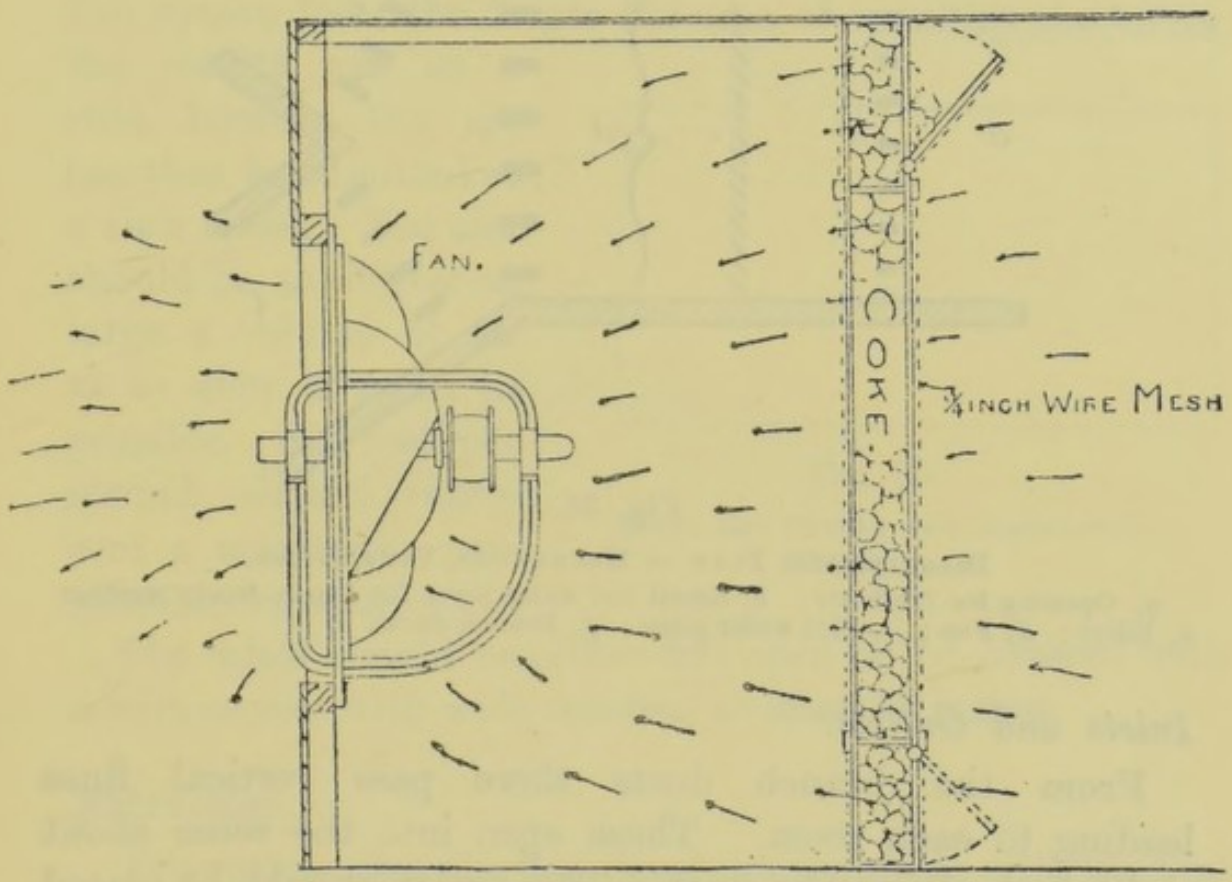


Fig. 33.

FAN AND COKE FILTER.

loss during passage through long ducts or for exposed rooms.

Source of Heat.

It is important to avoid the use of excessively hot pipes. A maximum limit of 228° F., equal to a pressure of 5 lbs. on the boiler, should be adopted. If higher temperatures are used, the air becomes "burnt" or "dead," and loses its "vitality." Possibly a great deal of the feeling of

oppression that many people experience in mechanically ventilated buildings is due to this cause.

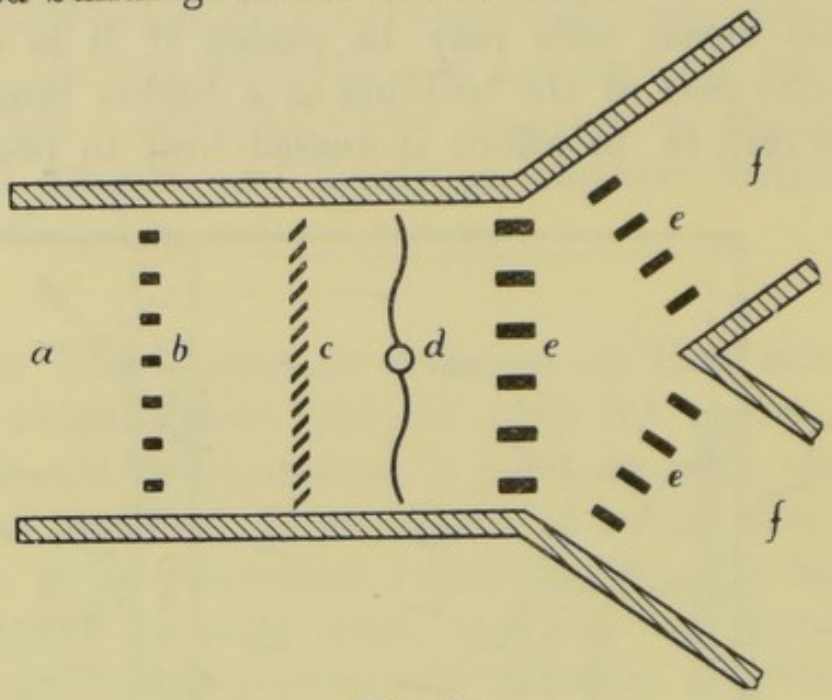


Fig. 34.

DIAGRAMMATIC PLAN OF MECHANICAL VENTILATION.

a, Opening for fresh air; *b*, Small hot water pipes for use in frosty weather *c*, Filter; *d*, Fan; *e*, Hot water pipes; *f*, Branch ducts.

Inlets and Outlets.

From the branch ducts there pass vertical flues leading to each room. These open into the room about eight feet above the floor. The outlet should be placed on the same wall, quite close to the floor. These positions for the inlet and outlet respectively are the outcome of a series of experiments made with a view of determining the respective positions for the inlet and outlet which would result in the most complete change in the air of the room. All other positions for the inlet and outlet were found to leave almost unchanged the layer of air, four feet deep, that rests on the floor. This layer is, of course, the air which is of the greatest importance, as the scholars live in it. The above arrangement not only produces a better distribution of the fresh air, but is more

economical in the working, as there is a greater amount of heat extracted from the air before it is finally discharged.

The inlet should be as large as possible: it is an advantage to arrange several inlets along the same wall, and the same number of outlets below. The total area of inlet for a room 30 feet by 25 feet should not be less than five square feet; the larger the area of openings the better the results are as a rule, because the air can then be admitted at a slow speed. The aim should be to deliver as large a volume of air at as slow a speed as possible. Six feet per second should represent a maximum permissible velocity.

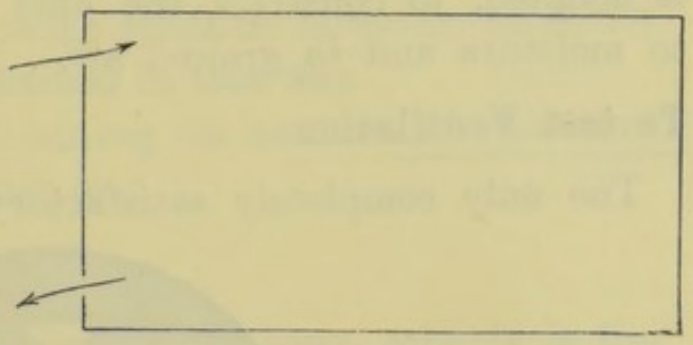


Fig. 35.

INLET AND OUTLET FOR MECHANICAL VENTILATION.

The inlets should be either left open or be covered with a wire screen with wide meshes, at least 1½ inches.

Extraction.

The outlets near the floor level communicate with the foul air duct which, in its turn, communicates with a vertical upcast shaft. The vertical shaft should be of very large sectional area and, as a rule, some assistance is necessary in order to secure a strong up-draught here. The methods that may be adopted for this purpose include—

(1) A fan fixed near the top of the vertical shaft. This is by far the best arrangment, as the whole system is then duplicated to a certain extent, so that, if the plenum fan breaks down, the other can still carry on a certain amount of ventilation. Another important advantage is that the amount of extraction can be regulated.

(2) A central cast-iron pipe bearing hot waste gases from the furnace.

(3) Lighted gas jets or steam jets at the bottom of the shaft.

Cool Air in Summer.

If the fresh air duct is carried underneath the basement the air supplied during the hot weather will be cooled several degrees. Great care should be taken, if this plan is adopted, to construct the duct so as to be impervious to moisture and to ground air.

To test Ventilation.

The only completely satisfactory test is to analyse the

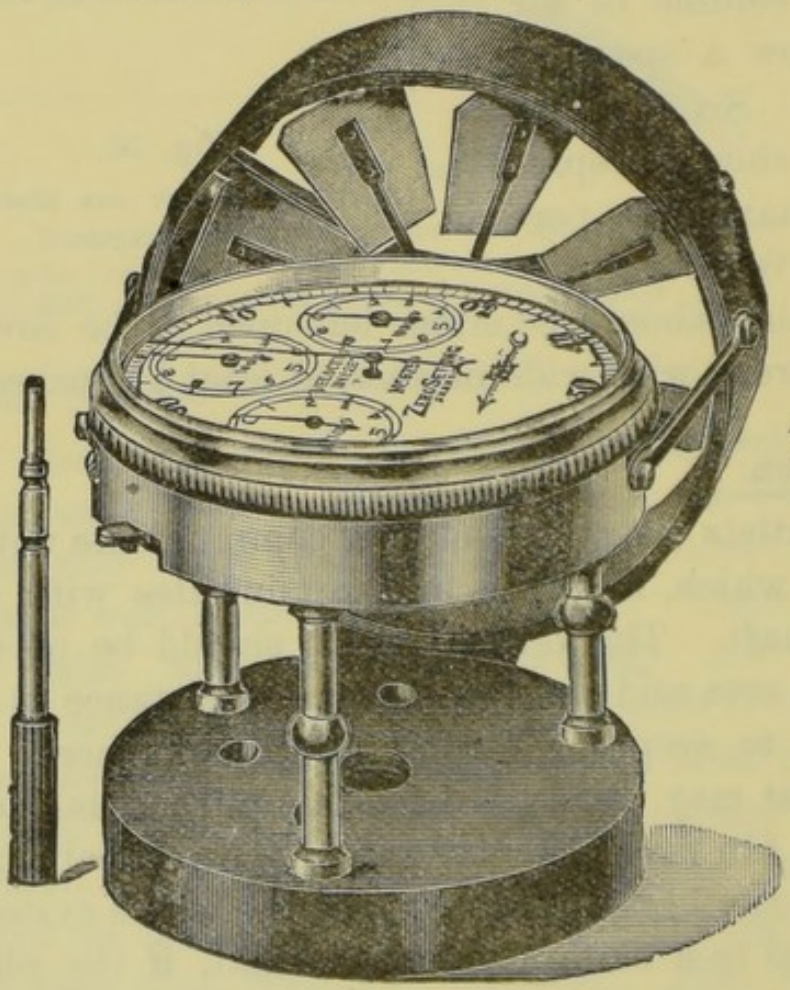


Fig. 36. ANEMOMETER.

air in the rooms at short intervals throughout the day. Another method is to measure by an anemometer the speed of the incoming fresh air as it passes the inlet,

estimate from this and the area of the inlet the volume of air that is entering per minute, and compare this with the necessary amount, which is, as we have said above, 30 cubic feet per scholar. The anemometer is placed in the aperture of the inlet, about two-fifths of the distance between the centre and the margin, and the delicate blades are driven by the current of air. These turn an axis with an endless screw running on small toothed wheels which record the results on the dial. Too much reliance, however, must not be placed upon results obtained in this way.

The importance of determining the amount of moisture in the air is referred to later on.

Town Schools.

The method usually advocated for town schools is the one already described, *i.e.* a combination of extraction with propulsion. This, if properly planned and intelligently supervised, gives excellent results, but suffers from the serious disadvantage of necessitating closed windows for its efficient working. In winter, before entering the room, the air may be warmed to the extent necessary to keep the room at the desired temperature, or, as is often advisable, it is simply introduced at the desired temperature, and the warmth of the room is maintained by coils or radiators placed along the walls of the room. This separate method for heating and ventilating has the advantage of making it possible to maintain the temperature of the school, through the night in winter, without keeping up the ventilation as well—a very economical arrangement.

Large Village Schools.

The cost of any mechanical system is usually too great for these schools. Many of them are heated by hot-water pipes under the high or the low pressure system, and some

plan should be adopted, such as ventilating radiators, whereby warm air can be admitted. Additional pipes to warm the room should be available for very cold weather. Ventilating grates and stoves may also be adopted in such cases. Attention should be directed to the adequate provision of outlets, which, in order to be under some control, may be connected with a main vertical shaft fitted with some appliance for heating and causing a continuous current of air. In summer some system of natural ventilation, preferably by windows, should be carefully arranged.

Rural Schools.

Some form of ventilating stoves or grates is necessary in winter. Stoves are often used. Willoughby recommends a form which is much used in Canadian schools. It can be arranged to introduce fresh warm air and also to aid extraction. The opening for the purpose of supplying the stove with fuel should be as narrow as possible. The fresh air passes from the outside along the duct beneath the floor into the space between the stove and its sheet-iron jacket, where it is warmed, and then into the room. The space between the jacket and the stove should be at least eighteen inches.

On the opposite side of the room a tin extraction duct should be constructed with its open end about one foot above the floor. Cross section dimensions of 12 × 6 inches are recommended, but for large rooms there should be two such ducts. The duct passes up vertically, then bends and passes horizontally along the ceiling, and communicates with a large flue, in the centre of which the stove pipe is fixed. The heat of the pipe causes this flue to act as an extraction force. For summer use there should be ample ventilation possible by doors, windows, or special ventilator openings.

The Supply of Moisture.

In those buildings which are heated by radiators or hot pipes the most satisfactory plan is to place porous clay vessels upon the radiators or pipes. The vessels should cover the top of the radiator entirely; and it should be the duty of someone to see that they always contain water.

Hot-air furnaces are often provided with a vessel for water, the evaporation from which is supposed to increase the humidity of the air sufficiently. As a rule, however, such means are found to be totally insufficient for the purpose, and are only likely to work well when the vessel is very large and is kept filled by some automatic arrangement.

An escape of steam from the radiator is occasionally adopted, but unfortunately it produces a limited area of excessive dampness.

The adoption of porous vessels seems to give the most satisfactory results, as the number can be increased or decreased until the wet and dry bulb hygrometer indicates a humidity between 50 and 65 per cent.

CHAPTER V.

WATER SUPPLY AND SANITARY APPLIANCES.

Water Supply.

The bountiful supply of pure water is now a popular demand, and, in most districts in this country, it is met. The school, in all urban districts, must share the general water supply, but in rural districts it may be necessary to arrange for its own water supply, either by the sinking of a well, or by providing for the collection and storage of rain-water. In all cases the supply should be carefully examined. If it comes from shallow wells or springs there should be no suspicion of pollution by drains or cesspools. After the vacations such wells should be inspected, and the water pumped out just before the opening of the schools. It is advisable for all country schools to possess a private deep or "artesian" well, because shallow wells are so liable to pollution.

Many country schools have to depend on the rainfall for their supply of water. In such instances the supply should receive the closest supervision in order to keep it up to the

highest possible standard. The school roofs are usually the collecting areas, and care should be taken to protect all gutters and spouts with wire netting to keep off birds as far as possible.

It is advisable to allow the first portion of every fall of rain to run to waste. This is effected by means of a rain-water separator, the separator of which is pivoted so that it directs the first portion into the waste pipe, and then turns over and directs the clean water into the cistern or filter.

The water should first pass through an underground sand filter, and then into an underground cistern. Rain-water is very liable to dissolve lead, so it should never be stored in lead cisterns or passed through lead pipes. Properly collected and stored it forms a pure and wholesome source of water supply.

Possible Contaminations of a Water Supply.

If the water supply is impure, the impurity may have been introduced in various ways:—

1. At its *source*, *i.e.* the water may have been drawn from a polluted supply, *e.g.* water from a marsh, a river receiving sewage, or a polluted shallow well.
2. In its *transit* from source to storage. For instance, the washings from cultivated lands, or sewage from drains may have obtained access.
3. During *storage*. This would include impurities derived from dirty cisterns, cisterns exposed to sewer gas, and lead cisterns.
4. During *distribution*. Lead may be dissolved from lead pipes.

5. During *filtration*. A bad filter will often render water impure.

The only satisfactory filters are those of the Pasteur. Chamberland or Berkefeld type, but it must be remembered that these filters act only as highly efficient strainers; and have no action on any dissolved impurities.

The Pasteur-Chamberland filter consists of an outer and an inner tube. The outer tube is of ordinary glazed earthenware and is fitted on the tap so that it contains the tap-water at the ordinary pressure. This pressure forces the water through the pores of the inner tube, which is composed of unglazed earthenware. These pores are so fine that even the smallest micro-organisms are unable to pass through. The inner tube can be removed for cleaning when required. The dissolved impurities are not affected by this filter.

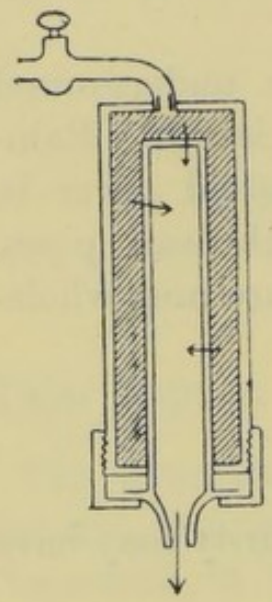


Fig. 37.

PASTEUR-CHAMBERLAND FILTER.

The Berkefeld filter is similar to the above in construction and in action, but is rather more rapid in its filtration. All filters should be cleaned regularly and the filtering material thoroughly washed and dried.

Where it is necessary to store water that is to be used for drinking purposes a separate cistern must always be used for this purpose, and such cistern should have no connection with the water-closet.

A plentiful supply of pure drinking water must always be accessible in schools and playgrounds. Children require a frequent drink of water, and their health suffers if such

is not available. In playgrounds a drinking fountain is best. These are so constructed that a small steady stream issues from an upright pipe for about three inches. The scholar drinks by receiving this stream in his mouth. Any form of continuous fountain is superior to the use of drinking cups in common, which are often the means of spreading such diseases as diphtheria. In country schools where there is no public water supply such fountains are impossible, and a tank or keg must be provided, from which the water may be drawn by a tap.

Cisterns.

In those cases where cisterns are necessary they must fulfil the following conditions :—

1. *Material.* The best material is either galvanised iron or slate with cement joints. Neither of these impart any injurious quality to the water. Lead cisterns are durable but dangerous, owing to metallic contamination.

2. *Position.* A cistern should be shielded from the sun's rays, but must be in an easily accessible position, so that it is readily inspected and cleaned. Covering and ventilation should be provided.

3. *Fittings.* The overflow pipe must be carried through the nearest outside wall, where it should be cut short. It must on no account communicate with any drain or soil pipe. The supply pipe for the water-closet must not pass direct from the cistern, a smaller cistern for this purpose being necessary.

School Drains.

The drains for schools do not differ essentially from those of any large building for public or residential purposes. Before any pipes are laid the whole system of drainage should be mapped out from beginning to end.

The whole length of the trenches should be dug and covered with concrete to a depth of four inches. Earthenware pipes should be used; they should be well glazed and free from flaws or cracks. Six-inch pipes, laid with a fall of 1 in 60 are

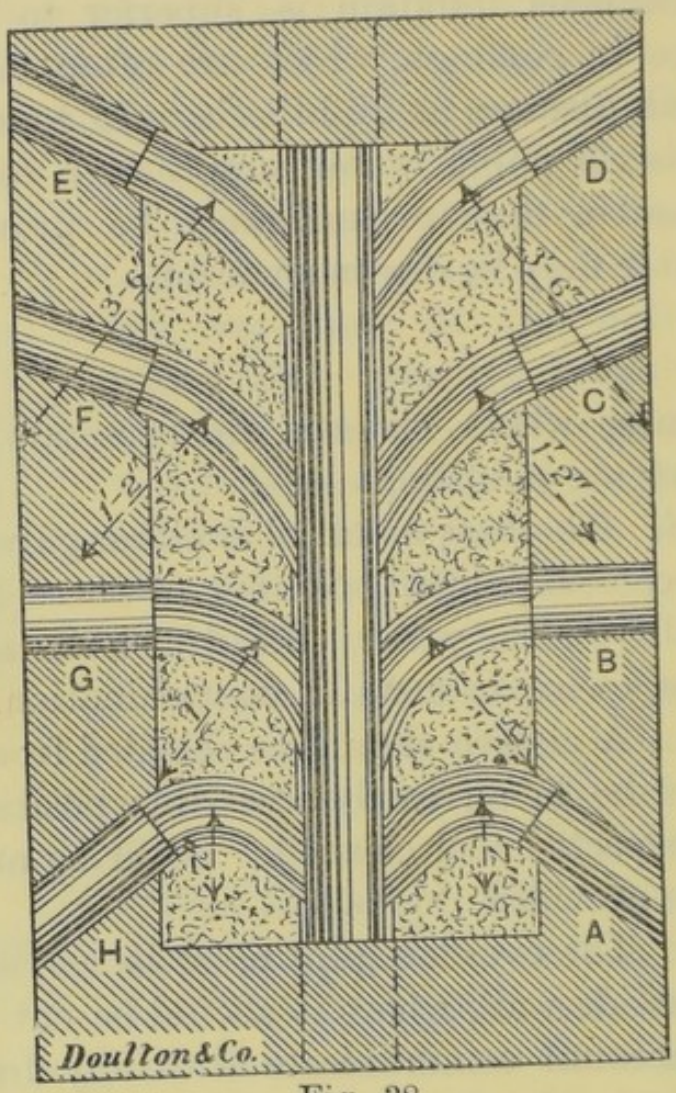


Fig. 38.

INSPECTION CHAMBER.

A, Rain-water; B, Butler's pantry; C, Housemaid's closet; D and E, Soil pipes from water-closet; F, Waste water from bath; G, Waste from kitchen sink; H, Rain-water pipe. The pipes at exposed part are half cylinders only. *N.B.*—Letters only refer to proposed positions, which may be varied according to plans of architect.

usually the best for ordinary use, but some of the branches, leading from single water-closets or gullies, may be made with four-inch pipes and have a fall of 1 in 40. All drains should be laid as straight as possible. If it is necessary

to alter the direction of the drain a proper bent pipe should be used. Branches should join the main drain at acute angles and by means of junction pipes. Old-fashioned drains nearly always effect a junction as quickly as possible, so that these points of union are scattered about and are difficult to locate. The modern plan is to make all junctions as near together as possible, at some convenient spot, where an inspection chamber is built. This is a small chamber built of brickwork set in cement. The drain and its tributaries meet in this chamber, being continued along the floor in the form of half-pipes set in concrete. A man entering the inspection chamber will therefore be able to tell at a glance whether there is any deposit at the junction. The chamber itself is easily cleared and rods can be passed up the different branches.

Joints.

Particular attention should be given to making good joints. The usual method is to soak a piece of yarn in some fluid cement, and to ram this well into the joint all round so as to about half fill it. The joint should then be filled up with stiff cement. Only the best Portland cement should be used.

Traps.

A trap is a contrivance which is placed in the course

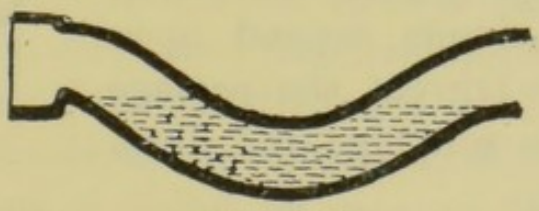


Fig. 39.

Simple Bend.

of pipes and drains with a view to prevent the passage of sewer air into a building. The only traps admissible

are the various forms of siphon traps. Figures 39 and 40 show the simplest form of such traps. Buchanan's disconnecting and ventilating trap is used to disconnect

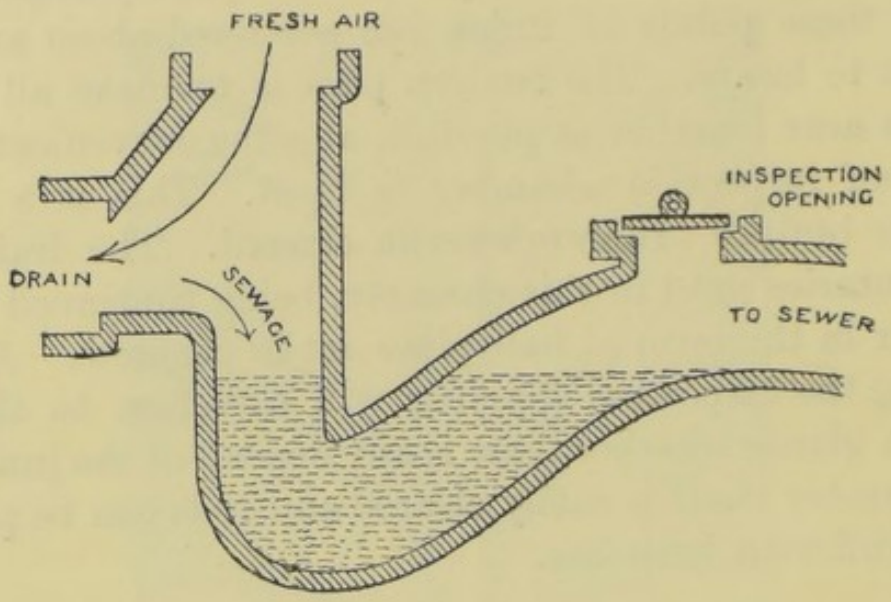


Fig. 40.

the drain from the sewer. It may be used alone, but more often a modification of it is adapted to use with an inspection chamber. A convenient trap for use with sinks or lavatory basins is shown in Fig. 41. It is fitted with a movable screw plug which is useful for removing any solid matter that may be stopping the pipe. The various forms of water-closets depend upon siphon traps to prevent the passage of gas from the soil pipe and drain into the building.

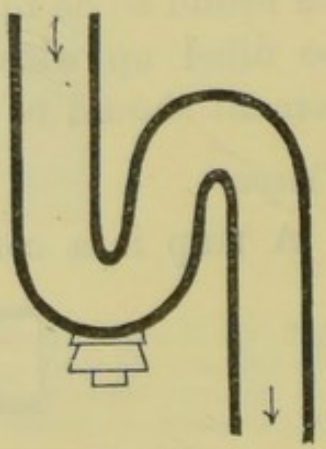


Fig. 41.
TRAP FOR SINK WASTE PIPES.

Ventilation of Drain.

The soil pipe (if water-closets are placed in part of the school building) or a special ventilating pipe (if there are

only closets on the ground level and away from the building) acts as the chief ventilator on the near end of the drain. It acts usually as an outlet. The grating over the inspection chamber, or a short ventilating pipe attached to a disconnecting and ventilating trap, is the ventilator at the far end of the drain, and this is usually the inlet. If the drain is well and evenly laid, and these two ventilators are properly fixed and remain open, there should never be any foul gases in the drain, and no bad smell ought to be observable near either of the ventilators.

Testing Drains.

Before the trenches are filled in, the drains must be carefully tested. Each opening in the inspection chamber should be plugged and the different branches of the drain separately filled up with water. If the water remains at the same level for an hour the drain is satisfactory. If the level falls an examination of the joints will reveal the faulty place.

Lavatories.

There should be ample lavatory accommodation in all schools. One lavatory basin to twenty scholars should be regarded as a minimum, and one to ten scholars is desirable. How is it possible to properly teach and encourage habits of cleanliness in children when schools are so often provided with a dark, dirty, and bad-smelling room called the lavatory, into which the children are rarely permitted to enter? The basin should be of hard, durable material, and the simplest means of outlet, an opening filled by a movable plug, is the best. The waste pipe and overflow pipe must be arranged as shown in the figure. The waste pipe must not communicate with any soil pipe, drain, or sewer, but must pass as quickly as possible through the outside

wall and immediately discharge upon a slanting surface sloping down to a gully trap, if the lavatory is on the

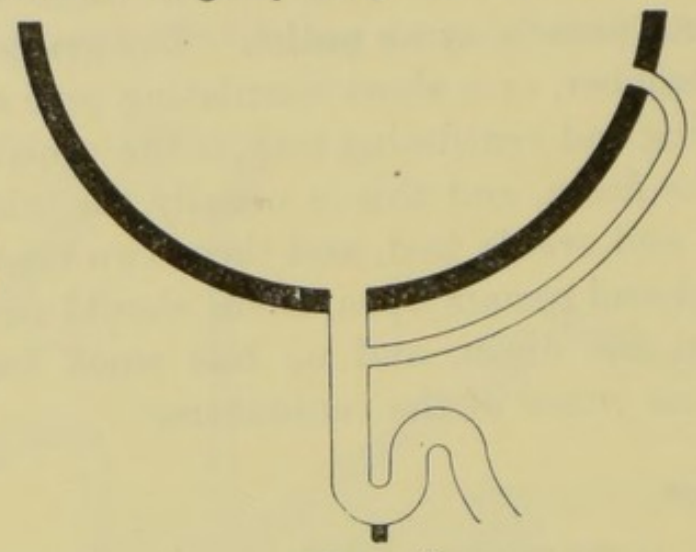


Fig. 43.
LAVATORY BASIN.

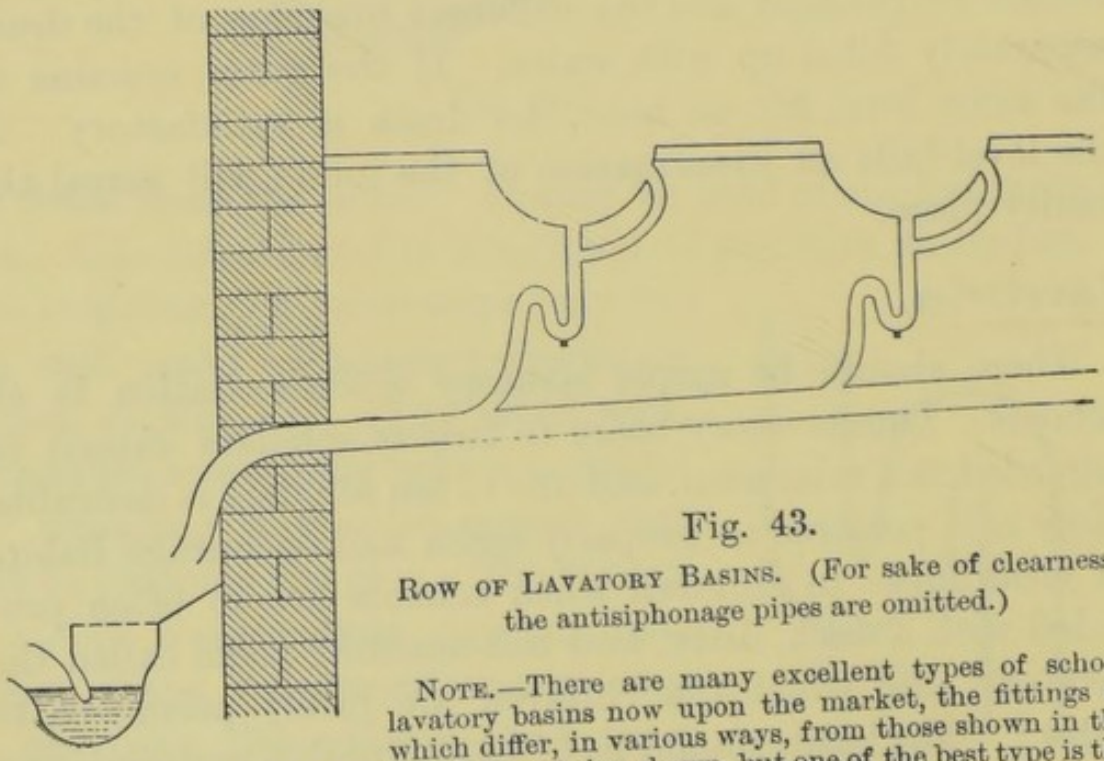


Fig. 43.
ROW OF LAVATORY BASINS. (For sake of clearness the antisiphonage pipes are omitted.)

NOTE.—There are many excellent types of school lavatory basins now upon the market, the fittings of which differ, in various ways, from those shown in the diagram. Space does not permit of these being shown, but one of the best type is the "running water" basin, which permits the rapid use of the basin by a large number of scholars without the same water coming into contact with different scholars.

ground floor, or into the open end of a vertical pipe which discharges on such a sloping surface, if the lavatory is on one of the upper floors.

In school lavatories the best arrangement is to place rows of basins round three sides of a room. The three rows of basins should be separately connected, *i.e.* there should be a separate waste pipe for each row. Each waste pipe should be trapped, and each trap provided with an air pipe to prevent siphonage. If these air pipes are not supplied the discharge of the end basin will suck out the water from the traps of those basins nearer the outlet, leaving an open pipe.

Baths.

The consideration of the subject of baths may seem to some to be superfluous in considering the needs of day schools. Few people, especially those who serve on education committees, appear to realise what has already been done in the direction of providing swimming baths for the purpose of physical exercise and health, and warm baths in pans or warm shower baths for producing cleanliness and also for educating the children in bodily cleanliness. There are swimming baths in connection with schools at Edinburgh and Govan in Scotland, the latter tank measuring 27 × 59 feet, and the depth varying from about 5 feet to a little over 3 feet. The temperature of the water is kept at about 70° F. Shower baths and soap must be provided in the same building, so that persons whose bodies are not sufficiently clean can be required to wash themselves thoroughly before entering the swimming bath. The cost of heating the water during the winter months is a very serious item, and for this reason it is not advisable to keep the bath in use during the whole year. Its maintenance from May to October entails little expense, and, especially if the bath is kept open during the summer vacation, it is an immense boon to the children of the locality.

At Giessen the school bathing facilities consist of eight

large zinc pans, five feet in diameter, for eight hundred pupils. The children bathe three together, and are allowed five minutes for the bath. The most satisfactory form of bath, however, is the shower bath, which is rapidly coming into use for school purposes. This has very great advantages over any other kind from every point of view. These advantages may be summed up as follows:—

(1) The original cost of the simpler forms is not at all excessive.

(2) It is economical. Only a moderate amount of water per head is necessary.

(3) The risk of contagion from one child to another is entirely removed, because the water that has touched a bather runs off at once down the waste pipe.

(4) No time is wasted. There is no filling and emptying. Immediately one child has finished another can commence.

(5) This form of bath is found to possess a great attraction for children.

In Berlin there are many schools fitted with shower baths. The temperature of the water at the commencement of a shower is 113° F., and it gradually cools down to about 86° F. In Boston, school baths have now been provided for the past six or seven years.

For a school with 800 scholars a set of ten shower baths and thirty dressing closets are found to be sufficient. A convenient and simple form of bath is that adopted by the Boston school. The bath closet is constructed of marble, and measures 3 feet by $3\frac{1}{2}$ feet and 6 feet high. There is no door, but a sliding rubber curtain hangs in front. An iron pipe supplies the water and descends vertically about halfway down the closet. On this is fixed a rubber tube, with a spray at the end, which reaches to the floor of the closet. The bather can vary the amount and the direction of the water, but the temperature is kept at 90° F. Dressing

closets are made slightly smaller than the bath. The average cost for both is said to be under twopence, but there is no reason why it should not be reduced to about one halfpenny per bath.

The floor of the bath should be of asphalt or lead sloping towards the waste outlet, which should be on one side or at the back. The waste pipes must be treated in the same way as has already been described for lavatory wastes.

Closet Accommodation.

There should be no closets in the school building for the scholars. Those provided for teachers should be separated from the building by cross ventilated lobbies. Each closet must be not less than 2 feet 3 inches wide, nor more than 3 feet, and must be fully lighted and cross ventilated. They are best divided by partitions carried up 6 feet only. Doors, if any, should be separated from the threshold by at least 4 inches, and from the head by at least 6 inches. The number of closets required by the Education Department is given by the following table:—

	Number of Closets.		
	For Girls.	For Boys.	For Infants.
Under 30 children.	2	1	2
,, 50 ,,	3	2	3
,, 70 ,,	4	2	3
,, 100 ,,	5	3	4
,, 150 ,,	6	3	5
,, 200 ,,	7	4	6
,, 300 ,,	8	5	7
		Urinals in proportion.	

The above numbers should certainly be exceeded wherever possible. The buildings and approaches to them must be wholly separate for the two sexes.

The floor should slope towards the door, and must be made of blue bricks set in cement or asphalt, so that it will dry rapidly after the daily washing which it must receive.

The walls should be lined with glazed bricks, and all corners should be rounded off.

Kind of Closet.

Where there is a proper water supply some system of water-closets must be provided, but if the public water supply is deficient or if there is no public supply, as is the case in country districts, the earth-closet should be used.

Earth-Closet.

The principle upon which this depends is that faecal matter, with which dry earth has been mixed, becomes not only inoffensive, but after a short time, unrecognisable as such. This absorbent and deodorising action of earth is dependent upon minute organisms or bacteria which are in the soil. These effect the conversion of nitrogenous matter into ammoniacal compounds, and these, by processes of oxidation are resolved into nitrites and nitrates. The best soils for this purpose are moderately dry and loose loams, garden soils, dry clay, and brick earth. Sand, gravel, and chalk are unsuitable and inefficient. The method of use is to cover each stool at once with one and a half pounds of dry earth. This is found to be sufficient to remove all smell and to form a "compost" which is suitable for potting plants, but is by no means a rich or valuable manure. When the pail is full its contents may either be

applied at once to the garden or removed to a dry shed where, after frequent turning over and exposure to the air, the earth may be used again as many as eight or ten times. Automatic closets, which apply a measured quantity of dry earth at each use, are obtainable. One is shown in Fig. 44. The handle of the closet is connected with a

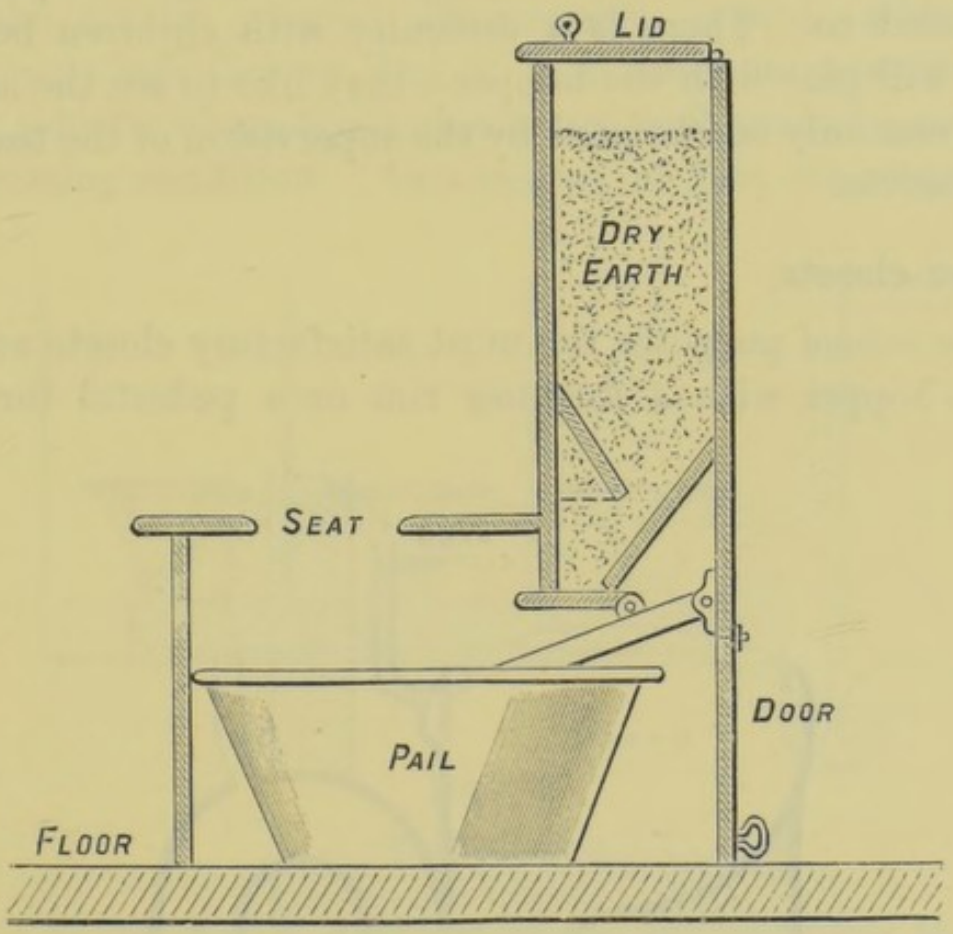


Fig. 44.

AUTOMATIC EARTH CLOSET.

receptacle behind and above the seat, which delivers the regulated quantity into the pail when it is raised.

The earth-closet requires the closest attention and the most constant supervision if it is to be quite free from smell. It should never be placed inside a school. The personal attention which it requires and the difficulty of

disposing of the large bulk of residue should prevent this method from ever being adopted in towns.

It must be remembered that earth-closets require the services of a special attendant to remove the soil, provide a fresh supply, and to prepare a stock of dry soil in the store-house for use during the winter. The head master should inspect them every day and see that things are properly attended to. There is a difficulty with children because they will play with the hopper—they like to see the action. This can only be obviated by the supervision of the teachers themselves.

Water-closets.

For school purposes the most satisfactory closets are the short hopper with a flushing rim or a pedestal form of

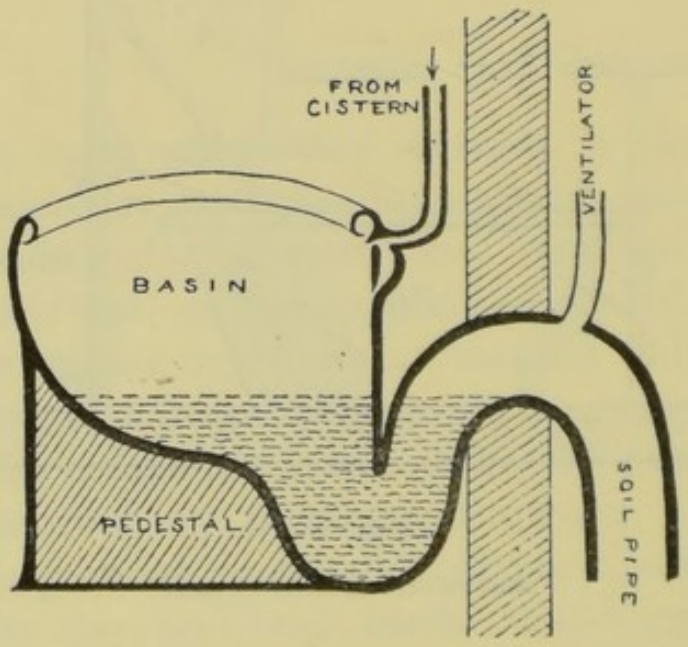


Fig. 45.

Pedestal (Hopper Type) with Flushing Rim.

wash-down closet. Each closet should have its own flushing cistern. It is more usual to provide trough closets with automatic flush cisterns, but it should be considered a necessary part of a child's education to know how

to use, and not abuse, an ordinary water-closet. All joints must be tested thoroughly before they are passed, and every precaution should be taken to ensure that the work is done in a first-rate manner.

Trough Closets.

The usual form of water-closet for school purposes is the trough closet. If properly looked after they are fairly satisfactory, but it is a common experience to visit schools where these closets are foul smelling and in a disgusting condition. As a matter of fact all closets are

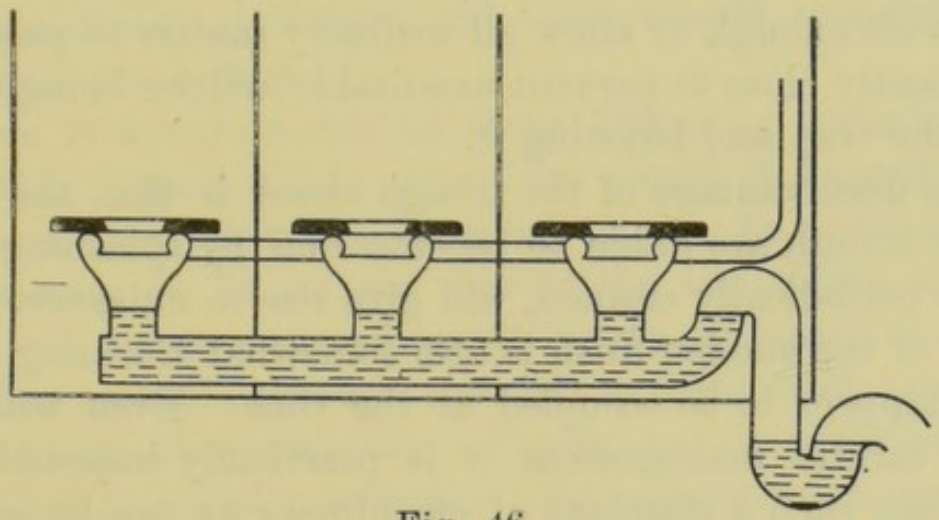


Fig. 46.

Trough Closet.

liable to become a disgrace to the school unless they are personally inspected by the head teacher every day. Such inspection should be made in the interests of the school and the scholars. An inculcation of maxims connected with the observance of decency in these places will have a good effect upon the children in every way, and is really an important part of their education, and any teacher who fails in this duty is neglecting an important branch of the child's instruction.

A form of trough closet is shown in Fig. 46. It is

simply a series of closets with a common flush. The trough should be of stoneware, and slopes downwards towards the outlet. At the end of the trough its floor turns upwards so that there is always a depth of from one to four inches of water in it. At the upper end of the trough, and four or five feet above it, is an automatic flush tank which should be arranged to discharge every six hours *at least*. The frequency of the flush is arranged by regulating the tap. Cases are unfortunately common where the cistern is discharged once or twice a week. The lower end of the trough connects with a siphon trap, the opening of which should be protected by bars with intervals wide enough to allow all ordinary matter to pass, but sufficiently close to prevent unsuitable articles being swept into the trap and blocking it.

One disadvantage of the trough closet is that the sides of the trough are liable to become foul by splashing and, if not periodically cleaned, will give rise to nuisance. The noise of the sudden flush is also somewhat alarming if the seat happens to be occupied at the time. Even with the most careful management it is practically impossible to maintain such a standard of cleanliness as can be secured where separate closets are employed, and all education authorities would be well advised to substitute ordinary water-closets for all trough closets in their district. No deodorisers should be permitted in closets, as they are merely palliative, and serve only to disguise and cover some evil which ought to be remedied. If there is any offensive smell in the closets there is something wrong either with the closets or their management.

Soil Pipe.

Mention has already been made that any water-closets in the school must be separated from the main

building by cross ventilated lobbies. In schools of more than one storey it is usual and convenient to place such water-closets above each other. The soil pipes, or pipes which carry the excreta from the water-closet to the drain, must be altogether outside the building, and ventilated by being continued, without any bend or alteration in diameter, above the eaves. Their termination should be protected by a wire cage to prevent their occupation by birds' nests. The best material for the soil pipe is drawn-lead. If iron pipes are used they must be of the water-main type, with caulked lead joints. A diameter of four inches is the most satisfactory size. Soil pipes are excellent drain ventilators, and there should therefore be no trap at the bottom.

There is always a risk of traps becoming unsealed by siphonage: particularly when one closet is immediately above another, using the same soil pipe. To avoid this it is necessary to fix an air pipe to the top of the siphon bend. In single water-closets it is only necessary to carry this pipe upwards through the wall to the outside, where it may be connected with the soil pipe, but if other closets are above, a special ventilating pipe must connect together all these air pipes and enter the soil pipe above the level of the highest closet.

Urinals.

All surfaces with which the urine comes in contact must be smooth and non-absorbent, the best materials being plate-glass, glazed earthenware, and slate. There should be either a continuous flow of water over such surfaces or an automatic flush of water at very short intervals. Dukes recommends a plate-glass trough, nine inches wide and six inches deep, kept full of water, and fitted with a self-acting outlet. Such urinals are devoid of smell. It is an

unfortunate but obvious fact that, owing to bad construction and lack of care, school urinals are often unsanitary and offensive in the highest degree. There is no excuse whatever for such a condition in those districts which have a plentiful public water supply.

Special closets for use as urinals by girls should always be provided where earth closets are used. Otherwise the proper treatment of the contents of the pails is seriously hampered by the excess of liquid.

Cesspools.

A cesspool would only be permissible for a school in a district with an excellent public water supply, so that water-closets are possible, but where there are no public sewers. Such districts are very rare. If there is no public water supply, or if it is inadequate, earth closets should be provided. Also if there are no public sewers the district must be somewhat rural, and here again earth closets would be the best arrangement.

If a cesspool system is regarded as indispensable, the cesspool must be as far removed from the school and playground as possible, be fenced in, properly ventilated, and perfectly watertight. It is somewhat beyond the scope of this book to give details of the necessary construction and management.

CHAPTER VI.

SCHOOL FITTINGS.

DESKS.

The problem of the desk is still with us, but is, perhaps, nearing solution, or at all events proper appreciation. Excellent desks are now made which will give fairly satisfactory results if the teacher thoroughly grasps the principle that the maximum length of time at a stretch that a child should remain seated in any form of desk is one hour, and that periods of half or three quarters of an hour are much to be preferred to the longer period. In fact there are few desks that will injure a child if the time during which they are occupied is strictly limited. The habit, which probably still prevails in some schools, of keeping children seated for a whole morning of about three hours has undoubtedly been the cause of a great deal of deformity and ill-health. Up to the age of fourteen the sitting posture should be regarded merely as a convenience, which is, nevertheless, unhealthy and unnatural for children. If this fact is properly appreciated there will be universal limitation of sitting-down periods to three-quarters of an hour, with intervals of play and of lessons given with the children standing upright. The ideal desk

is probably still an unsolved problem, but that is no reason why the most elementary and obvious rules concerning desks should be systematically ignored by so many education authorities even of large and important boroughs and districts. A desk should be just as accurately fitted for the child as its clothes are, and children require just as great a variation in desk sizes as they do in the measurements of their garments. A visit to the ordinary elementary school shows hundreds of children sitting in desks which are obviously unsuitable for them, and which cause them to bend their spines to the left, as well as to stoop forward with chest contracted, heart and lungs compressed, and cramped abdominal viscera.

It is necessary to remember that children of the same age and in the same standard at school vary greatly in height, a fact that is obviously unappreciated by the Board of Education, because the Rules for Elementary schools say "seats and desks should be graduated according to *ages*." Some interesting figures have been obtained by Bowditch as illustrating this important fact:—

Age.	Sex.	Height.	Difference.
		From to	
6 years	Boys	$40\frac{1}{2}$...47 inches	$6\frac{1}{2}$ inches
	Girls	$40\frac{1}{2}$...$47\frac{1}{2}$ „	7 „
11 „	Boys	$49\frac{1}{2}$...$57\frac{1}{2}$ „	8 „
	Girls	$49\frac{1}{2}$...58 „	$8\frac{1}{2}$ „
15 „	Boys	$56\frac{1}{2}$...68 „	$11\frac{1}{2}$ „
	Girls	$57\frac{1}{2}$...65 „	$7\frac{1}{2}$ „

Another important point is the variation in the rate of growth at different ages. Girls grow most rapidly between

twelve and fourteen years of age, while boys grow most from fourteen to sixteen. Still another matter to be allowed for is the greater "sitting height" of girls compared with boys of the same total stature. A very small amount of thought, therefore, should convince anyone that desks must be adjusted to the children, and that to order a roomful of desks all the same size for each standard is just as ridiculous, and far more harmful than to order the same sized clothes for all these children. It is by no means uncommon, in towns that pride themselves in being quite up-to-date, to find children who vary a foot in height sitting in desks of exactly the same size.

If the desk is of suitable size and structure it will allow the child to sit in accordance with the following conditions:—

1. The two ischial tuberosities rest equally on the seat.
2. The body is erect, and the back supported.
3. The head is in such a position that a line joining the centres of gravity of the head and the body bisects the line between the two ischial tuberosities.
4. The thighs are horizontal, the legs vertical, and the feet rest flat on the floor.

In this position there is the greatest possible economy of energy because the body is symmetrical and equally balanced. With the body so placed the eyes most easily look forwards and downwards. To raise them in order to look horizontally forward requires an effort. The least possible work will be given the eyes if the reading matter rests on a desk at an angle of 45° with the horizon, because in this position the bottom of the page will be at the same distance from the eye as the upper part, and the eye will be able to read all the type thereon without changing its focus to any appreciable extent.

For writing, however, a desk top at an angle of 45°

would have serious disadvantages. For instance, the ink would not flow properly from the pen at this angle, and moreover the arms and hands would have to be held in an irksome and tiring position. The most convenient slant for the writing-desk is an angle of 15° with the horizontal. The only objection to such a slope is that the lower part of the page will be nearer the eye than the upper portion The surface of the desk must be adjusted to such a height that the forearms may be easily placed upon it by moving the elbows three or four inches away from the sides.

VARIETIES OF DESKS.

In describing desks there are certain terms applied to different measurements.

1. The vertical distance from the edge of the desk to the level of the seat is called the "difference." This measurement should be such as to bring the edge of the desk

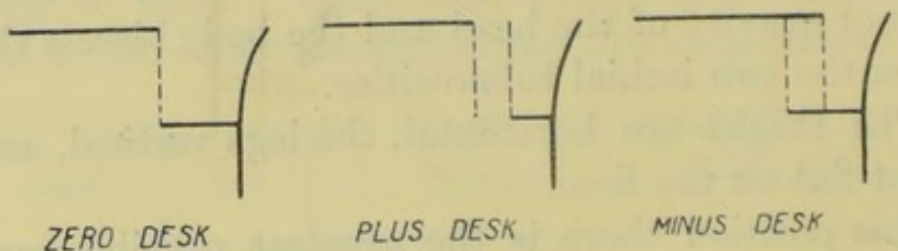


Fig. 47.

Relation of Seat to Desk.

opposite the navel of the pupil. The child will then be able to place the arms on the desk by moving the elbows slightly away from the sides.

2. The measurement from the edge of the seat to the vertical line dropped from the edge of the desk is called the "distance." This classifies desks into three varieties: (1) The "plus" desk, *i.e.* where there is a space between the edge of the seat and the vertical line from the desk. (2) The

'zero" desk, *i.e.* where the edge of the seat touches the vertical line from the desk. (3) The "minus" desk, *i.e.* where the vertical from the desk passes through the seat.

For writing the desk which involves the least deviation from the ideal position described above is the minus one. Nevertheless it is exceedingly common to find large schools without a single minus desk. The common desk is the plus variety, the use of which causes various ill effects: (*a*) The head and body are thrown forward so that the thorax,



Fig. 48.

COMMON POSITION FOR WRITING IN A PLUS DESK.

lungs, heart, and abdominal viscera are pressed upon and cramped. (*b*) The abdominal wall is folded and the viscera pressed out of place, thereby interfering with the functions of the different organs. (*c*) The vertical line from the centre of gravity of the body falls in front of the line joining the ischial tuberosities. This causes part of the weight of the body to be borne by the part of the thigh resting on the anterior edge of the seat, and some also by the elbows on the desk. (*d*) The effort of holding the head and body

in this position is a waste of energy, there being no balance. The muscles of the neck tire, and the head droops down. Fatigue is thus rapidly brought on. (*e*) The bending forward of the head brings the object nearer than twelve inches from the eyes, as well as causing congestion round those organs. If the desk is too low for the child the above effects are intensified.



Fig. 49

DESK AND SEAT ARRANGED IN MINUS POSITION.

The minus desk is undoubtedly the best for school use, but will only give satisfactory results if each child has the right size of desk for its requirements. The amount to which the desk overlaps the seat must be adjusted so that the edge of the desk just touches the child's abdomen without pressing upon it. If a fixed minus desk is used it is apt to become somewhat tiring owing to the shut in sensation it imparts and the absence of free movements.

Standing up is also irksome. Many of these desks have, therefore, been devised with the middle hinged, in order that the lower part may be lifted up and folded back on itself, so that the under surface is now turned up at an angle of 45° and presents the ideal desk for reading. In this position it is a plus or zero desk, and the reading matter is a little over twelve inches from the eyes of the pupil. Sometimes the seats are made to turn vertical in order to allow the child to stand. This plan, however, involves the use of the same shaped desk for reading and writing. As an alternative to the jointed desk-top there is the desk with a sliding top. In its ordinary position it is a plus or zero desk, but the top will slide down towards the child and so become one of the minus variety. It is undoubtedly desirable that a desk should be adjustable for plus and minus distances. A small plus distance gives a child more freedom of movement, and enables him to rise from the desk and to sit down with much greater ease.

DESK ADJUSTMENT.

In almost all schools, from the highest to the humblest, the bodies of scholars have to accommodate themselves to fixed seats and benches. The evil results of such a system appear later in the form of eye and spinal trouble, as well as consumption. Not only is it most harmful in the case of young children, but the injury and inconvenience is also very pronounced in the case of youths and young men and women who attend technical and evening classes held in elementary school buildings. This aspect of the case is often ignored, and the writer well remembers one instance where, after protests had been received on behalf of such adult students, members of the local education authority denounced the "luxurious

tendency " of the present race of students. Real progress must necessarily be slow in the face of gross ignorance and petty economy.

Most of the adjustable desks at present on the market possess merely a vertical movement, and the height is laboriously altered and fixed by means of a key, a screw, or a pinion. These methods have the serious defects that they are not easily adjustable and also are very liable to injure the hands and fingers of those who attempt to manipulate them. Adjustable desks of better and more convenient patterns are now being produced.

It should be distinctly understood that for day schools an adjustable desk will no longer be a necessity when the time-tables are under the control of medical men who have made a special study of hygiene as applied to child life. With three sizes of desks and seats for the ordinary standards it is possible to fit 95 per cent. of ordinary children sufficiently exactly to produce no ill effects **if the children are kept seated in them for short periods only.** But if the present system is maintained, then the adjustable desk is a necessity. Mr. Priestley Smith considers that four sizes of desks are desirable, and gives the following scale :—

Height of Scholar.	Height of seat from floor.	Width of seat.	Height of desk and back from seat.
$3\frac{1}{2}$ to 4 feet	13 ins.	10 ins.	8 ins.
4 ,, $4\frac{1}{2}$,,	$14\frac{1}{2}$,,	11 ,,	$8\frac{3}{4}$,,
$4\frac{1}{2}$,, 5 ,,	16 ,,	12 ,,	$9\frac{1}{2}$,,
5 ,, $5\frac{1}{2}$,,	18 ,,	13 ,,	$10\frac{1}{2}$,,

The old-fashioned private school inflicted far less physical injury upon the children than the public elementary school of to-day. In such schools at least half the children stood while receiving instruction, and, chiefly owing probably to a deficiency of desk accommodation, the period of each child's occupation of a desk was brief. It cannot be too often repeated that the possibility of injury resulting from the use of any desk is very remote if the time of occupation is made short.

Under present conditions each desk must be accurately adjusted to the needs of the child who has to use it. This being the case, it is indispensable that every desk and every seat should be adjustable. The desk seat must be of such a height that the thigh of the pupil is exactly horizontal when the leg is vertical and the foot resting flat on the floor. In such a position, obviously, the knee is bent at a right angle. In order to obtain such conditions for every child it is necessary that the seat should be adjustable to quarter inches. The front edge of the seat must be rounded off in order to prevent pressure upon the blood vessels and nerves of the thigh. For additional comfort and also in order to counteract the tendency to slide forward, the seat should be hollowed out to a depth of about $\frac{3}{8}$ inch, the concavity commencing $1\frac{1}{2}$ inch from the front edge of the seat, and deepest where the ischial tuberosities rest. The width of the seat should be at least two-thirds of the length of the child's thigh.

Each seat should be provided with a proper back, presenting a concave surface forward, and extending sufficiently far up the back to afford support to the lower parts of the shoulder blades.

Each child is measured carefully, so that the seat may be adjusted accurately to its requirements. The knee is bent at a right angle, while the foot rests squarely on the

floor, and the distance from the floor to the under side of the thigh near the knee is measured. This measurement is best made with special measuring rods for that purpose. These consist of a vertical scale with a sliding horizontal arm which is raised until it touches the under surface of the thigh.

Foot-rests are unnecessary and undesirable. By preventing free movement of the feet and legs they tend to increase the liability to cramp and stiffness. Another objectionable feature is that they prevent thorough cleaning of the floor.

The desk tops must be adjusted so that the child, when in the position for writing, does not bend the spine or have the shoulders raised. The edge of the desk should touch the navel, and the forearms should rest easily on the top without moving the elbows more than three or four inches from the sides.

It is desirable that all desks should be adjusted carefully twice a year, and the best times are March and September. No desk that can only be adjusted with difficulty should be allowed.

Single or Multiple Desks.

The Board of Education in the Rules for Elementary Schools distinctly discourage single desks, apparently on the ground of expense. According to these rules desks 12 feet long are permitted, and eight children (and even nine infants) are allowed to be packed on such a desk. Surely such rules must have been framed by people who have no knowledge whatever of the simplest hygienic principles. Under such circumstances it is no wonder that occasionally schools serve as hot-beds of infectious diseases, and that as a general rule most children are free from disease until they begin to attend school. Even

dual desks should be discouraged, not only on account of the increased possibilities of the spread of infection that they bring about, but also as tending to produce contorted attitudes. Entirely separate desks are undoubtedly the best, but if economy must be studied the Sheffield system should be adopted. These are long desks (without seats attached) of half a dozen places and are used with separate pedestal chairs. The advantages claimed for such an arrangement are :—

1. That the seats are isolated.
2. Each child is accessible.
3. Each child can stand up in its place, and drill can be taken for a minute or two with the children in their places.
4. The rooms cannot be overcrowded.
5. The cleaning operations are very much simplified.

Such an arrangement demands about 1,000 square inches of floor space per seat.

Infants.

For the young children the most suitable plan is to have flat tables or desks, and it is undoubtedly an advantage to provide sufficient of these to accommodate half the children only, so that the other half are compelled to stand. Those standing may do blackboard or other work, and take turn and turn about with those seated. For children under six years no desks should be provided at all; the babies should play about on the floor, or stools could be provided that they could move about themselves. It is very interesting to note that these babies are allowed for recreation a quarter of an hour in the morning and ten minutes in the afternoon. Is it to be wondered at that consumption continues to be such a dreadful scourge among young adults who have passed through the ordeal

of such an "education," or that the subject of physical degeneration of the race is assuming a most serious aspect?

ARRANGEMENT OF DESKS.

The desks should be arranged in the lightest part of the room, *i.e.* near the windows. It is advisable to arrange the desks so that the scholars face the long way of the

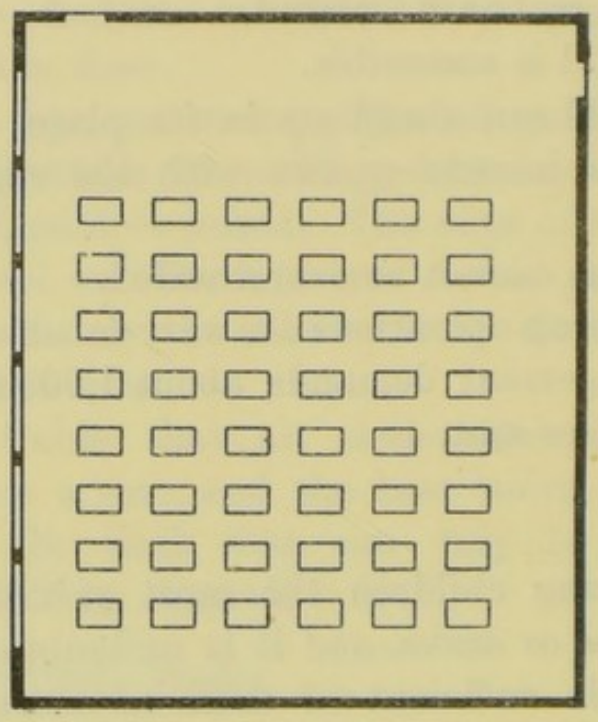


Fig. 50.

DESKS ARRANGED IN CLASS-ROOM.

room, in order to avoid as far as possible a foreshortened view of any apparatus shown them, or maps or diagrams on the blackboard. The typical class-room mentioned earlier in the book measured 25 × 30 feet. Such a room should accommodate 40 scholars only, whether the school be an elementary or a secondary one. The gangways mentioned in the Board of Education Regulations are 16 inches between dual desks, and 18 inches between

multiple desks. Single desks with gangways of 15 or 16 inches should be introduced into every school.

BLACKBOARDS.

The slate blackboard should be preferred to all other kinds because it can be washed without injury. The slate should be of a green or black colour. All teachers should remember that the inhalation of chalk dust is most injurious and may tend to predispose to consumption. For this reason it is advisable to always use a slightly damp duster. After a few trials it will be quite easy to obtain just that degree of dampness of the duster that will suffice to prevent the wafting of any chalk dust in the air, and yet will not appreciably wet the surface of the blackboard.

Blackboards should be all round the available walls of the room. There cannot be too much blackboard in any class-room. One of the best methods of preventing or affording relief from cramp and fatigue is to send scholars in batches to the blackboard to write various exercises. The width of the board should be 4 feet, and the height from the floor varied from 26 inches to 36 inches according to the size of the children who are to use the room. An excellent plan is to provide a trough about 2 to 3 inches wide at the bottom of the board and covered with an open wire cover. Most of the dust will fall into this trough and can be periodically removed.

Teachers' Platforms.

A platform for the teacher's desk and chair is undoubtedly a great convenience, especially to teachers of small stature. They are, however, unsanitary, because dust and dirt collect all round and beneath them. They also seriously interfere with the free movement of pupils about the room and at the blackboards.

SCHOOL CLEANING.

I. Desks.

It should be clearly understood that desks and seats accumulate grease and dirt rapidly, and that regular cleaning is necessary if it is desired that they should not become dangerous to health. Every desk and seat should be cleaned thoroughly with paraffin oil during each of the three vacations.

II. Windows.

Dirty windows not only decrease the amount of light that can enter the room, but also tend to render useless and ridiculous any instruction given by the teacher upon general cleanliness. It cannot be too often repeated that the teaching of hygiene will never produce much real effect upon the mass of the children until the schools themselves are object-lessons on this subject.

III. Walls.

The walls, which should be painted, must be thoroughly washed down during each of the three vacations, and it may be necessary to wipe them over more frequently as high as the scholars can reach, There should be no ledges or projections where dust can lodge, but if there are they should be carefully cleaned at the three thorough cleanings each year.

IV. Floors.

Every floor should be thoroughly swept at the close of each day that the school is occupied. Such cleaning is best carried out with all doors and windows widely open. The floors should be first liberally sprinkled with wet sawdust, and a wet broom should always be used. In many schools

no such care is taken to prevent the dust rising in the air, and where sawdust is used the quantity supplied is quite inadequate. A visit to such schools at the time when the daily "cleaning" is finished will reveal an atmosphere like a fog. Such conditions are injurious to the sweepers, and the dust so scattered in the air settles down on floors, desks, shelves, walls, etc., and adds to the general dirtiness and unhealthiness of the school. In fact it would probably be better to clean it thoroughly once a week than to go through such a farce as is usually represented by the daily "cleaning." Dust should be regarded as a most potent cause of ill health, and every effort should be made to prevent a dusty atmosphere in schools.

PART II.

THE SCHOLAR.

CHAPTER I.

INTRODUCTORY.

The substance of the body when examined with the higher powers of a microscope are seen to consist of special structural elements embedded in an intercellular substance or matrix.

The structural elements are either cells or fibres which have been derived from cells. In some instances the intercellular substance consists of a finely granular or homogeneous substance in which the cells are embedded, more or less like currants in a cake, whilst in others it is present only in small quantities, just sufficient to act as a cement connecting the cells together, like the mortar between bricks.

Cells.

The cells vary in diameter, usually between $\frac{1}{300}$ and $\frac{1}{3000}$ inch, and are made of a jelly-like substance called protoplasm. A small dark body near the centre of the cell is called the nucleus. This takes up colouring matters more readily than the ordinary protoplasm, and so in stained specimens under the microscope it appears more deeply coloured than the remainder of the cell. In many cases the cell is bounded by an external membrane, but this is not always present.

Protoplasm in an active state has the power to bring about important changes in the blood or lymph with which it comes in contact. All over the body the protoplasm of cells absorbs oxygen from the surrounding lymph and gives up carbon dioxide, heat and energy being set free. In special glands (mammary, peptic, etc.) the protoplasm of the cells is capable of manufacturing special substances (milk, pepsine, etc.), and in other instances it exercises a selective action on the blood, *e.g.* in the kidneys the epithelial cells select urea from the blood.

All these changes which go on in protoplasm are included in the term "metabolism."

Cells are constantly being worn out and new cells are formed to take their place. These new cells are formed by the division of existing cells.

Structure and Function.

The simpler organisms are composed of one or more cells which are alike, but when organisms of a higher order are examined it is found that some differentiation of structure has taken place, and that some cells have taken over some of the work of the body and other cells other work, constituting a division of labour. In man, the most complicated and highly developed part of creation, this differentiation of structure and subdivision of labour has been carried out to the greatest extent, with the result that many kinds of specially developed cells are found in the human body, grouped together into different materials or *tissues*, such as the epithelial, the connective, the muscular, the fatty, and the nervous tissues.

Every cell is directly or indirectly connected with every other cell by means of the thread-like processes (nerves) of the nerve-cells of the brain and spinal cord. In this way the physical condition of one set of cells may influence

the activity of another set at a distance. The nerves and nerve-cells are therefore the means whereby the scattered communities of cells are united together to form the complicated mechanism that we call a body.

By means of this division of labour, one tissue directs and controls, another moves in obedience to command, a third secretes or manufactures some useful liquid, a fourth distributes food and collects waste, another gets rid of waste, and so on. In this way each cell does its own particular work and no other, and all work together for the good of the whole.

In their turn varying amounts of the tissues are grouped together to form organs and *systems* which undertake special functions. The chief systems are:—

The Circulatory System.

This includes the heart and the blood-vessels with their contents. The heart is the great central pump of the circulation, and in health it beats with perfect regularity, almost as if it were kept going by clockwork! We shall see (Chapter III.) that it is more wonderfully constructed than a mere machine, for although it acts automatically yet it is able to adjust itself at a moment's notice to the ever-varying conditions of the body, whereby more vigorous work may be required of it at one time than at another. At each beat, the blood within it is forced or squeezed out through certain parts or vessels, known as **arteries.** These tubes distribute the vital fluid to every part of the body. Soon after the two main vessels leave the heart, they give off branches, and these, again, divide and subdivide into smaller branches.

It is important to bear in mind that the *blood inside an artery* is always *flowing away from the heart.*

A very minute artery is called an arteriole, and this

eventually splits up into the smallest possible blood-vessel, known as a **capillary**. This can only be seen by the aid of a microscope, being considerably finer than a hair. It is by means of blood-capillaries that the living cells of the body are fed, for the walls of these tiny tubes are so exceedingly fine that the nourishing constituents of the blood can actually pass out through them. In this manner, every organ and tissue receives its food, or, as it is called, its "blood-supply."

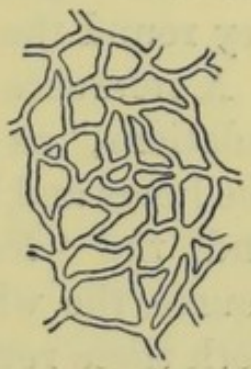


Fig. 51.
BLOOD-CAPILLARIES.

The waste-products of the cells themselves are discharged into the capillaries and carried away by the blood-stream. The capillaries speedily unite with one another, forming other minute vessels called venules. These join with others, so that larger and larger tubes are gradually formed, known as **veins**. They run in company with the arteries, but the *blood within them is flowing*, of course, *in an opposite direction*, i.e. *towards the heart*. Entering the upper part of the right side of that organ, the venous blood, which is impure and dark purple in colour, is despatched at the next heart-beat through a large blood-vessel to the lungs. Here it undergoes a complete transformation, becoming purified and, meanwhile, changing its colour to a bright scarlet. The arterial

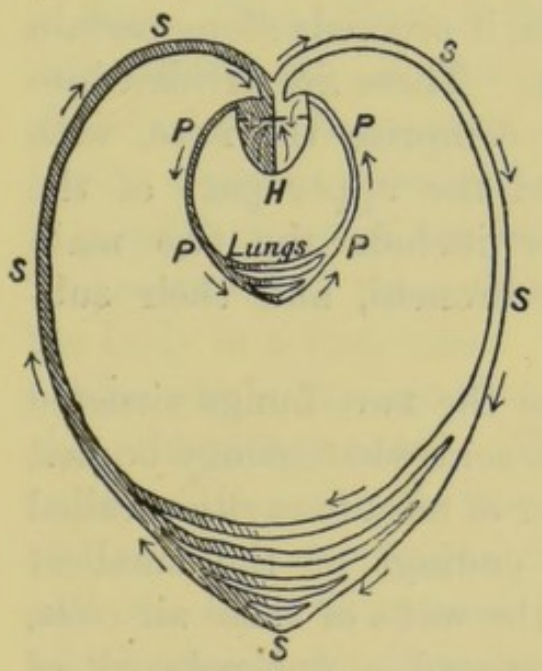


Fig. 52.
SCHEME OF BLOOD-CIRCULATION.
H, heart; *S*, systemic, or "greater," circulation; *P*, pulmonary, or "lesser," circulation. The arrows indicate the general direction of the blood-stream.

blood, as it is then termed, is brought back again to the heart, being now in a fit state to start upon its next journey round the body.

A reference to Fig. 52 will show that there are two "circulations," as it were—one through the body, the other to the lungs and back only. These are known as the "greater" and the "lesser" circulations respectively, though, of course, the whole of the blood in the body must traverse both these routes in turn.

The Respiratory System.

The object of breathing is to oxygenate the blood, *i.e.* to supply it with the needful oxygen, at the same time allowing the poisonous carbon dioxide within it to escape. As the atmospheric air is breathed in, it proceeds along certain channels known as **air-passages**. These are divided into upper and lower. The former comprise the nose, with its internal cavities (nares), and the upper part of the windpipe (trachea). The latter include the two main divisions of the windpipe, the bronchi, and their subdivisions.

The organs of respiration are the two **Lungs** situated within the chest-cavity. They are somewhat spongy bodies, consisting of an enormous number of minute cavities, called **air-cells**, which are the blind endings of the smallest possible bronchial tubes. Over the walls of these air-cells, which are exceedingly thin, is spread a fine network of minute blood-vessels, the pulmonary capillaries. In this manner the oxygen contained within the lungs inhaled by the breath is able to pass directly into the blood, and, at the same time, the carbon dioxide can find its way out of the capillaries into the air-cells, from whence it is exhaled.

This process, like that of the circulation, is quite automatic, and it takes place in health unconsciously. The act

of breathing itself is regularly performed, the lungs expanding with each inspiration (breathing in) and relaxing with each expiration (breathing out).

The Digestive System.

The food which is taken into the body, be it ever so nourishing, cannot be of the slightest use for building up the tissues until it has first gone through the several processes which constitute digestion. This consists, essentially, of a series of changes wrought upon the chief chemical constituents of the food by the action of four principal fluids or juices, prepared by organs called **glands**. Each juice, or **secretion**, as it is termed, is poured upon the food in turn. The object of this is to transform the nourishing ingredients into a state in which they can be readily absorbed into the system. Many of these processes involve highly complex chemical reactions, the net result of which is a splitting-up of the food-principles into simpler bodies. The majority of these changes can be easily studied outside the body in a test-tube.

The whole passage along which the food passes is called the **alimentary canal**. The chief parts of this digestive tube are, in order, the mouth, the pharynx (the back of the throat), the oesophagus or gullet, the stomach, the small and the large intestines (bowels). The principal organs which discharge their secretions upon the food as it is moved along this canal are the salivary glands, the stomach, the liver, and the pancreas or sweetbread. How and in what parts these different juices are brought to bear upon the food we shall study in Chapter V.

The **absorption** of nutritive material is carried out chiefly in the small intestine, while that which is of no value is rejected and ultimately cast out of the body.

The Excretory System.

It is a cardinal rule in physiology that waste-matters must be cleared away and disposed of as soon as possible. The active life of every cell in the body is necessarily accompanied by the production of a certain amount of refuse or waste-material—like the ashes of a furnace—which it is imperative to remove quickly if the vital action of the tissues is to continue unhindered. The process of excretion consists in the separation and removal of such harmful substances, and the chief organs which perform this work are the **Kidneys**. These two **renal organs**, as they are termed, are situated deeply in the loins, one on either side. Their work is to separate from the blood a liquid, the urine, in which are dissolved the chief waste-products of cell-activity. The urinary bladder receives the urine as it is excreted by the kidneys, and from this receptacle it is expelled from time to time.

The skin, also, excretes a watery fluid, the sweat, which likewise contains waste-products.

The Muscular System.

The muscles of the body, especially those found in the limbs and trunk, form the fleshy parts. The lean of meat is made up entirely of muscle. A typical muscle may be looked upon as a bundle of fibres, each possessing the power of shortening itself and, therefore, of bringing the opposite ends of the whole bundle nearer together. This shortening or *contraction*, as it is usually called, is followed by a return to its original length, or *relaxation*. A muscle is something like a piece of elastic, except that it has the power within itself to stretch or to contract.

Change of position or movement is the general outcome of muscular contraction. We might call the muscles,

then, the **organs of locomotion**. Those attached to the bony skeleton move only in response to the commands given them by the brain or the will—the connection between the two being effected by means of the nerves—hence they are called *voluntary muscles*. Others, such as those found in the wall of the stomach, are quite independent of the will. These are the *involuntary muscles*.

The Nervous System.

Without some central directing and controlling mechanism no organisation can work without confusion. It is so ordained that, in health, no disorder in the working of any system, organ, or tissue need arise, for the nervous system orders and manages every vital process in the body. The **Brain**, or organ of mind, situated inside the bony skull, is the "head-office," or "central telegraphic station," as it were. The nervous matter of which the brain is composed contains a number of special cells, known as **nerve-cells**, and these are grouped together in certain situations to form **nerve-centres**. Here ideas are formulated and impulses generated.

The **spinal cord**, a thick cable of nervous matter running down the brain within the bony spinal column, containing chiefly **nerve-fibres**, acts as the main conductor of nervous impulses from the brain to the distant parts of the body. It also contains several "sub-offices," or lower nerve-centres, which share a small part of the government of the body.

The **nerves** themselves, which are given off like branches from the brain and spinal cord to all parts of the body, may be likened to the telegraphic wires. They simply transmit messages, either from the brain, where the chief business of the body is transacted, to the tissues, or in the reverse direction, from distant parts up to head-quarters.

Other nerves, those of special sense, are gifted with the power of receiving certain impressions from the outer world and of transmitting them to the nerve-cells in the brain, where alone they can be really perceived and interpreted.

Thus it is that this vast "kingdom of cells," the human body, "is fitly joined together," every part working in harmony for the mutual advantage and benefit of the whole.

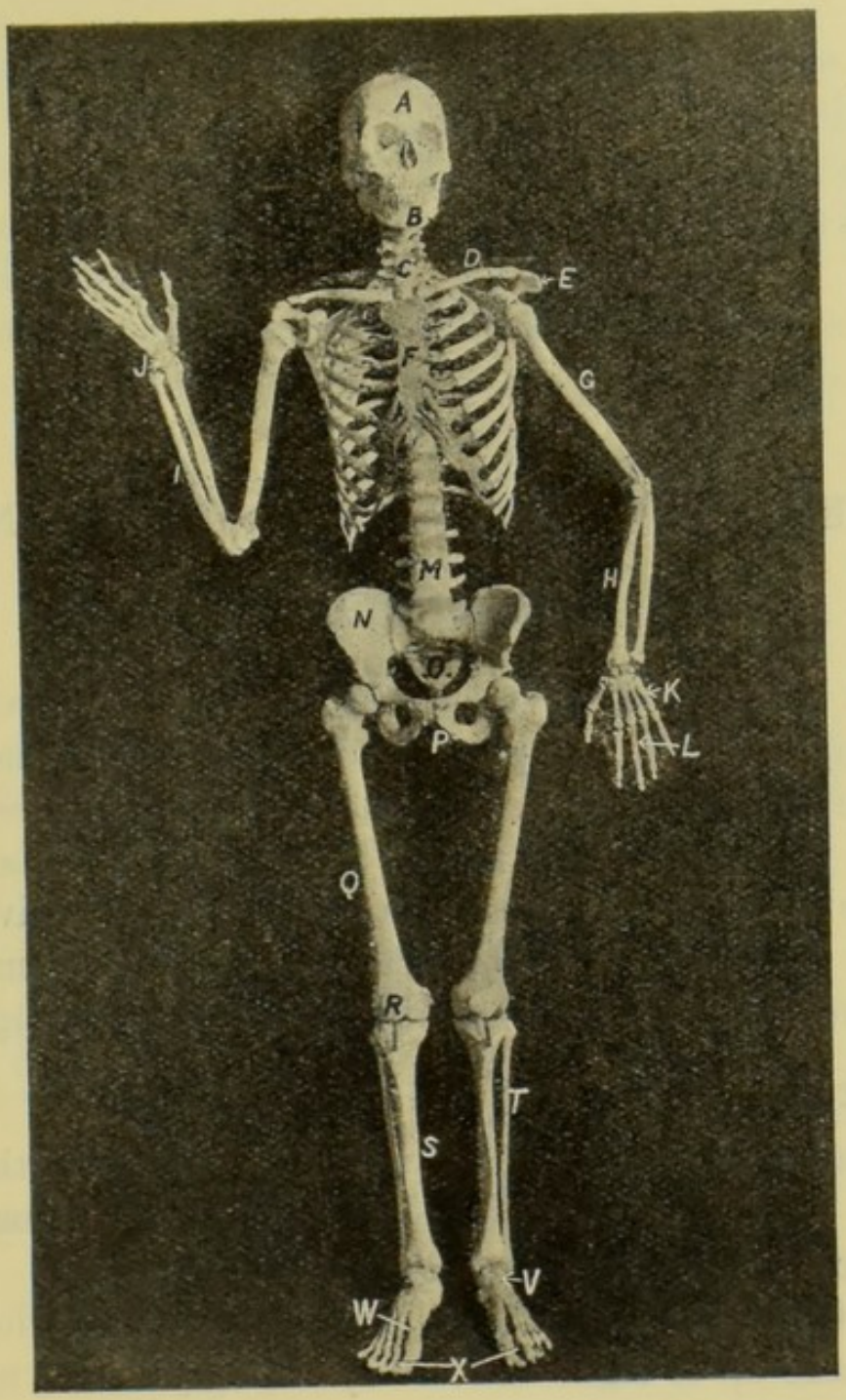


Fig. 53.

THE HUMAN SKELETON.

A, Frontal Bone.
B, Mandible (or Inferior Maxilla).
C, Cervical Vertebrae.
D, Clavicle.
E, Scapula.
F, Sternum.
G, Humerus.
H, Radius.
I, Ulna.
J, Carpus.
K, Metacarpus.
L, Phalanges (of fingers).
M, Lumbar Vertebrae.
N, Ilium.
O, Sacrum.
P, Os Pubis.
Q, Femur.
R, Patella.
S, Tibia.
T, Fibula.
V, Tarsus.
W, Metatarsus.
X, Phalanges (of toes).

For further illustrations of the Ribs, Thorax, and Pelvis see Chapters II. and III.

CHAPTER II.

SKELETON. MUSCLES. BODY TRUNK.

THE SKELETON.

The skeleton serves a double purpose. Primarily it is the support of the soft parts, and serves to give the body a definite shape or build. Secondly, it affords special protection to highly important structures and organs. Thus the skull and vertebral column serve as a protective covering for the brain and spinal cord, and the ribs form a bony framework for the protection of the heart and lungs.

The Skull.

Balanced on the top of the vertebral column is the skull. It may be divided into two parts: (1) the **cranium**, which is a bony box for the brain; (2) the face bones.

The **Cranium**, as we have said, is a box for the brain. It is made up of eight bones very strongly bound together. The bones forming the base are very rough and irregular, while the front, back, roof, and sides are formed of smooth flat bones. Leading into the skull are several openings, one large, and the remainder comparatively small. The large opening—the foramen magnum—serves for the passage of the spinal cord from the brain into the canal provided for it in the vertebral column. Close to this opening, one on each side, are two smooth surfaces or

facets which rest upon two similar facets on the first vertebra. In the action of nodding these two pairs of facets glide upon each other. Through the smaller openings in the cranium pass the cranial nerves from the brain to the various parts of the head and face.

The **Face** is made up of fourteen small bones which are closely bound either to each other or to the bones of the

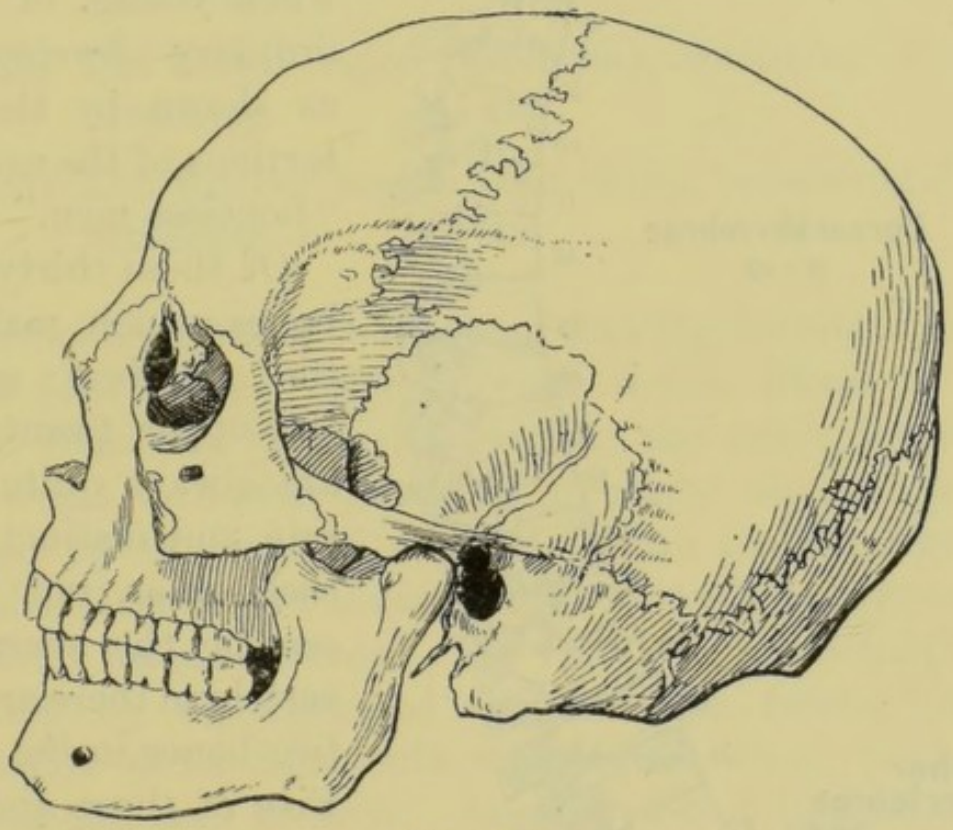


Fig. 54.

SKULL (Side View).

cranium. The lower jaw bone is fastened only at each end and can be moved about more or less like a door upon hinges.

The Vertebral Column.

The vertebral or spinal column is the chief support of the trunk. It consists of thirty-three bones which are so tightly fastened together that only a very small amount of

movement can take place between any vertebra and its neighbour. Taken as a whole, however, the vertebral column can perform very wide movements, and these are capable, by practice when young, of extraordinary development, as shown by the contortions of the so-called "boneless men."

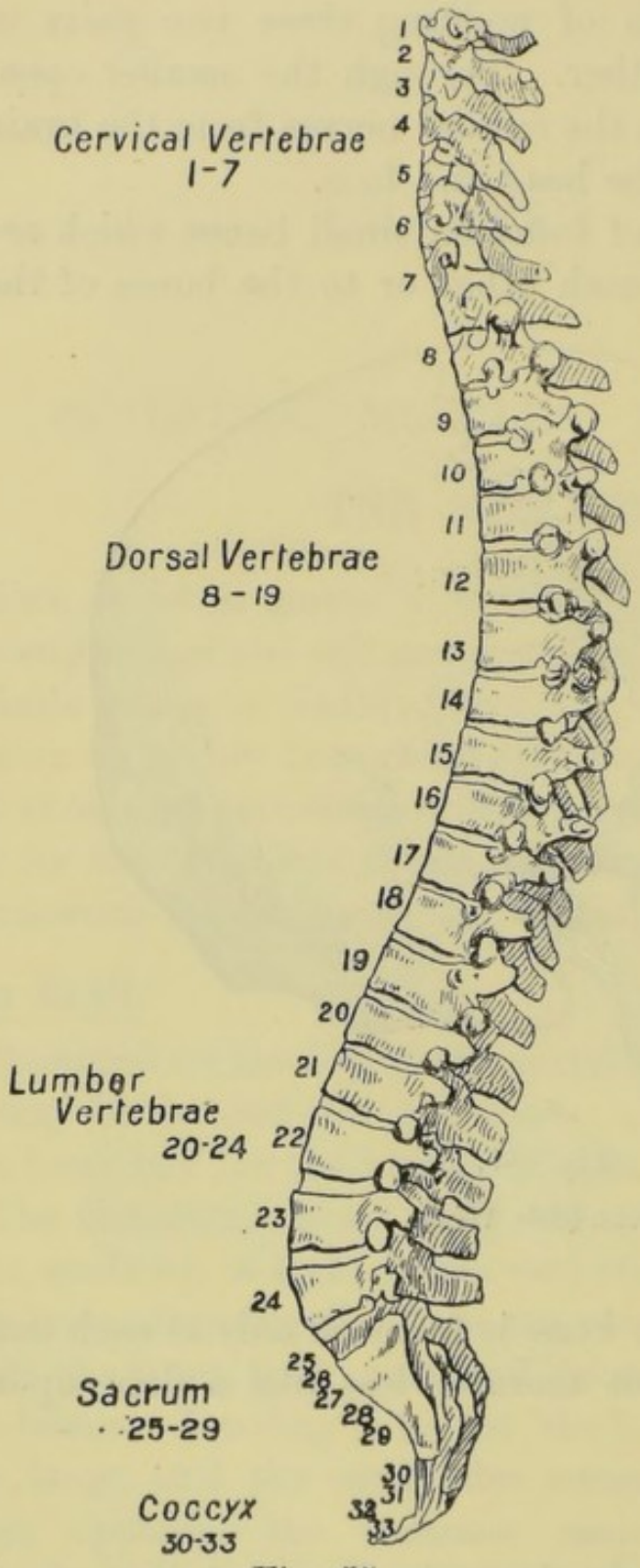


Fig. 55.
THE VERTEBRAL COLUMN.

Of these thirty-three bones which make up the vertebral column the upper twenty-four are always quite separate and distinct from each other, but representing the lower nine vertebrae there are only two bones in the adult. Five of these nine vertebrae have united together to form a large strong bone called the **sacrum**. This is a wedge-shape bone with the narrow end below. To it are fastened the hip bones, one on each side. The four lowest vertebrae have united together, and are represented by a small bone, the **coccyx**,

which is attached to the bottom of the sacrum. The coccyx is the rudimentary tail in the human body; in animals it consists of a large number of vertebrae. The upper twenty-four vertebrae are divided into three regions :—

(1) The cervical region (the neck), consisting of seven vertebrae.

(2) The dorsal region (the back), consisting of twelve vertebrae.

(3) The lumbar region (the loins), consisting of five vertebrae.

Viewed from the side it is seen that the vertebral column forms four curves. The cervical region forms a curve whose concavity points backwards; the curve formed by the dorsal vertebrae faces the opposite way, while that formed by the lumbar vertebrae again looks backwards, and the sacrum and coccyx unite to form a curve whose concavity faces forwards. The vertebrae are bound firmly together by ligaments at the articular facets, and by numerous other ligaments which pass from process to process and arch to arch. Another set of ligaments pass from vertebra to vertebra down the front and back of the bodies.

Another means of connection between each vertebra and its neighbour are the **intervertebral discs** which are placed between them. Each disc is firmly attached to the body of the vertebra above and below. These intervertebral discs are composed of cartilage, and serve not only as a ligament but also as a cushion or buffer between the vertebrae, and thus deaden the force of any concussion in just the same way as the buffers fixed to railway carriages.

The Ribs and Sternum.

The dorsal vertebrae at the back, and the sternum or breast bone in front, together with the curved bones connecting them, the **ribs**, constitute the bony cage called the thorax. There are twelve pairs of ribs. Each pair is

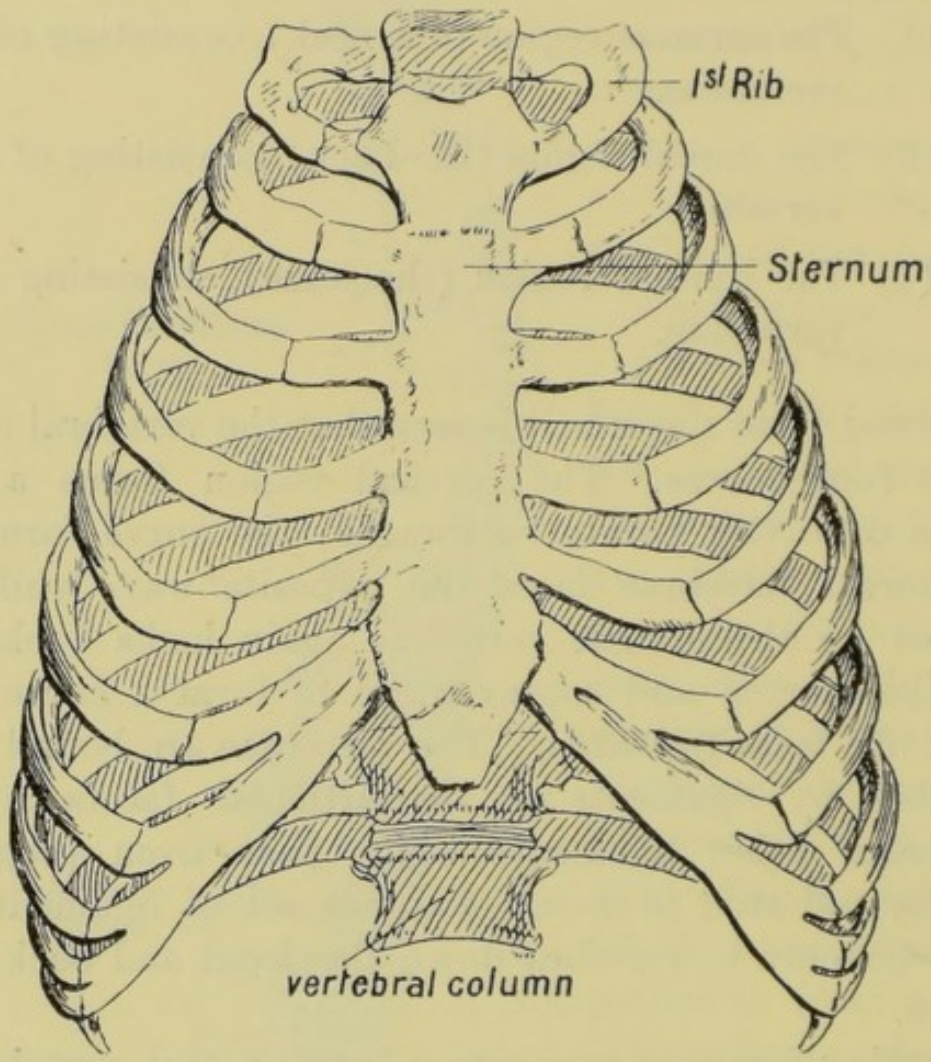


Fig. 56.
The Bony Thorax.

attached to a dorsal vertebra, one on each side of it, and the joints by means of which the ribs are attached allow movement to take place up and down. This movement takes place during respiration. The first ten pairs of ribs are attached in front to the sternum by means of cartilages —the **costal cartilages**—the first five pairs having separate

costal cartilages, while the second five are united to a single cartilage, the sixth. The last two pairs, the eleventh and twelfth, are not attached to the sternum at all, and are therefore called floating ribs. These are easily pressed inwards by tight lacing.

The **sternum** or breast bone is flat and shaped more or less like a dagger, being broader above than below. Viewed as a whole, the bony thorax is of a conical shape, being broader below than above, when not distorted by corsets. The intervals between the ribs are called **intercostal spaces**, and are filled up by muscles called the intercostal muscles.

Shoulder Bones.

Passing from the top of the sternum to the shoulder is the **clavicle** or **collar bone**. This bone is curved like the



Fig. 57.
THE CLAVICLE.

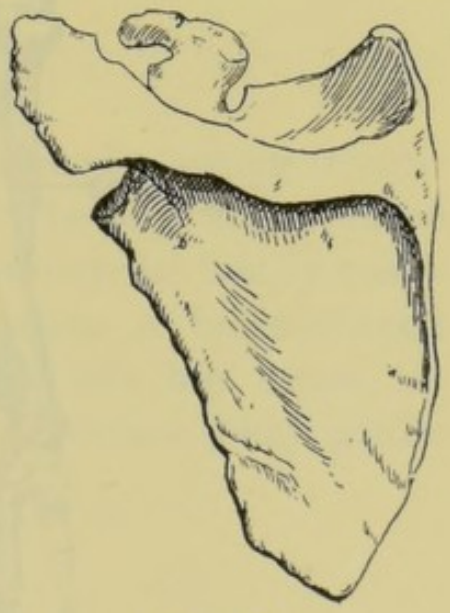


Fig. 58.
THE LEFT SCAPULA (from the back).

italic *f*, and extends outwards and backwards to the shoulder, where it is fastened to the outer part of the **scapula** or **shoulder blade**. The scapula is a triangular flat bone which lies on the upper ribs, at the back of the thorax. It is not directly connected with the thorax. The outer part of the scapula is smooth and hollowed, and forms with the top of the arm bone the shoulder joint. Each shoulder is, therefore, made up of a clavicle, scapula, and humerus.

The shoulder joint possesses great mobility, the arm

being easily moved forwards, backwards, upwards, and downwards, in addition to being rotated. This great mobility is due mainly to the shallowness of the depression in the scapula, and to the numerous and powerful muscles that act upon the joint.

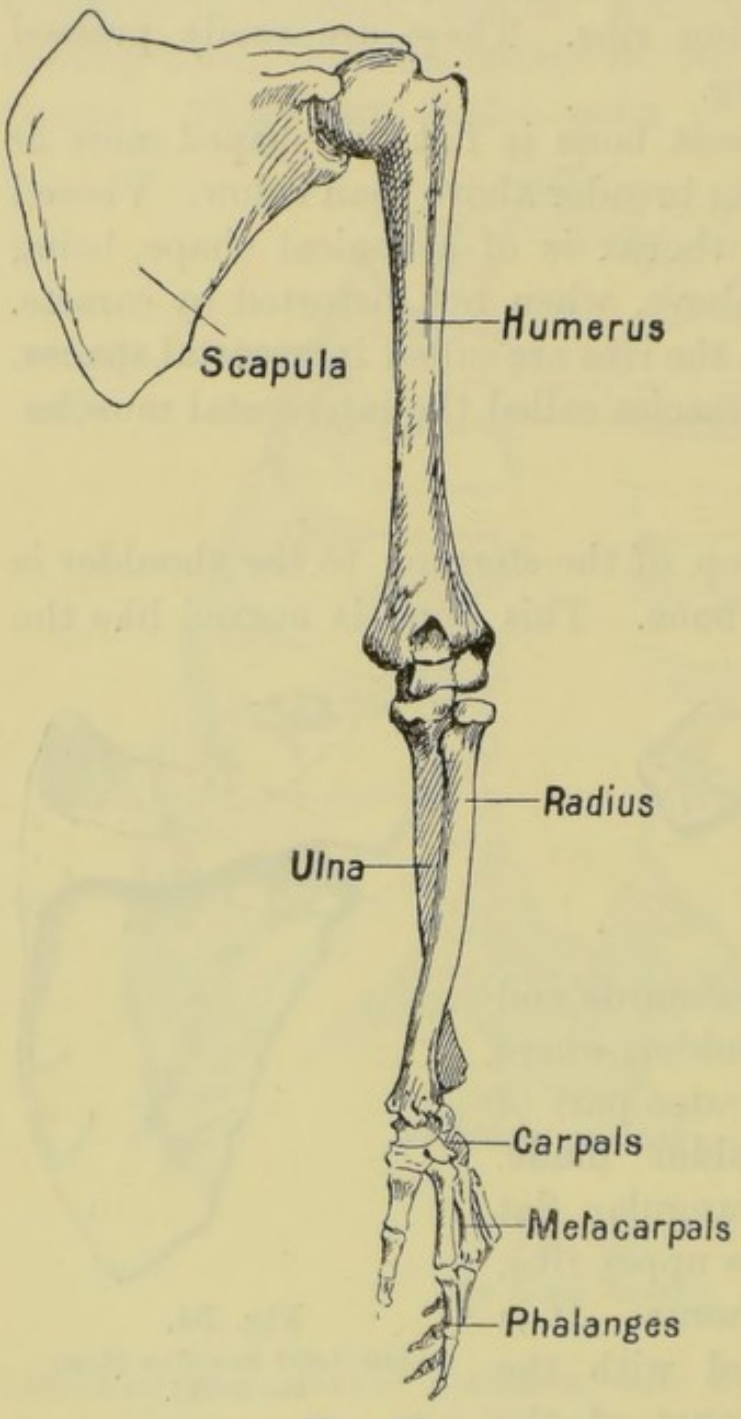


Fig. 59.
THE SCAPULA AND THE ARM.

Upper Limb.

The arm bone or **humerus** has a large rounded upper end, the head, which enters into the formation of the shoulder joint. The lower end is flattened, and meets the two bones of the forearm at the elbow joint.

The bones of the forearm are the **radius** and the **ulna**. The ulna is the inner bone and is on the same side as the little finger. The point of the elbow is formed by the hook-shaped end of the ulna. The upper end of this bone is much broader than the lower, so that, while it forms a

great part of the elbow joint, it only has a minor share at the wrist joint.

The radius, on the contrary, is narrow at its upper extremity, and much broader below, where it forms the greater part of the wrist joint. If the hand be laid with its back on a table and then turned over, it will be noticed that the thumb describes a semi-circle round the little finger. In the forearm it is the radius that describes the semicircle round the end of the ulna—hence the name radius.

The **wrist bones** or **carpals** are eight small bones arranged roughly in two rows of four. The **hand bones** or **metacarpals** are the five long narrow bones that can be easily felt at the back of the hand. Attached to the ends of these are the **phalanges**, each finger possessing three and the thumb two.

Hip Bones.

On each side of the sacrum is fastened a strong irregularly shaped bone, the hip bone. The hip bones curve outwards and then forwards and downwards, finally meeting each other in front. They inclose a basin-shaped cavity called the **pelvic cavity**. The two hip bones, together with the sacrum and coccyx, form a bony girdle called the **pelvis**.

Lower Limb.

The outer side of the hip bone contains a rounded cavity for the reception of the ball-shaped head of the **femur** or **thigh bone**. The thigh bone is the longest and strongest bone in the body. The lower end forms part of the knee joint. The other part of this joint is formed by the **shin bone** or **tibia**, while in front of the joint is the small rounded bone called the **kneecap** or **patella**, which is held

in position by a strong tendon. On the outer side of the tibia is a long thin bone, the **fibula**. Both the tibia and the fibula help to form the ankle joint.

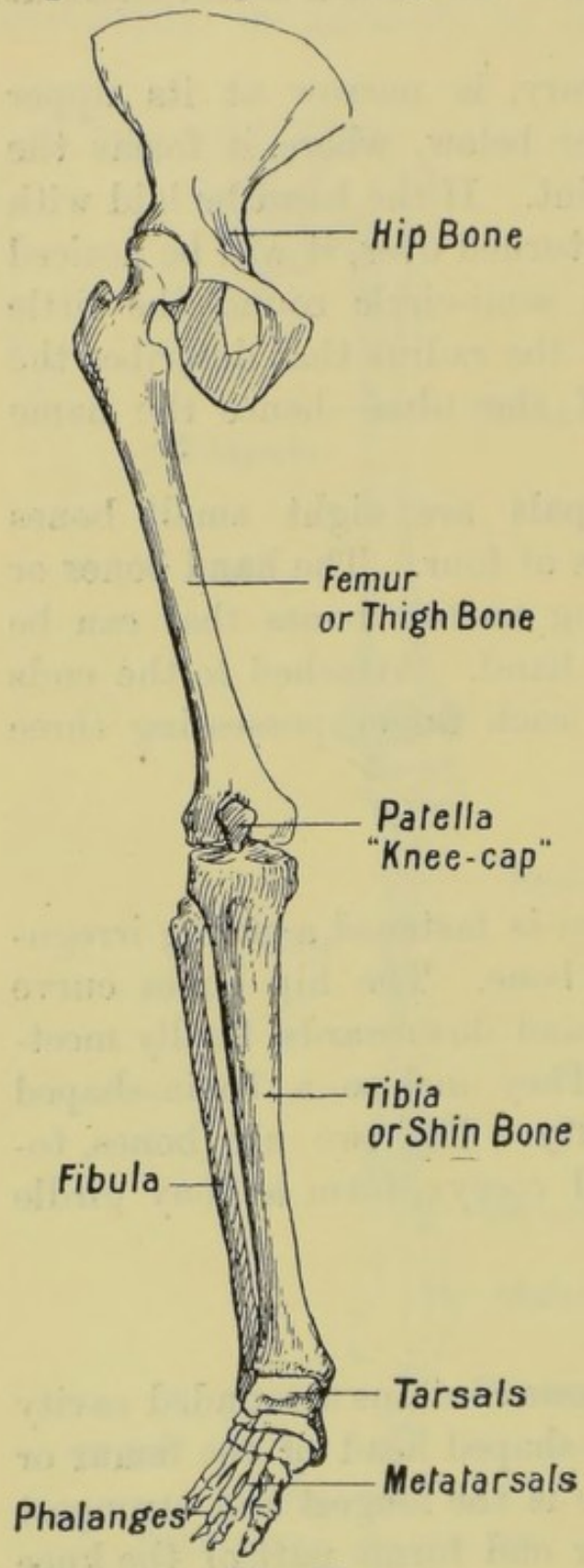


Fig. 60.
HIP BONE AND LOWER LIMB.

Forming the ankle and the heel are seven bones, the **tarsal bones**. The bones in the middle of the foot are long and narrow, and are called **metatarsals**. There are five of them, one corresponding to each toe. The **phalanges** or toe bones correspond exactly with the finger bones, there being two in the big toe and three in each of the others.

The **foot** is narrowest at the heel and broadest at the ends of the metatarsal bones. The bones of the foot form two arches, one from the heel to the ends of the metatarsal bones, the other transverse from side to side. In the ordinary position of standing the foot rests on the heel, the outer edge of the foot, and the ends of the metatarsal bones. The inner side of the foot is too much arched for it to touch the ground, except in the condition known

as "flat foot." These arches give elasticity and strength to the foot. This, together with the great number of joints, and the excellent leverage obtained by the muscles of the

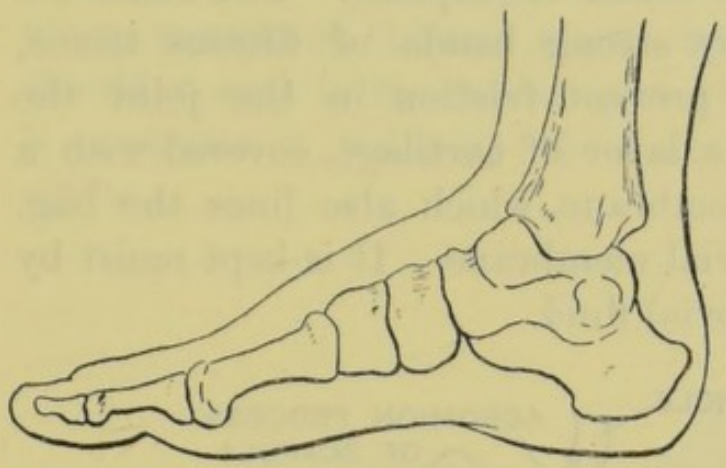


Fig. 61.
THE FOOT.

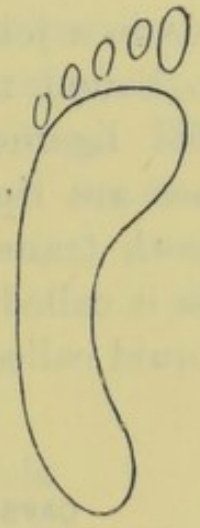


Fig. 62.
IMPRINT OF FOOT.

calf which pull on the heel bone in raising the body on tiptoe, renders the foot peculiarly adaptable to the act of walking.

JOINTS.

The movable joints of the body allow variable degrees of movement to take place. Thus the joints between the vertebrae allow only of a small amount of gliding movement; the joint at the elbow allows a backward and forward motion like a hinge; at the hip and the shoulder the movements are very wide on account of the ball-and-socket nature of the joint; some, like the one between the head of the radius and the ulna, allow rotation only to take place, and are called pivot joints.

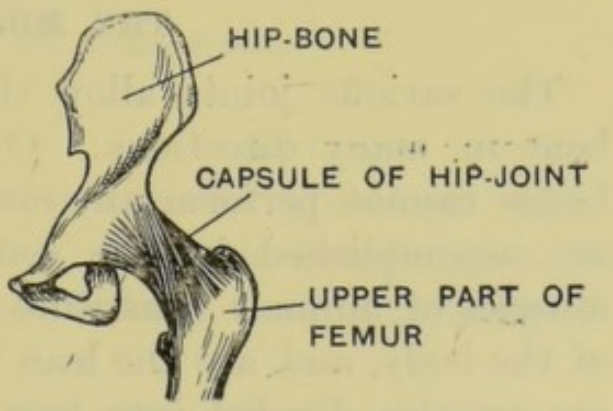


Fig. 63.

A thin tough material in the form of a bag round the ends of the bones forming the joint, and attached all round the bones a little distance from their ends, completely shuts in a joint, and is called its capsule. The bones are also bound together by strong bands of fibrous tissue, called ligaments. To prevent friction in the joint the bones are tipped with a layer of cartilage, covered with a smooth transparent membrane, which also lines the bag. This is called the synovial membrane. It is kept moist by a liquid called the synovial fluid.

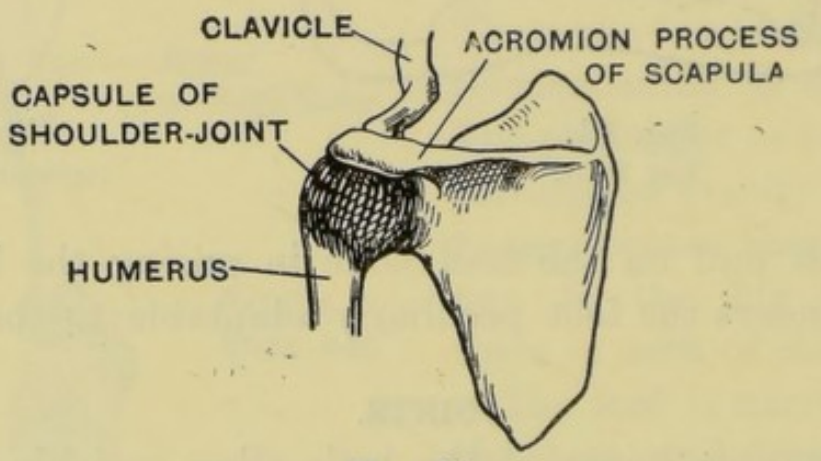


Fig. 64.

THE MUSCLES.

The various joints allow the bones of the body to be bent in many directions. Of themselves, however, the bones cannot perform any movement, but all movements are accomplished by the contraction of muscles. The muscles of animals constitute the chief part of the flesh of the body, and are the lean part of the meat. Muscles are usually divided into two classes: (1) the voluntary muscles; (2) the involuntary muscles.

The **voluntary muscles** are those muscles whose movements are under the control of the will. The two ends of a muscle are usually attached to two bones with a joint

between. When the muscle contracts it bends the joint, and when the joint is bent it may be straightened out again by the contraction of another muscle, which tends to bend the joint in the opposite direction. For instance, the biceps muscle of the arm is attached to the scapula at the shoulder, and to the radius just below the elbow. When it contracts it pulls up the forearm and so bends the elbow.

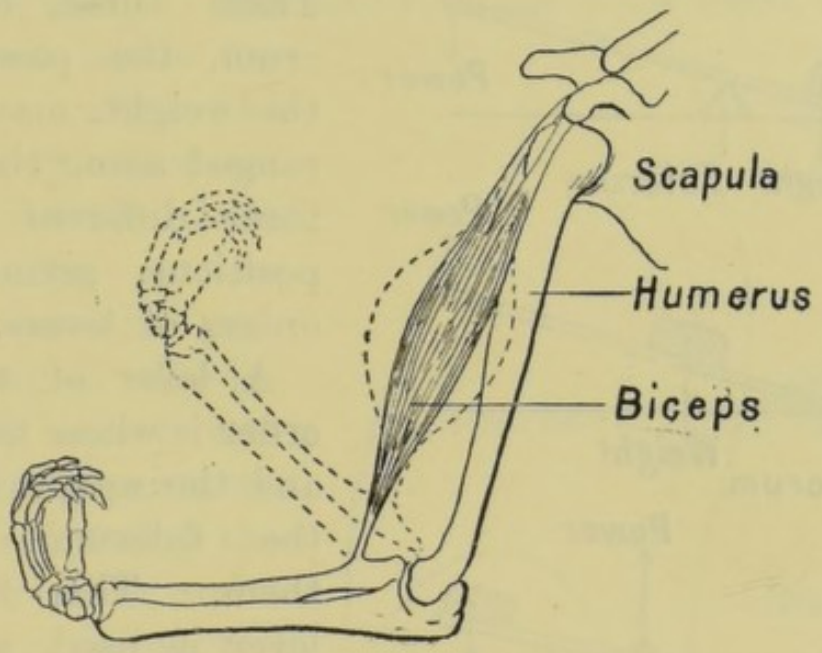


Fig. 65.

THE ACTION OF THE BICEPS MUSCLE.

The **involuntary muscles** are those which act independently of the will. They form the muscular walls of the stomach, intestines, bladder, heart, and blood-vessels.

Passing to each muscle is a nerve which conveys to it the messages from the brain or spinal cord. This is called a **motor nerve**, because we find that if it is divided the muscle becomes paralysed and incapable of producing any movement.

Levers.

Our voluntary movements are usually produced by a muscle or a set of muscles using a bone as a lever.

A lever is a rigid bar which is capable of being moved about a fixed point. This fixed point is called the **fulcrum**. The force producing the motion is generally called the **power**, and the body which is being moved by the lever is referred to as the **weight**. These three, the fulcrum, the power, and the weight, may be arranged along the bar in three different relative positions, giving three orders of levers.

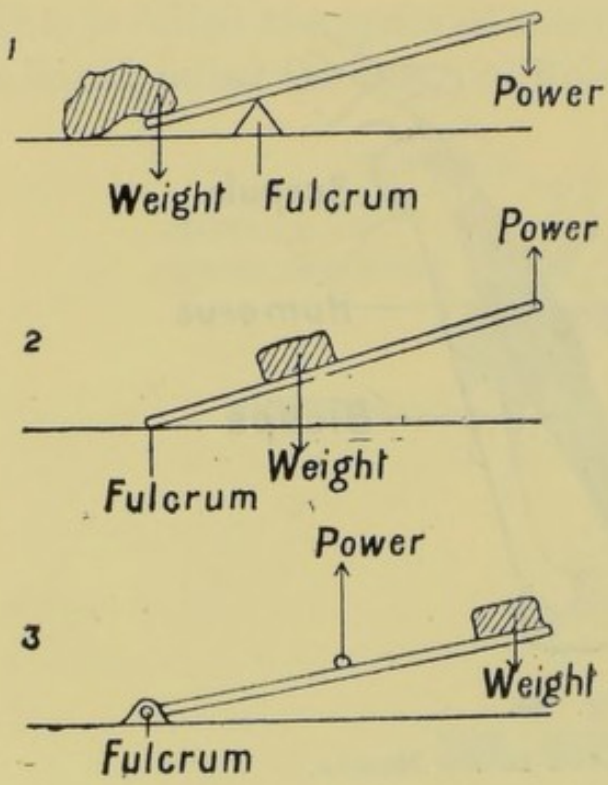


Fig. 66.
LEVERS.

A lever of the **first order** is where the power and the weight act with the fulcrum between them. This form of lever is used when we nod our head. A set of muscles pull down the head in front, and another set pull down at the back, the fulcrum being the point at which the skull rests on the atlas.

The **second order** of lever is where the fulcrum is at one end of the lever and the power at the other end, with the weight between them. This is the position when the body is raised on tip-toe. The force here is represented by the muscles at the back of the leg, which are pulling up the heel. The weight of the body acts in the middle, and the toes form the fulcrum.

The contraction of the biceps producing movement of the forearm illustrates a lever of the **third order**. The fulcrum is the elbow joint. The power is the contracting biceps, and is applied about an inch away from the elbow. The weight acts further down and is represented by the arm which is lifted.

THE BODY TRUNK.

The limbs are practically solid structures, composed of the above tissues. The trunk, on the other hand, is hollow. This space inside the trunk is called the **body cavity**. At about the level of the three lowest ribs is an arched muscular partition, which divides the body cavity into two distinct parts, an upper part called the **thorax** or chest, and a lower part called the **abdomen**.

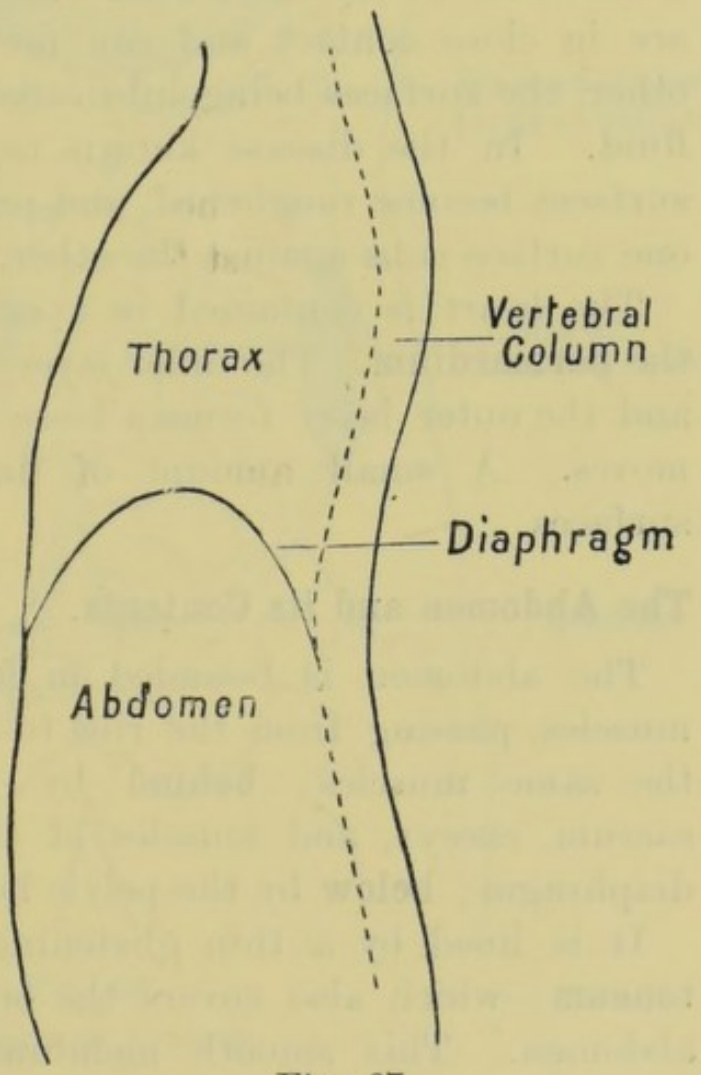


Fig. 67.
THE BODY CAVITY.

The Thorax and its Contents.

This cavity is bounded **in front** by the sternum and the cartilages of the ribs; **laterally** by the ribs and the intercostal muscles between them; **behind** by the ribs, vertebral column, and the great muscles of the back; **above** by the first rib, the collar

bone, and the neck; **below** by the arched muscular partition called the **diaphragm**.

It is convenient to divide the thorax into three parts. At each side it is filled with the lungs (right and left). In the middle portion there are the heart and great blood vessels, the trachea and its branches, the oesophagus, the thoracic duct, and lymphatic glands. Surrounding each lung is a double bag called the **pleura**, the inner layer of which is attached to the lung itself, while the outer layer is fastened to the chest wall. In health these two layers are in close contact and can move smoothly over each other, the surfaces being lubricated by a small quantity of fluid. In the disease known as pleurisy these smooth surfaces become roughened, and pain is felt every time the one surface rubs against the other.

The heart is contained in a similar double bag called the **pericardium**. The inner layer covers the heart closely, and the outer layer forms a loose bag in which the heart moves. A small amount of fluid lubricates the two surfaces.

The Abdomen and its Contents.

The abdomen is bounded **in front** by the abdominal muscles, passing from the ribs to the pelvis; **laterally** by the same muscles; **behind** by the lumbar vertebrae, sacrum, coccyx, and muscles of the back; **above** by the diaphragm; **below** by the pelvic bones and muscles.

It is lined by a thin glistening membrane—the **peritoneum**—which also covers the organs contained in the abdomen. This smooth membrane is kept continually moist by a small amount of fluid which it secretes. In the abdomen are the stomach and intestines, the liver and pancreas, the spleen, the kidneys, ureters, and bladder. Immediately under the diaphragm and chiefly on the right

is the **liver**, a large organ with a curved upper surface to fit the arch of the diaphragm. On the left, touching the diaphragm, is the stomach, the right end of which is

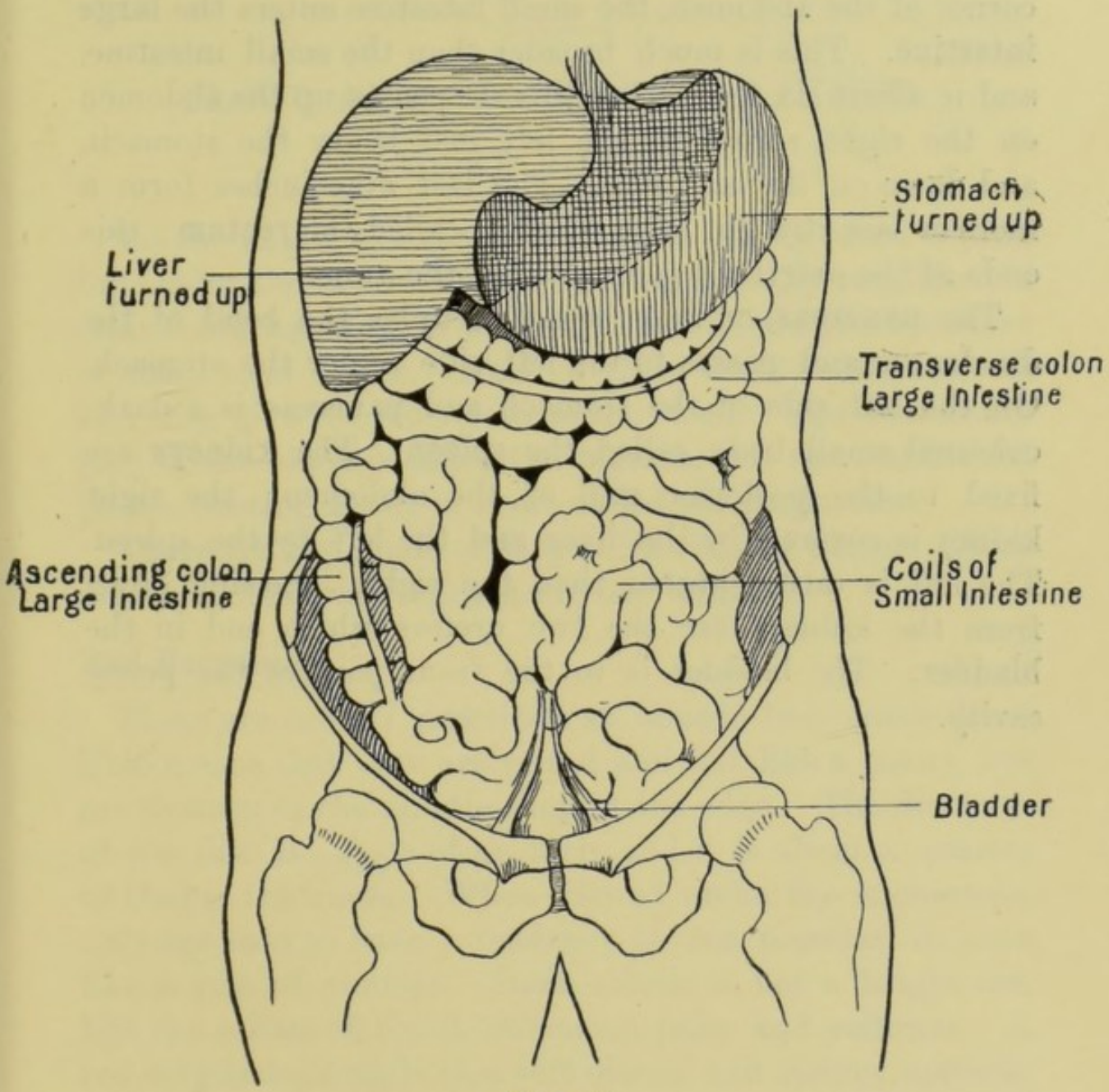


Fig. 68.

CONTENTS OF ABDOMEN.

continuous with the **duodenum**, or the first part of the **small intestine**. The duodenum forms a noticeable bend which brings it under the stomach.

The remainder of the small intestine forms a number of coils situated in the middle of the abdomen, and making a total length of about twenty feet. At the lower right-hand corner of the abdomen, the small intestine enters the **large intestine**. This is much broader than the small intestine, and is about six feet in length. It passes up the abdomen on the right, across to the left just below the stomach, and down on the left side. The last nine inches form a more or less straight tube which is called the **rectum**; this ends at the external opening called the anus.

The **pancreas**, or sweetbread, occupies the bend of the duodenum and passes to the left side under the stomach. On the left side of the stomach and pancreas is a dark-coloured small body called the **spleen**. The **kidneys** are fixed to the posterior wall of the abdomen; the right kidney is covered by the liver and the left by the spleen. The left is rather higher than the right. Passing down from the kidneys are the two ureters which end in the **bladder**. The bladder is in the front part of the pelvic cavity.

CHAPTER III.

BLOOD AND CIRCULATION. LYMPH.

THE BLOOD.

To the naked eye the blood appears to be a red liquid, but under the microscope we see that it really consists of a clear colourless fluid in which are suspended a great number of small solid bodies. Most of these small bodies are red, and they give the red colour to the blood. The clear liquid part of the blood is called the **plasma**, and the small solid bodies floating about in it are called the **corpuscles**.

There are two kinds of corpuscles, red and white. There are about 500 red corpuscles to one white.

Red Corpuscles.

These are usually described as minute bi-concave discs. This means that they are round and flat like a penny, but are thinner in the middle than at the edge. The diameter of the disc is $\frac{1}{3200}$th of an inch, and it is about a quarter of that in thickness. When viewed under the microscope, they are seen to have a tendency to run together in rows like a pile of pennies. Their colour is not a bright red, like the colour of blood, but much paler and yellower. A red corpuscle is made of a soft elastic and spongy material called **stroma**. Owing to their flexibility they can be forced through a small blood-vessel which has a less diameter than their own.

This spongy network or stroma is itself colourless, but contains in its meshes a red colouring matter called **haemoglobin.** Haemoglobin is a chemical substance

capable of combining loosely with oxygen and forming **oxyhaemoglobin**, which has a bright scarlet colour. This can give up its oxygen and return again to haemoglobin. The haemoglobin therefore acts as the oxygen carrier of the

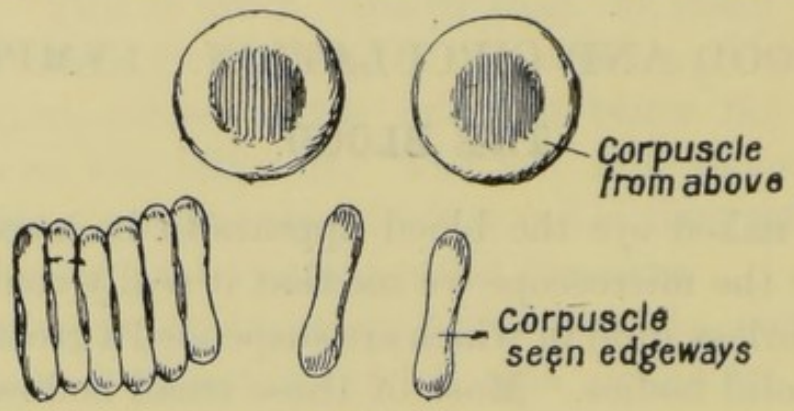


Fig. 69.
Red Corpuscles (Magnified 600 times).

body. In the lungs it absorbs oxygen and becomes oxyhaemoglobin, and then this oxygen is carried all over the body to burn up the waste products of the various parts.

The White Corpuscles (Leucocytes).

These vary very greatly in form and in size. They average $\frac{1}{2500}$th of an inch in diameter. The red corpuscles have no power of movement of themselves, but the white ones are constantly moving and changing their shape. Each white corpuscle is a complete cell, made of a clear jelly-like substance called protoplasm. In the protoplasm are seen a number of black dots called granules, and, if the cell is treated in a certain way, a rounded body can be distinguished which appears darker than the rest of the cell. This body is called the nucleus. The red corpuscles have no nucleus.

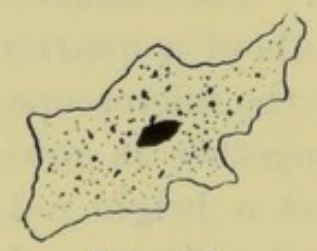


Fig. 70.
White Corpuscle
(Magnified 1600 times).

Uses of Blood.

(1) The haemoglobin in the red corpuscles acts as the oxygen carrier from the lungs to all parts of the body. (2) The impurities of the body are carried by the blood to the lungs, kidneys, liver, and skin, where they can be got rid of. (3) When the food is digested it passes into the blood, which conveys the nourishment to the various parts

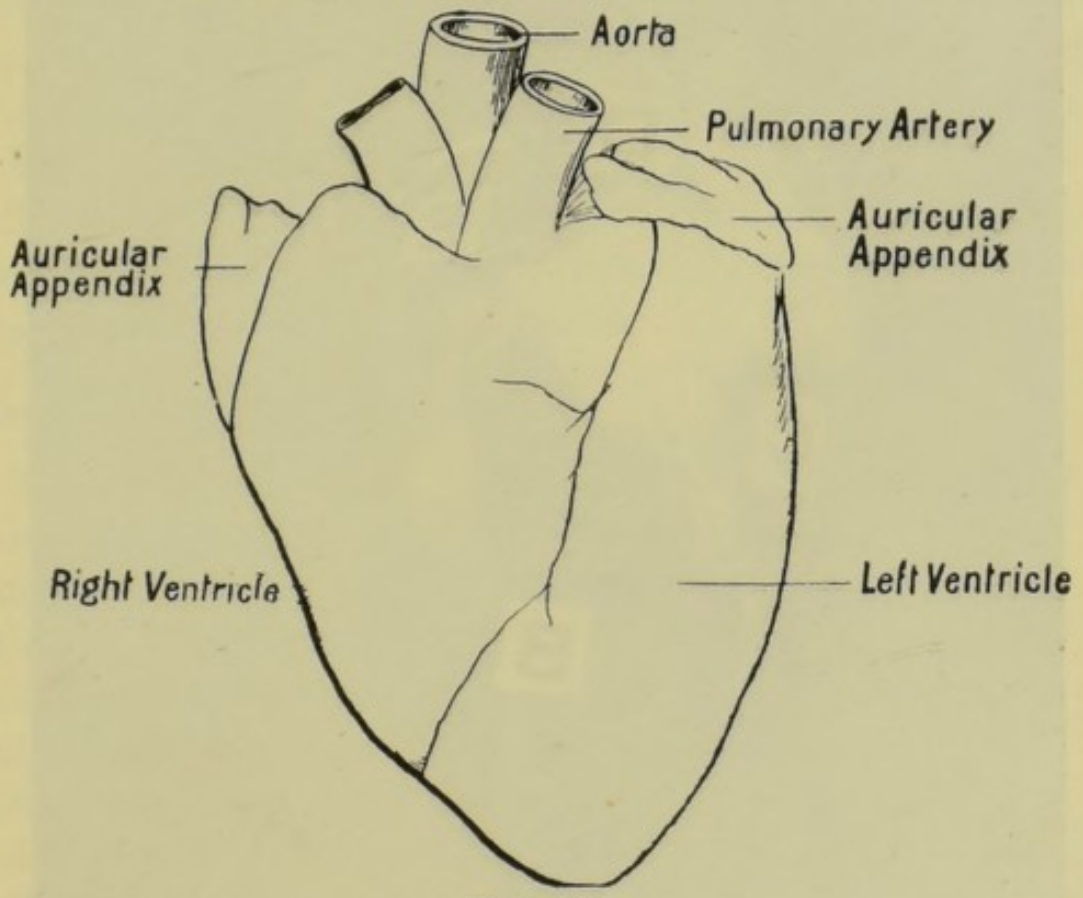


Fig. 71.
SHEEP'S HEART (Front View).

of the body. (4) The flow of the blood through all parts keeps the temperature of the body uniform.

THE HEART.

The heart lies in the thorax between the two lungs, and is partly covered by the lungs, but part of it is in contact with the chest wall. The walls are made chiefly of muscle, and the heart weighs nine or ten ounces. It hangs

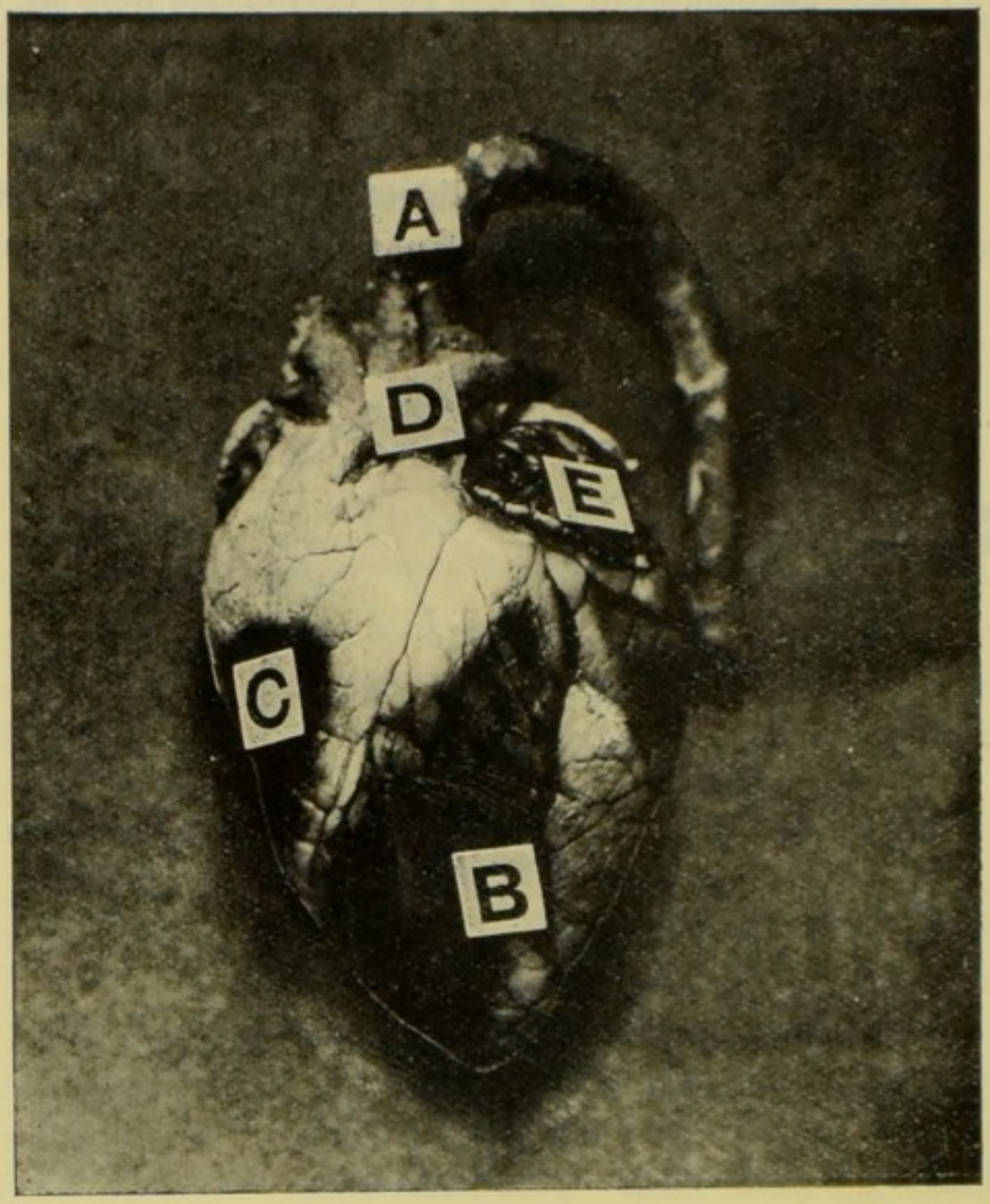


Fig. 72.

FRONT VIEW OF HEART.

A is placed over the aorta.

B = left ventricle, separated from *C*, the right ventricle, by the oblique interventricular groove, well seen in the photograph.

D is placed over the pulmonary artery as it arises from the right ventricle. This essel can be seen dividing into its two main branches.

E = left auricular appendage.

freely in a closed membranous sac called the pericardium. The inner surface of the membrane is smooth and shiny, as is also the outer surface of the heart. The heart is conical in shape, the base being uppermost and directed upwards and to the right, while the apex points downwards and to the left. The **front** of the heart differs from the **back** by being more rounded and convex, and by having a groove filled with fat running from the top on the left across towards the bottom on the right. The back of the heart is much flatter, and the groove in it is hardly noticeable.

The **left** side of the heart differs from the **right** side by feeling firm and solid when pinched between the fingers; the right side feels soft and flabby.

Structure of the Heart.

The heart is divided into a right and a left half by a partition, and there is no communication through this partition from one half to the other. Each half is again subdivided into an upper and a lower compartment called respectively **auricle** and **ventricle**. Each auricle communicates with the ventricle of the same side by an opening which is guarded by valves. The object of these valves is to prevent any blood flowing from the ventricle to the auricle. They allow blood to flow freely from the auricle to the ventricle.

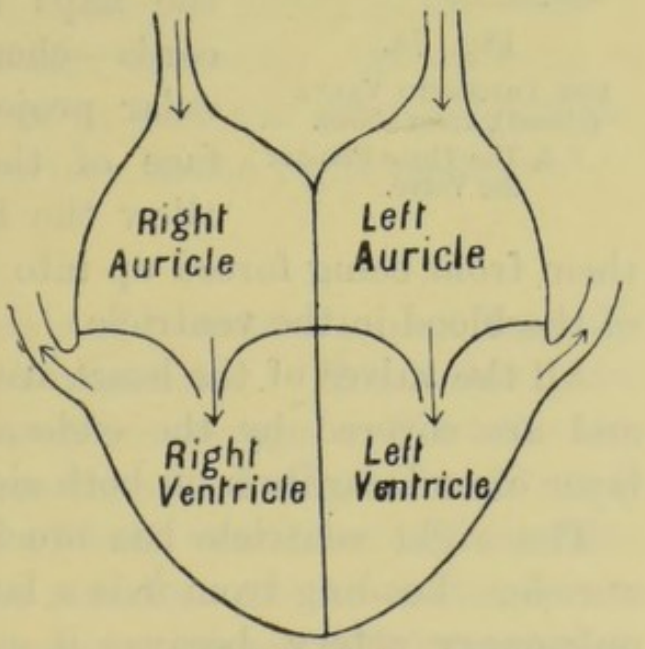


Fig. 73.
DIAGRAMMATIC HEART.

In describing the heart it is best to consider separately its four cavities, the right and left auricles, and the right and left ventricles. The **Right Auricle** is a thin-walled cavity. In common with the other three cavities of the heart it is lined with a thin transparent membrane, called the **endocardium**. Opening into the right auricle are two large veins, the **superior vena cava** and the **inferior vena cava**. These veins bring blood from the whole of the body except the lungs.

The **Right Ventricle** is separated from the right auricle by a valve which is composed of three triangular flaps or cusps, and is called the **tricuspid valve**. The apices of the flaps can meet together in the middle of the opening between the auricle and the ventricle and prevent blood passing from the ventricle to the auricle. The apices and margins of the flaps are connected by fibrous cords—**chordae tendineae**—with muscular projections on the inner surface of the ventricle. These cords allow the flaps to meet, but prevent them from being forced up into the auricle by the pressure of the blood in the ventricle.

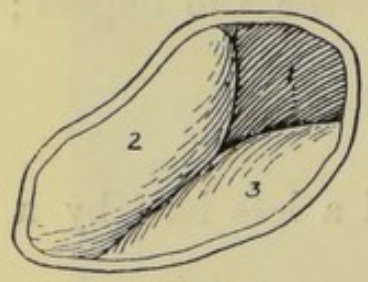


Fig. 74.

THE TRICUSPID VALVE (closed), from above.
1, 2, 3, The Three Flaps of the Valve.

All the valves of the heart are formed of fibrous tissue and are covered by the endocardium, so that there is a layer of endocardium on both sides of the flap.

The right ventricle has much thicker walls than the auricle. Leading from it is a large blood-vessel called the **pulmonary artery**, because it carries blood to the lungs. The opening from the right ventricle into the pulmonary artery is guarded by a valve to prevent blood flowing back into the ventricle after it has been forced into the artery. The valve consists of three semi-circular flaps which are

called the **semilunar valves**. Each flap forms a kind of pocket with the wall of the artery, and allows blood to pass easily into the artery, but not back again.

The **Left Auricle** has thin walls. Opening into it are four **pulmonary** veins which bring blood from the lungs. Below it communicates with the left ventricle by the **mitral** or **bicuspid** valve. This valve prevents blood from passing from the ventricle into the auricle, but allows it to pass in the opposite direction. The structure of the valve is exactly similar to that of the tricuspid valve, except that it is composed of two flaps instead of three, and that the flaps are thicker and stronger.

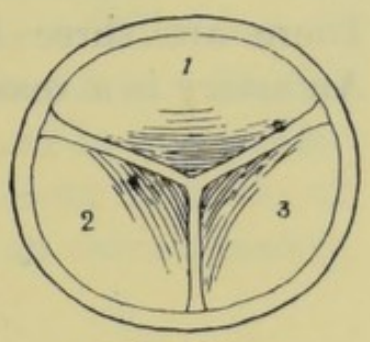


Fig. 75.
THE PULMONARY VALVE.
1, 2, 3, Flaps of the Valve.

The **Left Ventricle** is the thickest-walled cavity of the heart. It is longer and narrower than the right ventricle. The largest artery in the body—the **aorta**—goes from the left ventricle. Its opening is guarded by semilunar valves in just the same way as the opening of the pulmonary artery in the right ventricle.

The Beat of the Heart.

A beat of the heart consists of a contraction of the walls of both auricles and both ventricles. This takes place about 75 times in a minute on an average. First the two auricles contract at the same time, and this is immediately followed by a contraction of both ventricles. Then there is a pause during which the auricles and the ventricles are relaxed; then the auricles again contract, and immediately afterwards the ventricles contract; then follows a pause, and so on. In a new-born baby the heart beats one hundred and forty times a minute, while in old people it only beats sixty times a minute or even less. Exercise

increases the rapidity of the heart beat. It is generally quicker in women than in men.

THE BLOOD-VESSELS.

The blood-vessels are branched tubes which convey the blood to and from the different parts of the body. There are three kinds—arteries, veins, and capillaries. An artery is a vessel that brings blood from the heart to

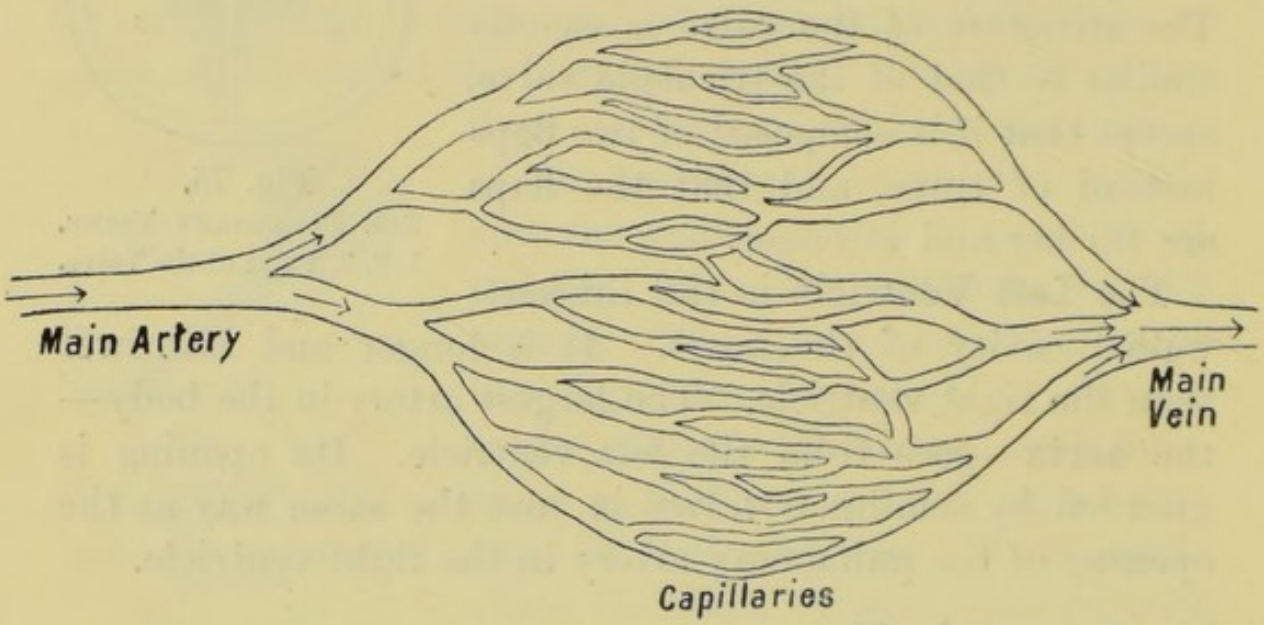


Fig. 76.

Diagrammatic Representation of Artery, Capillaries, and Vein.

any part of the body, and the vessel carrying the blood back again to the heart is called a vein. When an artery reaches the organ which it supplies it breaks up into smaller branches, and then each branch subdivides again and again until very small vessels are arrived at. These are called capillaries, because they are as fine as hairs. The capillaries eventually reunite and form the vein taking the blood back to the heart.

The Arteries.

These are thick-walled vessels which do not collapse when empty. Their walls are strong and elastic, and consist of three layers—an inner, middle, and outer coat. The inner coat of an artery is a transparent colourless membrane called **endothelium**. This is continuous with the endocardium lining the heart. The middle coat is made up of layers of muscle and elastic tissue. In the large arteries this coat is chiefly elastic, and in the smaller ones it is mainly muscular. The outer coat is made of connective tissue. When an artery has an extra quantity

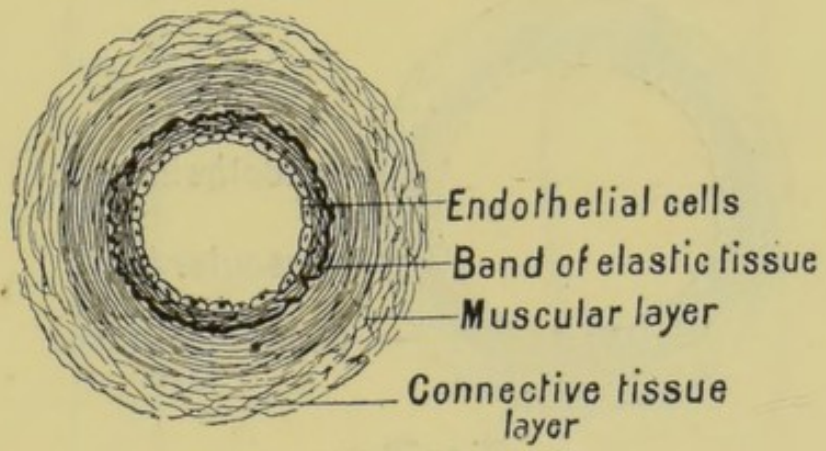


Fig. 77.
SECTION THROUGH AN ARTERY.

of blood suddenly forced into it, its elastic coat enables it to dilate, and afterwards to recover its normal size. By means of its muscular coat the size of an artery can be regulated independently of the pressure of blood within it.

The Capillaries.

As the arteries get smaller they gradually lose their elastic tissue. Then the muscular coat diminishes and finally disappears, so that a capillary blood vessel is simply a tube of **endothelium** consisting of thin flat cells united together at their edges.

The Veins.

The capillaries gradually unite together and increase in size, assuming the same three layers as in the arteries. These three coats of the veins are, however, much thinner than the coats of the arteries and contain much less elastic and muscular tissue. A vein collapses when it is empty. Another difference between an artery and a vein is that many veins, especially those in the arms and legs, have valves which allow the blood to flow only towards the heart. These valves are semilunar folds of endothelium with a small amount of connective tissue.

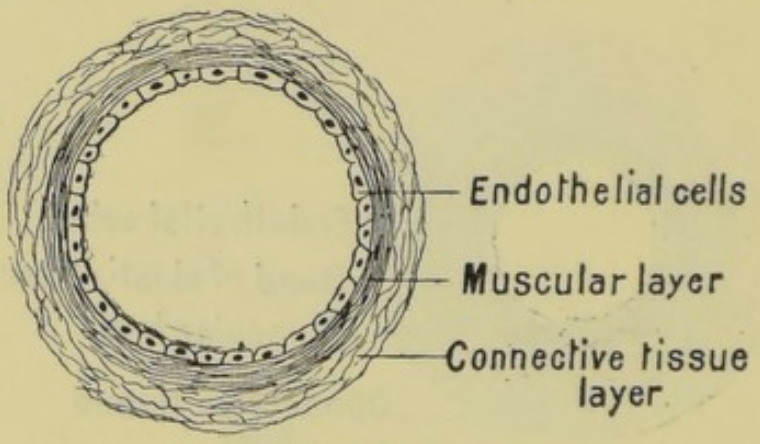


Fig. 78.
SECTION THROUGH VEIN.

CIRCULATION OF THE BLOOD.

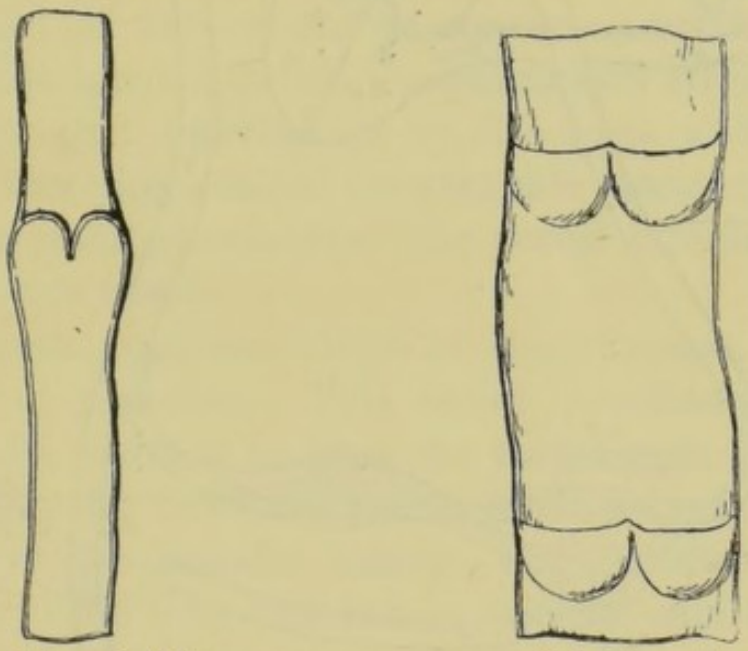
When describing the heart, mention was made of the fact that the blood vessels opening into the ventricles are arteries, while those opening into auricles are veins. The forcing power producing the circulation of the blood is the heart, which by its contraction squeezes the blood into the arteries and receives a supply from the veins during its dilation.

When the auricles contract they close the openings of the veins, and force the blood into the ventricles through the mitral and the tricuspid valves. Then the ventricles

contract. This closes the mitral and tricuspid valves and forces the blood into the arteries.

In any description of the circulation, it is best to begin with the blood that is contained in any one of the four chambers of the heart and to trace its journey over the body until it again reaches the chamber from which it started. We will begin with the blood in the right auricle.

When the right auricle contracts it forces the blood



Section through Vein. Vein Opened.

Fig. 79.

VALVES IN VEIN.

through the tricuspid valve into the right ventricle. Then the right ventricle contracts, closes the tricuspid valve by the blood pressure, and forces the blood into the **pulmonary artery** through the semilunar valves. It passes along this artery and reaches the capillaries of the lungs, where it receives oxygen from the air in the lungs and gives up some of its impurities to the air. The **pulmonary veins** bring the blood back from the lungs to the **left auricle**, which, by its contraction, forces the blood into the **left**

ventricle through the mitral valve. By the contraction of the left ventricle the mitral valve is closed, and the blood

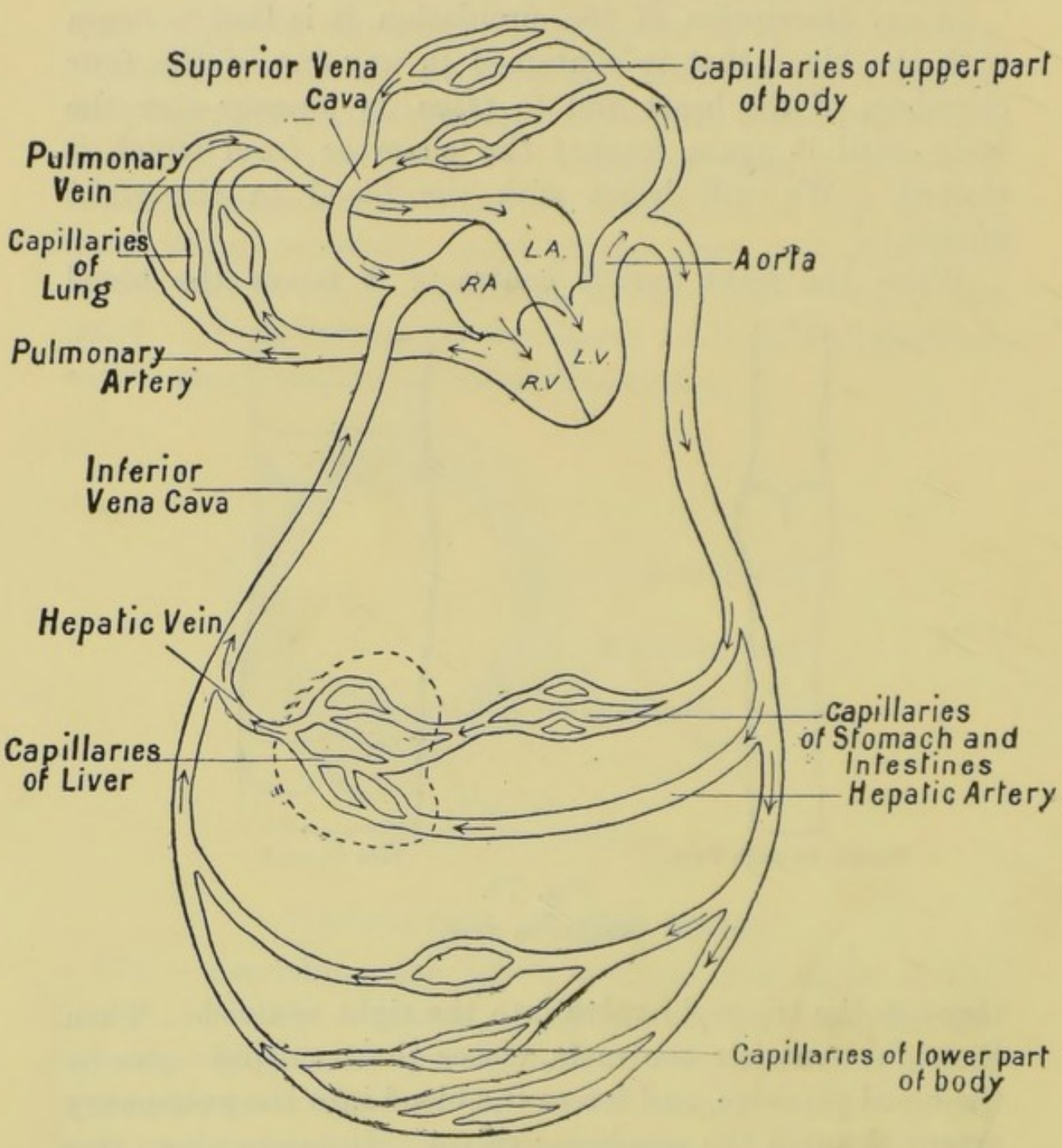


Fig. 80.

DIAGRAMMATIC PLAN OF CIRCULATION.

is forced through the semilunar valves and along the great artery of the body, the **aorta**.

This artery distributes the blood over the whole body except the lungs. Its distribution may be divided into two parts: (1) The head, neck, and upper extremities, from which parts the blood is collected by veins which unite together and form a great vein, the **superior vena cava**; (2) the lower part of the body and the legs. The blood from these is collected by veins which coalesce and form another great vein, the **inferior vena cava**. Both these great veins empty themselves into the right auricle.

That part of the circulation concerned in the supply of blood to the lungs is called the **pulmonary circulation**, and the greater part (carried on by the aorta and the venae cavae) is sometimes called the **systemic circulation**. There is another small circulation—the **portal circulation**—that has to be described.

The aorta supplies blood to the stomach, intestines, spleen, and pancreas. This blood is collected by veins which unite together to form the **portal vein**. The portal vein goes to the liver and there breaks up into capillaries. An artery—the **hepatic artery**—also passes direct from the aorta to the liver and breaks up into capillaries there. The liver therefore has two blood supplies, one from the portal vein and one from the hepatic artery. The blood from the liver is collected from a single vein—the **hepatic vein**—which joins the inferior vena cava.

The Cause of the Circulation.

The capillaries offer a very great resistance to the flow of blood through them because of their very small diameter. Now the arteries have a definite quantity of blood forced into them at each beat of the heart. They will obviously therefore become overfilled with blood. Their elastic coat enables them to distend in order to accommodate much more blood than would fill them in their ordinary condi-

tion. The elasticity of the walls tries always to decrease the diameter of the distended arteries, and so there is set up a pressure in the blood—**blood pressure**—that tends to force the blood out of the arteries, *i.e.* into the capillaries.

When the contents of the ventricles are suddenly pushed into the artery an extra distension takes place in order to accommodate this extra amount of blood, and therefore the blood pressure will suddenly increase in the arteries at each contraction of the ventricles. This causes the pulsation of the arteries, *i.e.* the **pulse**. Between any contraction and the following one the pressure in the arteries decreases because the pressure in them is forcing blood into the capillaries, *i.e.* the arteries are emptying themselves.

Thus the elasticity of the arterial walls acts as a reservoir of the heart's force, "just as the distended air-bag of a piper acts as a reservoir of his expiratory efforts." Its effect on the circulation is to convert the pulsating force of the heart into a continuous force, the energy of each heart-beat being mainly absorbed in keeping the arteries distended, by which means a constant flow is kept up in the interval between the beats. On this principle, fire engines, garden watering engines, etc., are made.

The blood pressure steadily decreases in passing from the larger to the smaller arteries, because of the friction which opposes the flow in the small arteries and the capillaries. In overcoming this friction, the energy of the heart-beat is turned into heat, and thus the pressure produced by the heart is changed into heat in the small arteries. When the blood has been driven through the capillaries and has reached the veins the force is almost entirely expended, and so the blood pressure in the veins is very small indeed.

Minor forces assisting the circulation of the blood are

the respiratory movements of the chest, and the muscular movements of the body.

THE LYMPHATIC SYSTEM.

The blood is always shut inside definite tubes, but the walls of the smallest tubes—capillaries—are so thin that part of the plasma of the blood passes through and so brings nutritive material actually to the cells. This fluid, which passes from the blood vessels and bathes the tissues, is called lymph.

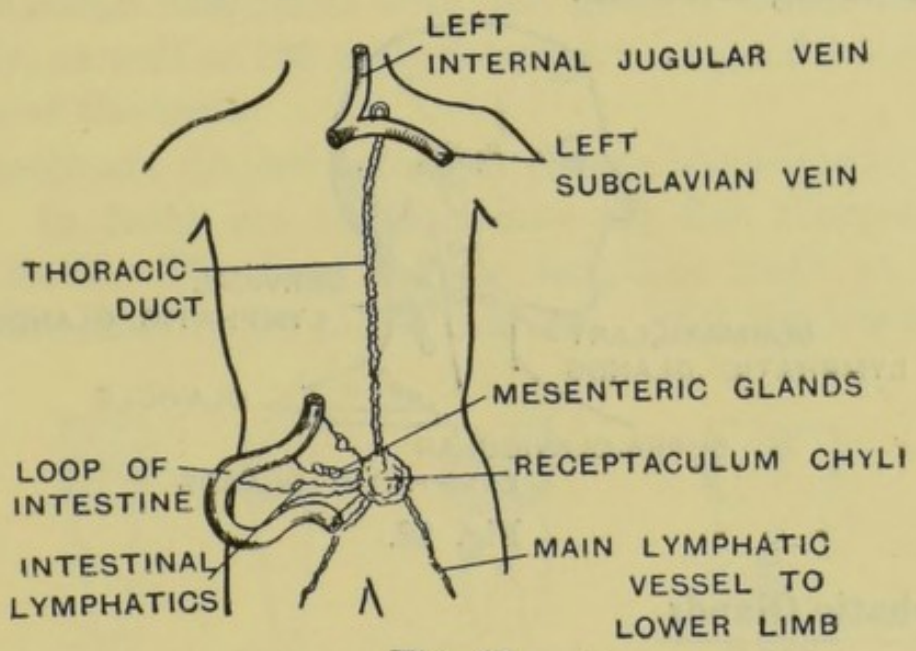


Fig. 81.

Lymph is a colourless liquid, and may be described as blood minus its red corpuscles. Like blood plasma, it clots when shed.

The lymph, after having bathed the cells, supplied them with nourishment, and received their waste products, is collected by a network of delicate vessels, called lymphatics, or lymphatic vessels, which unite with each other and form larger vessels, and these with each other again, finally forming main lymphatics. These main vessels can be traced into the abdomen to the chief lymphatic lying in front of

the vertebrae (the thoracic duct). The upper end of this vessel turns towards the left, and, at the root of the neck, opens into the jugular vein, thereby completing the return of the lymph to the blood.

The flow of the lymph is caused by the excess of pressure in the capillaries (where it is produced) over that in the great vein (into which it discharges). Also all muscular movements tend to cause its flow by pressing on the walls of the vessels, the valves in the vessels preventing a flow in the wrong direction.

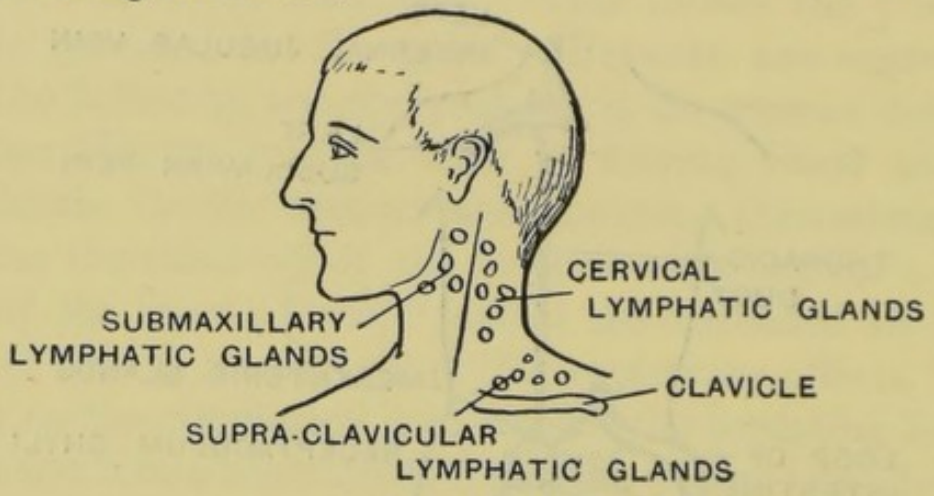


Fig. 82.

Lymphatic Glands.

Placed at irregular intervals along lymphatic vessels are small solid bodies called lymphatic glands. These vary in size, the commonest being about the size of a pea. The lymphatic vessels open into one side and leave on the opposite side. The gland is composed of a network of fine fibres, with colourless lymph corpuscles filling the meshes of the network. These are young white corpuscles of the blood in the process of manufacture by the simple plan of division of existing corpuscles into two, then each of these into two more, and so on. The lymph leaving these glands is found to contain an increased number of white corpuscles, which it takes on with it to the blood.

CHAPTER IV.

CARE OF THE TEETH.

INTIMATELY associated with the general cleanliness of the body, as well as the early formation of good habits, is the care of the teeth.

The teeth are divided into four classes according to their shape. In front are the incisors—the flat sharp-edged biting teeth. The long narrow fang-like teeth at each side of the incisors are called canines. Still further along

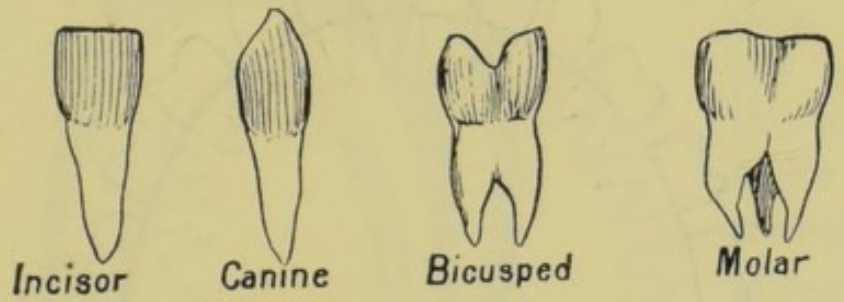


Fig. 83.
KINDS OF TEETH.

the jaw are teeth which seem to be partly split into two at the top—these are the bicuspids. The molars are the broad-topped grinding teeth placed at the back.

There are two sets of teeth, the first set or the temporary teeth, and the second set which are more or less permanent. The first set are called the milk teeth. They are twenty in number, and consist of eight incisors, four canines, and eight molars; each half of each jaw being provided with

two incisors, one canine, and two molars. This set is usually complete at three years. They begin to drop out about the seventh year, and have all gone at twelve. By

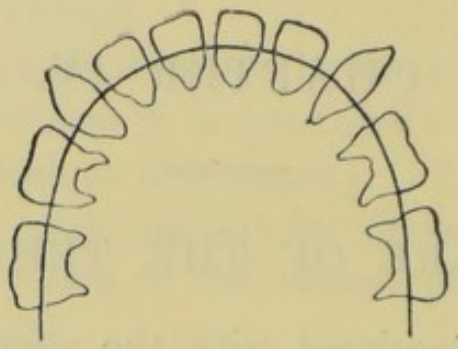


Fig. 84.

MILK TEETH (upper or lower jaw).

the fourteenth year all the permanent set have appeared except the last four molars, called the wisdom teeth. These may not be cut until the twenty-fifth year.

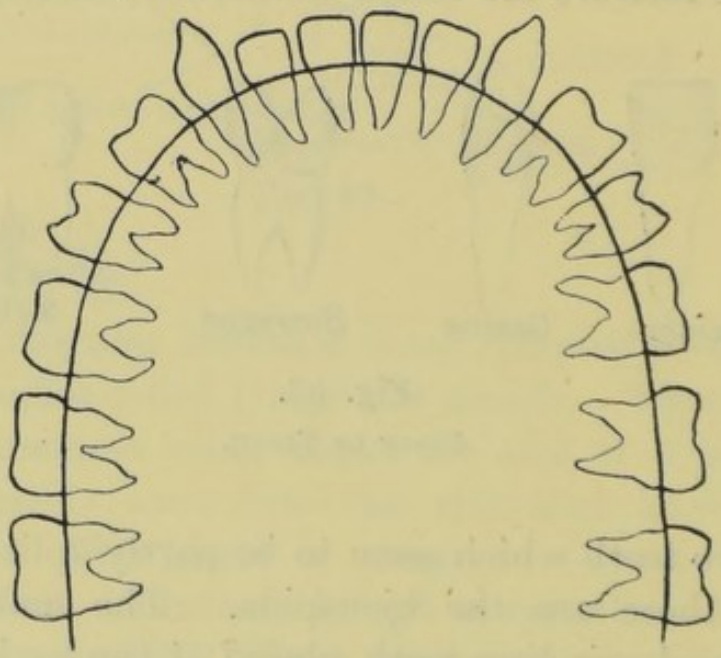


Fig. 85.

PERMANENT TEETH (upper or lower jaw).

The permanent teeth are thirty-two in number, and are divided into eight incisors, four canines, eight bicuspids, and twelve molars. At about fourteen years there would

be twenty-eight teeth, the last four molars not being cut at this age.

Structure of a Tooth.

Each tooth consists of a crown, or the part showing above the gum, and the root, or the part imbedded in the jawbone. The root consists of one or more fangs. A slight constriction is visible at the line where the crown and the root meet; this is called the neck. The main body of a tooth is made of a substance called dentine which closely resembles bone in its structure and composition. Covering the crown of the tooth is a layer of extremely hard material called enamel. It differs from ordinary bone by containing a much smaller percentage of animal matter. For this reason the enamel rarely or never decays; but when it gets chipped off, decay at once attacks the softer dentine. The fang of the tooth is covered by a bony layer called cement which fixes the fang securely in its socket.

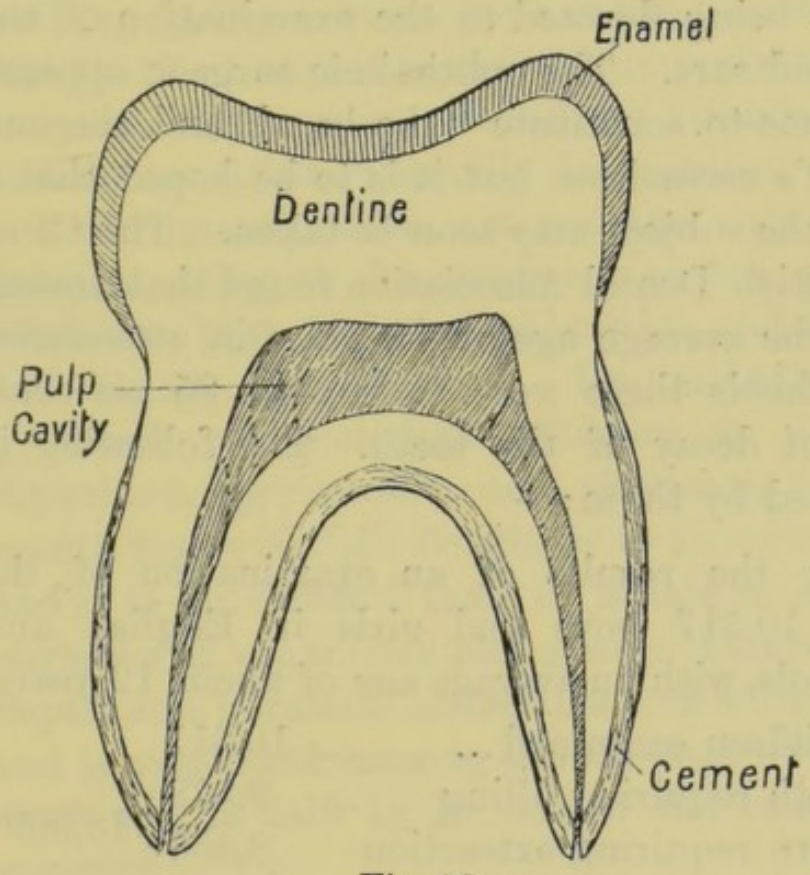


Fig. 86.

In the body of the tooth is a cavity which is filled with a pulpy substance containing nerves and blood-vessels.

These enter the tooth at the tip of each fang, and pass into he pulp cavity. Ordinary toothache is caused by the inflammation of this pulp in the tooth.

The question of children's teeth constitutes one of the most vexing and hopeless problems of child hygiene. Moreover it is a subject intimately associated with the national physique, and of the utmost importance to the well-being of the race. In spite of this, however, there is general public apathy on the subject, compared with the attention that is being devoted to the examination of the children's eyes and ears. The ophthalmic surgeon appears at the present time to constitute "the be all and the end all" of the child's necessities, but it is to be hoped that a broader view of the subject may soon be taken. The Committee of the British Dental Association found that among the children of the average age of 12 years in attendance at elementary schools there were more than 85 per cent. showing signs of decay of the teeth. The following is the table presented by them:—

TABLE showing the results of an examination of the mouths of 10,517 boys and girls in English and Scotch Schools, with an average age of about 12 years.

Number of children examined ...	... 10,517	
Temporary teeth requiring filling	... 9,573	18,009
Temporary teeth requiring extraction	8,436	
Permanent teeth requiring filling	... 13,017	19,096
Permanent teeth requiring extraction ...	6,079	
Total unsound teeth ...	...	37,105
Teeth already extracted		2,174

Sets of teeth free from decay 1,508 = 14·2 per cent.

An examination of ancient skulls shows that caries or decay of the teeth was formerly almost entirely absent,

and it is also an undoubted fact that it is now rapidly increasing.

The attitude of the lower classes towards the subject can only be compared to a kind of Oriental fatalism. A decayed tooth is regarded as one of the unpreventable dispensations of Providence, and it is ignored until the pain can no longer be tolerated, when it is hauled out by some more or less competent individual. Then they wait for the next to come on. At an early age the whole of the working teeth are often gone or are useless. The result is that the food cannot be chewed properly, and the digestion is upset. Dyspepsia with all its attendant evils follows, and the constitution rapidly deteriorates.

Unfortunately these are not the only results. While decay is going on the condition of the mouth cannot be otherwise than foul and unhealthy, and the gums, throat, and tonsils are affected. Undoubtedly there is thus produced an increased tendency to such diseases as diphtheria, pneumonia, and rheumatic fever. In such a mouth bacterial life flourishes to an unimaginable extent, and it is no difficult task to isolate a hundred different varieties of organisms and a large number of each breed. Septic and purulent material is formed in large quantities and is swallowed, causing serious disorders of the intestinal tract, and is said to be one of the causes of pernicious anaemia.

In addition to all this there is pain of a most wearing and aggravating character, and the breath is foul and infectious. Such an individual "pollutes the air that is breathed and contaminates the food that is swallowed." To carefully ventilate schools and to provide good wholesome food is a waste of money under such circumstances. The nutrition of such a child must be defective, and its growth is inevitably stunted. Among the more remote

effects of bad teeth are the enlarged and suppurating glands in the neck, diseases of the jawbones and accessory cavities, and cancer of the tongue.

Causes of Decay.

The causes of decay of the teeth, like those of all diseases, are best classified into the predisposing and the determining. The predisposing causes include heredity, malnutrition, and acute illness. Heredity is important so far as it provides the child with a good or a poor material for its teeth. If the teeth are soft and friable, then when caries is established they will disappear rapidly. Also greater care will be necessary to prevent decay commencing in such teeth. As illustrating the effect of heredity it may be mentioned that Jewish children, as a rule, show less decay of teeth than the Gentiles. Dr. W. Hall, of Leeds, obtained the following figures:—

In good class Jewish school	11 per cent.	had defective teeth.
„ „ „ Gentile „	38 „ „	
In poor class Jewish school	25 per cent.	
„ „ „ Gentile „	60 „ „	

Probably the fact that nearly all the Jewish women suckle their children largely accounts for the differences.

Malnutrition is another important predisposing cause of caries. The improper feeding in infancy on patent foods, instead of milk, has a most injurious effect upon the teeth. The poorer the class of school, and the more neglected and underfed the children are, the greater is the percentage of children with bad teeth.

The nutrition of the teeth during development is arrested, for the time being, during an acute illness. The

time of the illness will be marked on the teeth by a line, just as the nails become similarly marked.

The determining cause of decay of the teeth is composed of two factors—the presence of bacteria and the formation of an acid medium. Bacteria in the mouth have already been referred to. From our point of view there are three chief kinds—those which attack and destroy the teeth, those which produce disease, not only of the mouth, but of other organs, and those which produce fermentation. Those micro-organisms which attack the teeth can only do so when they are surrounded by an acid medium. Now the natural condition of the mouth is to be alkaline, but acid is produced when particles of food are left in the mouth and allowed to ferment. Fermentation produces an acid in the mouth just like it does in milk. If milk is kept too long without special precautions we say it has gone sour. Fermentation has gone on which has produced an acid, and this acid gives the sour taste. So in the mouth the food left between the teeth and round the gums will ferment and produce an acid, thereby affording the necessary opportunity for the bacteria to attack the teeth and cause decay.

Prevention.

The method of prevention now becomes almost obvious. If all particles of food are removed from the mouth there will be no acid produced and no decay. This simply amounts to regular and thorough cleaning of the teeth and mouth. The teeth should be cleaned every night. Just before bedtime is best because if any particles of food are left during the night the bacteria causing fermentation will have an undisturbed time of it, and a good deal of damage may be produced. A stiff brush should be used

and the teeth and gums thoroughly scrubbed. Some simple tooth powder should be used; one of the best is carbonate of soda, another good one is powdered borax, and if the use of this is combined with some mildly antiseptic mouth wash, such as a very dilute solution of carbolic acid, there will be produced not only an appearance but also such a sense of cleanliness of the mouth and throat as, once acquired, will be parted with very reluctantly.

Surely a good case has been made out for the introduction of the separate tooth-brush at school for each child, and the daily performance of what will probably be known as tooth-brush drill. . I have no hesitation whatever in saying that it will be the very best and most beneficial drill that has ever been introduced into schools. The small expense that it would entail would prove an excellent investment, as it would undoubtedly have an immediate effect upon one of the most active causes of deterioration of physique. Since the above was written a notice has appeared in the daily press to the effect that Mr. Cadbury was about to introduce the use of the tooth-brush into the public elementary school at Bournville. It is impossible to overestimate the value of such an advance in school hygiene.

Of course a good deal can be done by proper direct practical instruction on the subject. The children should be taught the importance of saving their teeth, and the simple methods that will effect this. This instruction should be given in the infant schools and in every standard, so that there should be no danger of the subject being looked upon as limited to some special year's work and being subsequently forgotten. It is important to remember that the first teeth must be brushed and cleaned regularly. Many people fail to understand that

a carious milk tooth will cause the permanent tooth to become carious also. There should also be regular inspection of the teeth of the children, and efforts made to get any defects remedied.

In many areas definite instruction is now being given to parents and children concerning the care of the teeth, either in the form of popular lectures, distribution of leaflets, or lessons in school. An excellent example of such leaflets is that circulated by Dr. James Wheatley, County Medical Officer for Shropshire, which reads as follows:—

Prevention of Decay of Teeth.

Food often sticks about the teeth after eating. It then decomposes and acts upon the teeth, causing them to decay. It is the starchy and sugary foods (see below) that do the harm when they stick to the teeth. *If food can be prevented from sticking to the teeth there will be no decay.*

To prevent decay you should observe the following rules:—

(1) As soon as an infant needs food other than milk (8—9 months) give it in a solid, hard form requiring mastication, such as crusty bread, twice-baked bread, or crisp toast. In this way good teeth are likely to grow and good habits of mastication will be formed. Never give bread soaked in milk, or flour added to milk, or other soft, starchy foods (such as most patent foods).

(2) As the child grows up you should still give most of the food in a hard form, compelling mastication. Food should rarely be taken in a liquid form or soaked in liquid or minced. Bread should not be eaten new, and it should have plenty of good, firm crust.

(3) Drinking between each mouthful is very injurious. Liquids should be taken principally at the end of a meal.

(4) *Sweets should never be taken between meals, nor at the end of a meal;* but only with food requiring mastication.

(5) A meal should always be finished with a cleansing food (see below). It is very desirable that fresh fruit should be eaten freely, particularly at the end of a meal.

(6) Mouth breathing in children should always be corrected, and, if obstinate, medical advice should be obtained.

Examples of Foods.

Starchy Foods.—Bread, biscuits, etc.; potatoes; rice, tapioca, sago, etc.; oatmeal, porridge; patent foods.

Sugary Foods.—All foods to which sugar is added; sweets; honey; milk; jams; marmalades; patent foods.

Cleansing Foods.—Fresh fruit, particularly apple; raw vegetables—celery, radishes, lettuce, carrot, etc.; crusts of bread,* crisp toast, twice-baked bread; meat, fish; bacon.

The following rules, drawn up by the Council of the National League for Physical Education and Improvement, and issued as a leaflet by that body at cheap rates, also serve a useful purpose as an aid to the education of the public on this important matter.

The Care of the Teeth.

1. *Clean teeth seldom decay.*
2. Decayed teeth cause much suffering and bad health.
3. Food left on the teeth causes decay.
4. Unclean teeth decay, chiefly at night.
5. Clean all the teeth thoroughly, inside and out, before going to bed and again in the morning.
6. Use a small toothbrush, with soap or chalk powder.
7. Keep the toothbrush perfectly clean. Do not use a brush belonging to anyone else.
8. Chew your food slowly and thoroughly.
9. Bad teeth should be stopped by a dentist or removed.

* The coarse whole-meal flours are better for this purpose.

STATISTICS REGARDING CHILDREN'S TEETH.

1. Ages at which the Milk Teeth are lost.

4	Central incisors	drop about	the 7th	year.
4	Lateral ,,	,,	,, 8th	,,
4	First molars	,,	,, 9th	,,
4	Second molars	,,	,, 10th	,,
4	Canines	,,	,, 11th	,,
20				

2. Ages at which Permanent Teeth appear.

4	First molars	appear about	the 6th	year.
4	Central incisors	,,	,, 7th	,,
4	Lateral incisors	,,	,, 8th	,,
4	First bicuspids	,,	,, 9th	,,
4	Second bicuspids	,,	,, 10th	,,
4	Canines	,,	,, 11th	,,
4	Second molars	,,	,, 13th	,,
4	Third molars	,,	,, 18th–25th	year.
32				

3. Average Number of Teeth at School Ages.

Age.	Temporary Teeth.	Permanent Teeth.	Total.
6	20	4	24
7	16	8	24
8	12	12	24
9	8	16	24
10	4	20	24
11	—	24	24
13	—	28	28

CHAPTER V.

FOOD AND DIGESTION.

THE DIGESTIVE SYSTEM.

The food we eat is subjected to a great many processes before it is really assimilated by the body. Some of these processes are merely mechanical or physical, and are very simple, while others are complicated chemical actions.

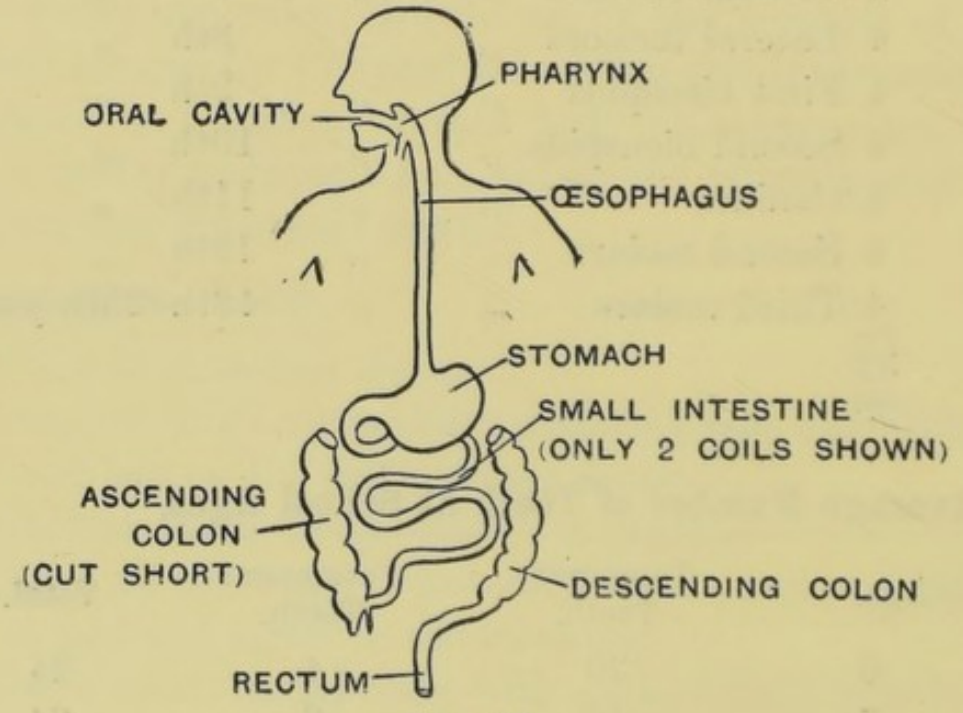


Fig. 87.

The food is first broken up thoroughly by the teeth, and while this is going on it is being acted upon chemically by the saliva. It is then forced through the funnel-shaped pharynx into the oesophagus, down which it passes on its

way to the stomach, and in the stomach it is again subjected to chemical changes. From the stomach it passes along the intestines, where it is still further acted upon. Absorption of digested material is going on all the while, from the moment the food enters the stomach.

The Salivary Glands.

There are three pairs of glands which secrete the saliva. Small tubes or ducts lead from each gland, and the saliva trickles along these into the mouth. Each pair of glands

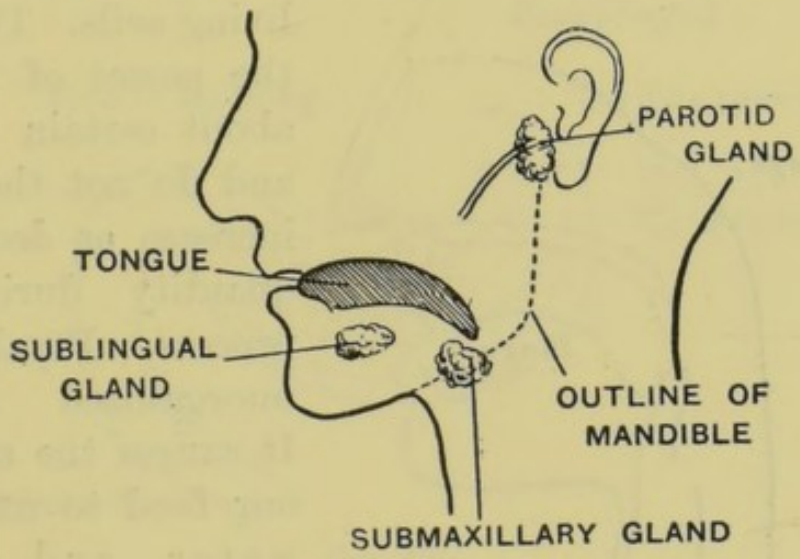


Fig. 88.

has a special name. Those placed in front of and below each ear are called the **parotid** glands; another pair, close to the inner side of the lower jaw on each side, are called the **submaxillary glands**; the third pair are placed under the tongue, and are called the **sublingual** glands. These glands are lined with cells which secrete the saliva, the flow of which into the mouth is increased by placing food there, or even by the sight or smell of food.

Saliva is an alkaline liquid made up of water, salts, mucus, and a peculiar substance called **ptyalin**, a ferment. This is the first example we have had of this important

class of bodies called **ferments**. They have the property of causing remarkable changes to go on in various substances when the conditions are favourable. We divide ferments into two classes: (1) the **organised ferments**, or living ferments like yeast, which is really a tiny plant, and which has the power of converting sugar into alcohol and carbon dioxide; (2) the **unorganised ferments**, which have no life at all, but are simply chemical substances secreted from living cells. They have the power of bringing about certain changes, and do not themselves increase or decrease in quantity during the process. Ptyalin is an unorganised ferment. It causes the starch in our food to unite with water and become changed into sugar.

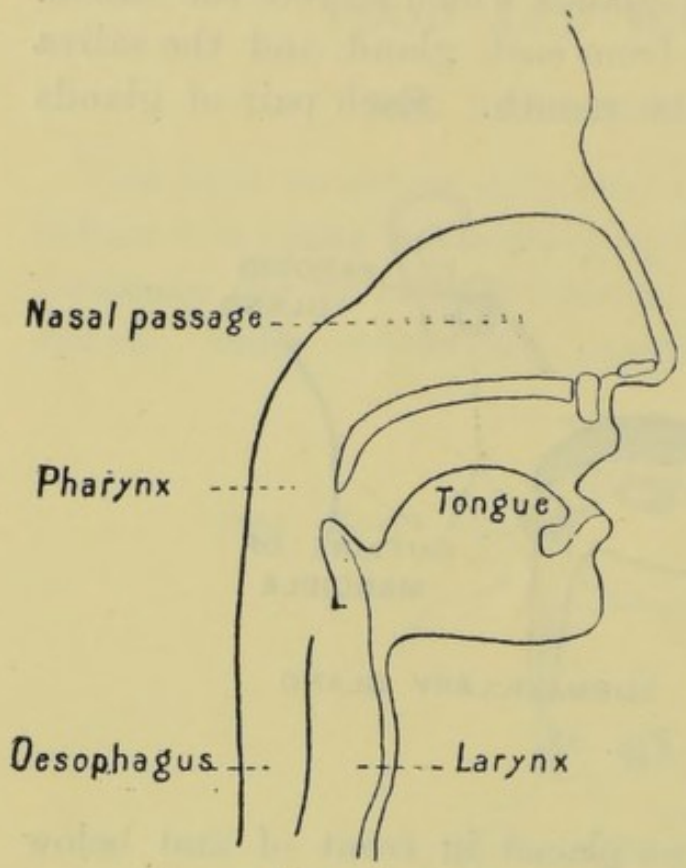


Fig. 89.
PHARYNX.

The saliva also serves to moisten the food and thereby assists mastication. After the food has been thoroughly broken up by the teeth and moistened by the saliva, it is collected into a mass, and is forced through the pharynx into the oesophagus. By dissolving some of the constituents of the food the saliva aids the sense of taste.

The Oesophagus.

The oesophagus is a soft fleshy tube about nine inches long. It is the first part of a continuous tube called the

alimentary canal which extends from the mouth to the anus. It passes from the pharynx above to the stomach below. Owing to the softness of its walls, it does not remain open when there is no food passing down. Lining the tube is mucous membrane, which is thrown into folds, and contains some small glands. Outside the mucous membrane is a double muscular coat, the fibres of the inner part running in a circular direction round the oesophagus; while in the outer layer the fibres run in a

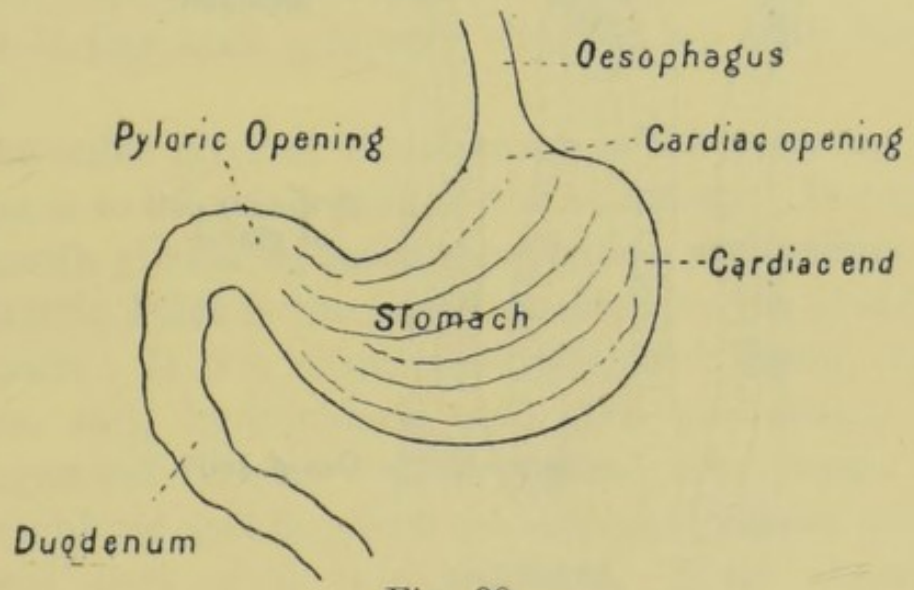


Fig. 90.
STOMACH AND DUODENUM.

longitudinal direction. The oesophagus plays practically no part in the actual work of digestion.

The Stomach.

This may be described as a somewhat irregular dilation of the alimentary canal. It is situated in the abdomen, just below the diaphragm. It measures about ten inches from left to right. The enlargement is greatest on the left or **cardiac** end of the stomach. On the right, the **pyloric** end of the stomach becomes continuous with the first part of the small intestine (the duodenum). The upper border

of the stomach is concave, and is sometimes called the **lesser curvature**, in comparison with the lower convex border, which is called the **greater curvature**.

The stomach is lined with mucous membrane, which is quite smooth when the stomach is full, but becomes thrown into ridges and folds as the stomach gets empty and contracts. This mucous membrane is almost entirely made up of minute simple blind tubes running at right

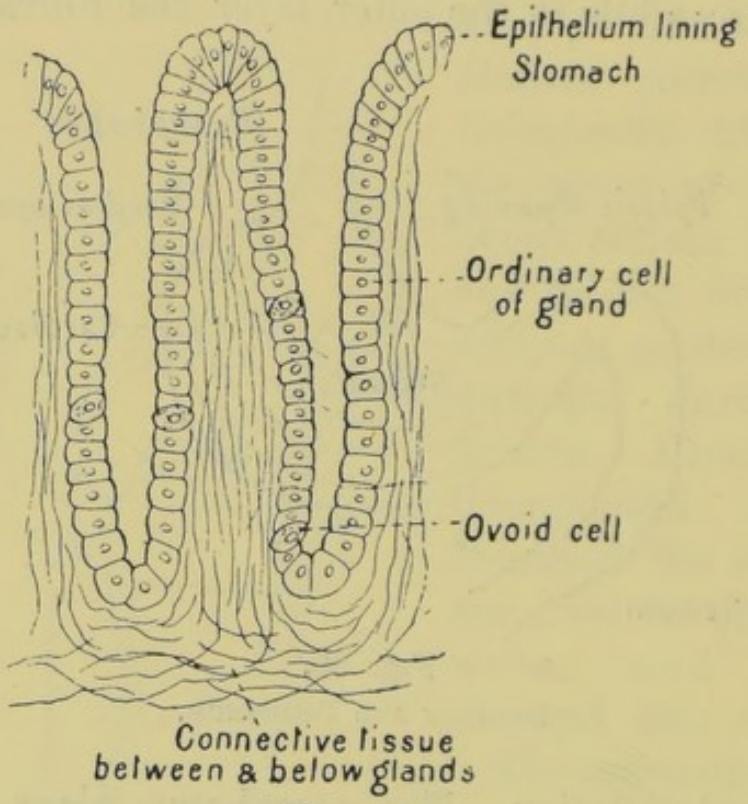


Fig. 91.

TUBULAR GLANDS OF STOMACH. (Very highly magnified.)

angles to its surface. These are called **tubular glands**. They are lined with cubical cells, amongst which are a few round or ovoid cells in the cardiac region of the stomach. Between the tubules is connective tissue containing blood-vessels and lymphatics. The presence of food in the stomach causes the blood-vessels to dilate and to bring extra blood to the stomach. Then the cells in the tubular glands at once secrete a colourless liquid called the **gastric**

juice, which is poured out into the stomach and mixes with the food.

Outside the mucous coat of the stomach is the muscular coat, which is divided into three layers according to the direction in which the muscular fibres run. In the inner layer the fibres run obliquely; in the middle layer they run circularly, and in the outer layer longitudinally. At the pylorus there are a greater number of circular muscular fibres than anywhere else, and here they form a sphincter muscle which prevents the food passing from the stomach until it has been properly churned up with the gastric juice.

The outer layer of the stomach is the covering which is common to all the organs of the abdomen. It consists of a smooth glistening membrane, called **peritonæum**.

Gastric Juice is the liquid secreted by the glands of the stomach. It is a clear, colourless, acid liquid, containing water, salt, hydrochloric acid (0·2 per cent.), and an unorganised ferment called **pepsin**. The pepsin and the hydrochloric acid together act on the food and convert the proteid part of it into **peptones**. Some absorption of digested food takes place in the stomach.

The Small Intestine.

This commences at the pyloric opening of the stomach, and ends at the ileocaecal valve, which is situated in the lower right-hand corner of the abdomen. The greater part of the small intestine is coiled up in the centre of the abdomen. When uncoiled it measures about twenty-one feet. It is usual to divide it into three portions, the duodenum, the jejunum, and the ileum, but there is no need to do this in an elementary text-book.

The walls are made up of three coats arranged in just the same order as those of the stomach. Inside we have

a mucous coat, next a muscular coat in two layers, and outside this the peritoneum. The mucous coat of the small intestine is thrown into large folds, some of them being a quarter of an inch in depth. These folds differ from the folds of mucous membrane in the stomach by *not* disappearing when the intestine is filled with food. By

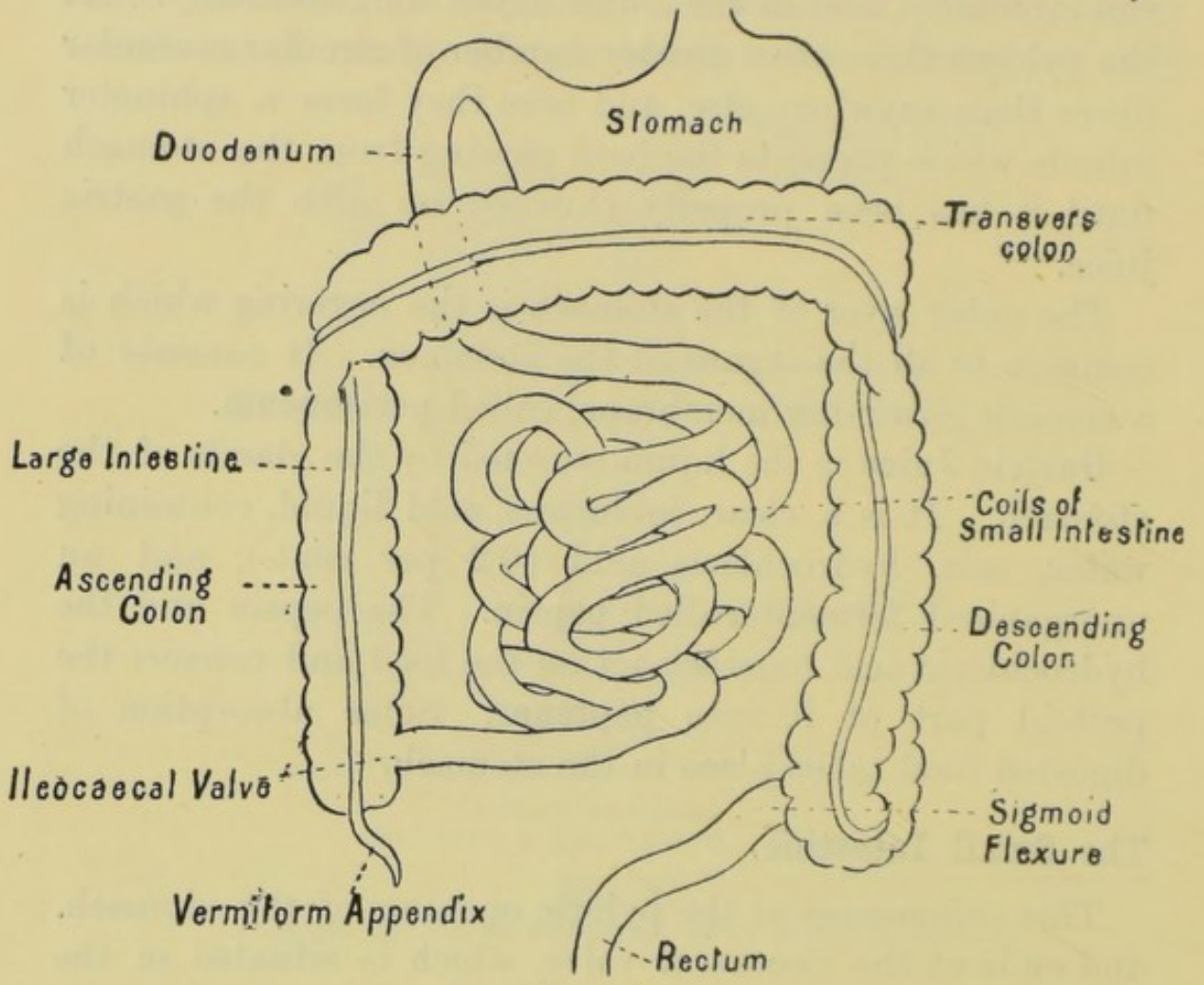


Fig. 92.
SMALL AND LARGE INTESTINE.

means of these folds—called **valvulae conniventes**—the area of surface of the mucous membrane is very greatly increased.

If a piece of small intestine is opened, put into water, and the inner surface examined with a magnifying glass, it will be seen to be covered with a great number of tiny

projections like the fingers of a glove, which give the surface a velvety appearance. These projections are called **villi**. Between the villi are small holes—the openings of small tubular glands, lined with columnar epithelium—which secrete a liquid called **intestinal juice**. At the lower part of the small intestine are found groups of cells arranged in oval-shaped patches. These are called Peyer's patches, and are the parts chiefly affected in typhoid fever.

The chief function of the small intestine is the absorption of digested foods. This is carried out by the villi. The intestinal juice is not important for digestive purposes.

The **Ileocaecal Valve** is situated at the part where the small intestine enters the large intestine. It consists of a double fold of mucous membrane which is so arranged that it allows food to pass freely from the small to the large intestine, but not in the reverse direction.

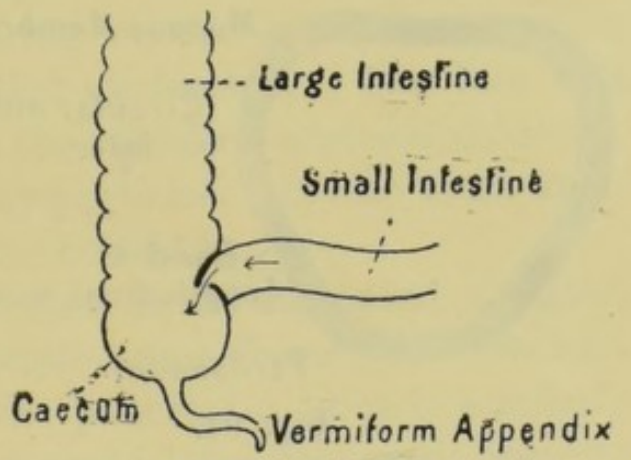


Fig. 93.
ILEOCAECAL VALVE.

The Large Intestine.

This is about six feet in length. The part below the ileocaecal valve is called the **caecum**, and from this a narrow worm-like process is given off, called the **vermiform appendix**. Above the caecum comes the **ascending colon**, which reaches to the under surface of the liver on the right side, then the **transverse colon** stretching across the upper part of the abdomen, and then the **descending colon**

down to the left side of the pelvis, where there is a bend like an S, called the **sigmoid flexure**. For the last few inches the intestine is comparatively straight, and is called the **rectum**. This opens externally at the **anus**.

The coats of the large intestine are the same as those of the small intestine, mucous membrane inside, then muscle, and outside peritoneum. The mucous membrane is quite smooth and has no villi, but it contains a large number of tubular glands which secrete mucus and intestinal juice. The muscular coat is peculiar, because the longitudinal muscular fibres are gathered up into three bands, arranged symmetrically round the intestine. These bands are rather shorter than the rest of the wall, and so they produce the characteristic puckering of the walls of the large intestine, just as a piece of cloth may be puckered up by running a thread along it and drawing the thread short.

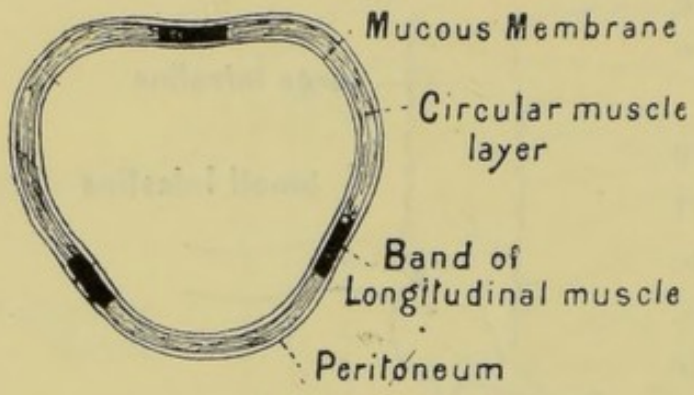


Fig. 94.
Cross Section of Large Intestine.

Function of the Large Intestine. The tubular glands secrete a small quantity of fluid, but the chief function of the large intestine is to absorb what is left of the useful material of the digested food. The veins receive this and carry it to the portal vein.

Liver and Pancreas.

We have now studied the structure of the long tube which connects the mouth and the anus, and we have seen that in its walls are various glands which have a digestive

action on the food. These glands alone, however, would be insufficient to carry on the digestive process in the best possible way, and so there are connected with the small intestine two large glands—the liver and the pancreas—which secrete two very important liquids, the bile and the pancreatic juice. These two liquids are poured together into the small intestine near its commencement, and therefore are able to act upon the food as it passes from that point to the end of the alimentary canal.

The **bile** is a yellow liquid containing water, mucus, and salts. Among these salts are those which are found in the blood, and, in addition, peculiar salts of sodium called **bile salts**. There is also colouring matter or pigments, and a peculiar fatty substance called cholesterin. The bile acts upon the fat in the food in the intestine and emulsifies it, or breaks it up into very tiny particles. It also is an antiseptic and a stimulant to the bowels.

Pancreatic juice is a colourless liquid composed of water, salts—chiefly sodium carbonate—and ferments. The carbonate of sodium causes the pancreatic juice to emulsify fats. The ferments present enable the pancreatic juice to act upon all kinds of food. The proteids are turned into peptones; the starch is changed into sugar; and the fat is, to a small extent, decomposed into a fatty acid and glycerine.

FOOD.

Experience teaches us that food is necessary for our existence. The old comparison drawn between a living body and a steam engine at work is instructive and useful. The engine will only work as long as food is supplied to it in the shape of fuel, water, and air. Also, after a time, another kind of food is supplied to it in the shape of various metals which have to replace the worn-out parts. Supplied with its food, then, the steam engine becomes

active, works its own internal machinery, and is, moreover, capable of doing work such as dragging along a heavy train. This is not all: there are produced various waste matters in the form of carbon dioxide, water vapour, and cinders from the furnace.

In just the same way the body takes oxygen from the air, and receives a supply of food. As the result of the combination of these two, heat and energy are produced. The food also serves to repair and keep in working order the blood and the various parts of the body. The body is kept warm and the different organs are kept automatically at work.

This is **internal work**. **External work** is also done, such as walking, running, talking, etc. Various waste matters are at the same time produced: the lungs giving off carbon dioxide and water vapour; the kidneys getting rid of water with waste substances in solution; the skin chiefly eliminating water as sweat; and the undigested remains of the food being thrown out by the rectum.

Uses of Foods. From the above it is obvious that the uses of foods are: (1) to keep up the heat of the body; (2) to supply the energy for internal and external work; (3) to make good any loss, and replace decayed tissues. In addition to this, part of the food of young children is used to build up the growing tissues.

Classification of Foods.

Perhaps the simplest classification of foods is to divide them into: (1) solid foods; and (2) liquid foods, such as water, milk, etc. A more useful classification is to divide foods according to their source into—

(1) **Inorganic** foods, which include the various mineral salts.

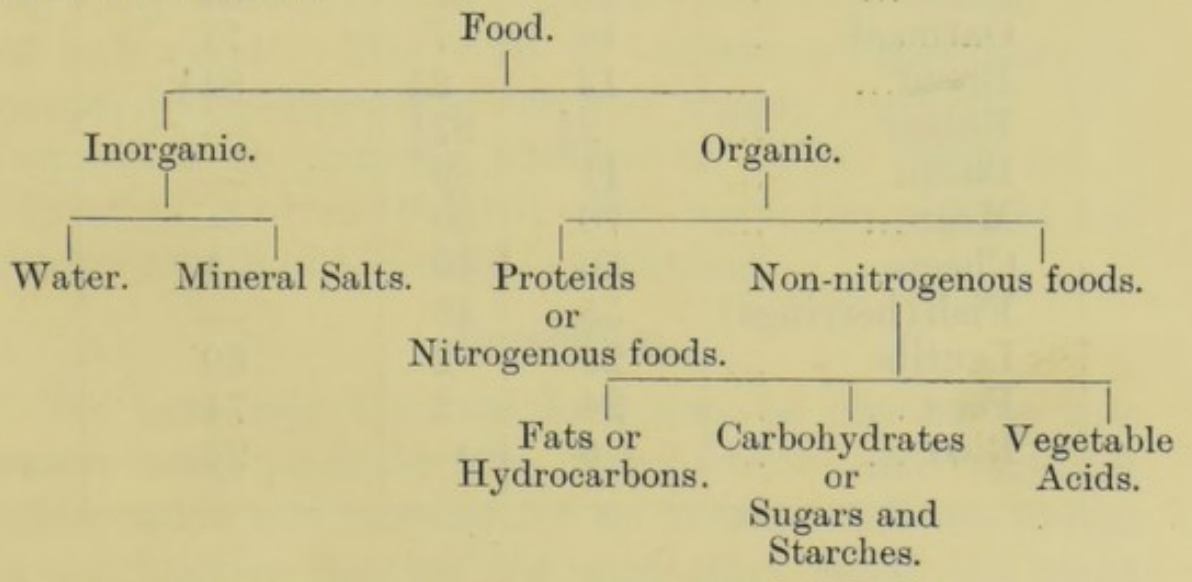
(2) **Organic** foods, *i.e.* those of animal or vegetable origin.

The organic foods are further subdivided into those which contain nitrogen and those which do not. The foods containing nitrogen are called **nitrogenous** foods or **proteids**, and those containing no nitrogen are called **non-nitrogenous** foods.

Non-nitrogenous foods include three chief classes, the **hydrocarbons** or **fats**, the **carbohydrates** or **sugars** and **starches**, and the vegetable acids.

We may say, therefore, that all foods can be divided into groups of **foodstuffs** or **proximate principles**. Some foods contain representatives from practically all the divisions, while other foods, we shall find, contain one proximate principle only, or mainly one with very small quantities of one or two others. We may classify all foods under one or more of the following headings: water, mineral salts, proteids, fats, carbohydrates, and vegetable acids.

The following table clearly shows the division of foods into foodstuffs:—



Food can be regarded as composed of two chief materials; the one kind is used by the body in producing heat and energy, and the other kind goes to form the growing body of the child and to renew and repair the various tissues and

organs. Fats, starches, and sugars are burned up in the body and heat and energy result, while such foods as the lean of meat, fish, the white of eggs, the greater part of cheese, and a considerable proportion of such foods as milk, oatmeal, bread, peas, beans, and lentils serve to produce actual body tissue and repair any worn out parts.

The food of children should contain some tissue-forming material, as well as fats, sugars or starches, and some vegetables or fruit. The following table will give some idea as to the relative quantities of these materials that common foods contain.

RELATIVE PROPORTIONS.

Food.	Tissue-forming.	Force-producing.	
		Fats.	Starch or Sugar.
Milk	37	29	34
Oatmeal ...	16	7	77
Bread... ...	13	$2\frac{1}{2}$	$84\frac{1}{2}$
Butter ...	$2\frac{1}{2}$	$97\frac{1}{2}$	—
Bacon ...	11	89	—
Meat	70	30	—
Cheese ...	50	49	1
Fish (herrings)	55	45	—
Lentils ...	29	2	69
Peas	24	2	74
Rice	6	—	94

Fats are particularly valuable foods for children, but the average child among the poor classes has far too little fat provided in the food. This lack of fat in the diet during early life undoubtedly predisposes to consumption and ill

development. The great desire for sweet things, possessed by most children, is probably a manifestation of the physiological need of the body for sugar. Tissue-forming foods, on account of their expense, are often lacking, the result of which is deficient physical and mental development. If tissue-forming materials, fats, starches or sugars, and vegetables or fruits are not all represented in the diet, or are there in improper proportions, or are deficient in quantity, the child cannot develop as it should do. If the diet is deficient the nutrition of the body is more or less arrested; if the diet is ill-balanced but abundant the nutrition is perverted. Scurvy, rickets, and anaemia are all nutritional diseases.

To try to educate underfed children is not only wasteful of the teacher's energy, but is also cruel to the child because deterioration of physique is promoted by exhausting the enfeebled nervous system. Such a child's mental apparatus is not in a condition fit for work. If work is insisted upon, then the nervous system is speedily exhausted and all sorts of evils result. The limits of educational possibility are primarily determined by the food supply available. It is impossible to properly educate an ill-fed child, and if education is attempted the effect upon the physical and mental health of the child is disastrous.

DIGESTION.

We have seen that the food may be divided up into water, salts, proteids, fats, carbohydrates, and vegetable acids, and it now remains for us to trace each constituent in its journey through the alimentary canal, the blood stream, the tissues, and the excretory organs. The water that we drink is probably absorbed into the blood-vessels all along the alimentary canal, beginning with the stomach. The salts accompany the water into the blood stream and

are used up, in growing children, to manufacture bone and other tissues requiring salts. Part goes, as we have seen, in producing the hydrochloric acid of the gastric juice, the iron of the haemoglobin, etc. Eventually the salts are excreted by the body, some in their original form, but others with an altered composition. The salts are got rid of in the sweat, the urine, and the excreta from the intestine. The water is got rid of through the same channels, and in addition a large quantity is excreted with the breath.

Action of Saliva.

The solid part of the food is broken up by the teeth, and at the same time is mixed with the saliva. The ptyalin in the saliva slowly converts the starch into grape sugar. At the same time the sugar and the salts present dissolve in the saliva. As the time during which the food remains in the mouth is somewhat limited, it is obvious that this conversion of starch into sugar is necessarily only on a small scale.

Action of Gastric Juice.

The food is then swallowed, and reaches the stomach. Here it is quickly mixed with the gastric juice which, being acid, puts an end to the action of the saliva, because ptyalin is destroyed by acids. The pepsin in the gastric juice, together with the hydrochloric acid which accompanies it, converts the proteids into peptones. Peptones differ from other proteids in being very soluble, and are, moreover, **diffusible**, that is, they are able to pass through a membrane from a solution rich in them to a solution poor in them. These peptones rapidly pass through the lining membrane of the stomach and are absorbed into the blood vessels which lie beneath the mucous membrane.

The muscular coats of the stomach contract, first in one

part and then in another, and so move the food about and churn it up thoroughly with the gastric juice. This churning goes on until the whole of the contents of the stomach is brought to a semi-fluid consistency. The turbid fluid that thus results is called **chyme**. The gastric juice has no action on carbohydrates or on fats, but it assists the digestion of these bodies by dissolving away the proteids amongst which they lie. It also dissolves the proteid walls of the fat cells, while the warmth of the stomach melts the fat.

Action of Bile and Pancreatic Juice.

After a variable time—usually between three and four hours—the chyme passes through the pylorus into the duodenum, or first part of the small intestine. Here it is acted upon by two important liquids, the bile and the pancreatic juice. The first effect of these liquids is to make the acid chyme alkaline. This stops any further action of the pepsin. The pancreatic juice then converts any starch that may be present into malt sugar. Any proteids that have escaped the action of the gastric juice are also attacked by the pancreatic juice and converted into peptones. The peptones and the sugar pass directly into the blood vessels which lie in the villi. The bile has no action on proteids or starches.

Both the bile and the pancreatic juice act upon fats. They mainly produce what is called emulsification. This simply consists in breaking up the fat into very tiny globules, which remain suspended in the liquid and do not run together again. If oil is shaken up briskly with water it is broken up into small globules, but these run together again on standing. By first adding a little carbonate of soda to the water, and then shaking up with oil, a much more permanent effect is produced, and this milky fluid

may be allowed to stand for some time without any of the oil running together again. The emulsification of fats by the bile and the pancreatic juice is greatly aided by the chemical change that the pancreatic juice causes fats to undergo. It acts upon a very small portion of the fat, and changes it into glycerine and a fatty acid. The fatty acid unites with the alkaline salts of sodium that are present and forms a soap, which greatly increases the power of the pancreatic juice to emulsify fats.

Unlike the sugars and the peptones, the emulsified fat is unable to pass direct into the blood vessels which lie below the mucous membrane of the villi. It can, however, pass through the epithelium covering the villi, and makes its way into the irregular vessel which occupies the centre of each villus, the **lacteal vessel**. Shortly after a meal, therefore, the lacteals will be filled with a milky fluid which contains fine globules of fat. This milky fluid is called **chyle**. The chyle passes from the lacteal vessels into the lymphatic vessels, which finally pass it into the blood stream.

Peristaltic Contraction.

The food in the small intestine is moved along by a peculiar movement called **peristaltic contraction**. The circular fibres of the intestinal wall at any place contract, thereby decreasing the capacity of the intestine there, and so squeezing out the greater part of the contents at that point. This contraction is next taken up by the fibres adjoining these, and then by their neighbours, and so on, the contraction passing along the intestine like a wave, and always towards the large intestine.

By the time the food reaches the end of the small intestine it is semifluid, and has very little serviceable material left in it. It passes through the ileocaecal valve into the

large intestine. Here the remains of the useful material are absorbed, together with the greater part of the water, into the blood vessels which lie below the mucous membrane. These convey the food to the portal vein. As the contents are passed along they become more and more solid, until the remainder, which is chiefly the indigestible part of the food, is discharged from the rectum as faeces.

Ultimate Results.

It is sometimes useful to consider the process of digestion from another standpoint, namely by considering each chief foodstuff separately. Starch is acted upon in the mouth by the saliva, and is converted into sugar; the same change of starch into sugar is also carried on by the pancreatic juice in the small intestine. Proteids are changed into peptones by the gastric juice in the stomach, and by the pancreatic juice in the small intestine. Fats are emulsified in the small intestine by pancreatic juice and bile.

After it is digested, the food reaches the blood. In the case of sugar and peptones the passage seems to be direct from the alimentary canal to the blood vessel, but the emulsified fats pass first into the lymphatic vessels and then into the blood vessels. The blood brings all these foods to the various tissues of the body. Eventually all the food becomes changed into carbon dioxide, water, and urea, but this change may either be brought about very quickly or may be postponed for a long time by the food being converted into the tissues of the body.

Excess or Deficiency of Food.

Excess of food throws unnecessary work on those organs which have to deal with it, and leads to many forms of ill-health. There is little doubt that the majority of people who can afford to do so eat more than is necessary. The

result is that not only are the organs concerned in the digestion and disposal of the food overtaxed, but also the body suffers from an accumulation of waste materials.

Too little food leads to a condition of physical and mental incapacity, known as malnutrition. The precise and immediate effects differ slightly according to the kind of food that is specially deficient; for example, a large number of children suffer from chronic starvation, so far as the fatty part of their food is concerned, and an increase in this kind of food is often attended by extremely satisfactory results. Many children also are always lacking the proper amount of proteid or nitrogenous food. Lack of food in children prevents proper growth and development, an effect which is accentuated if, at the same time, extra demands are made upon them by attempting to educate them in their half-starved condition.

FEEDING OF SCHOOL CHILDREN.

A large number of the badly nourished children suffer from unsuitable food rather than from lack of food. Without adding anything to the family income. it would be possible to produce an immense effect upon the physique of the children if their dietary could be merely rearranged without adding to its cost. Such a step is only possible, however, by gradual instruction, and one of the most hopeful of such methods of educational improvement is the object lesson afforded by the school meal.

The Provision of Meals Act, 1906, gives to Local Education Authorities statutory powers in regard to the provision of meals for children in elementary schools. In order to do this it is possible to combine with voluntary agencies, but the Local Authority may provide kitchens, dining rooms, and plant, as well as cooks, servers, and other necessary officers. To the extent of a halfpenny

rate, the Authority may provide food for such meals where *sufficient* funds are not forthcoming from voluntary contributions and parents' payments. Examples of economical and suitable meals are as follow:—

Dinners.

(1) Yorkshire pudding, gravy, peas, bread. Rice and sultanas.

(2) Lentil and tomato soup, bread. Currant roly-poly pudding.

(3) Meat pudding (stewed beef and boiled suet pudding), bread. Ground rice pudding.

(4) Scotch barley broth, bread. Currant pastry or fruit tart.

(5) Irish stew, bread. Cornflour blanc-mange.

The cost of these dinners is less than twopence per head.

In providing school meals it should be remembered that a child of ten years of age requires, roughly, two and a half ounces of proteid. At least one ounce should therefore be provided by the school dinner, and more than half an ounce by the school breakfast, where such is provided. Where one meal only is provided it is best to give a dinner, but in many cases breakfast should be given as well.

Breakfasts.

The proper breakfast for children is oatmeal porridge and boiled milk, with treacle or sugar. Some children, used to unsuitable food, will object to this at first, but there is rarely any permanent difficulty. Such a breakfast provides for all the needs of the child and costs only one penny per head. Possible alternatives are:—

Hot bread and milk.

Bread and margarine, cocoa or hot milk.

Bread and jam, cocoa or hot milk.

Bread and dripping, cocoa or hot milk.

It should be clearly understood that Education Authorities have the power to provide meals for poor children whose parents are unable to pay for them, and also for any and all children whose parents are willing to pay the sum determined by the Authority. A great deal may be expected from such powers in the future, and one may expect to find that the ultimate development will be that the midday meal at school will be the rule, and not the exception.

Organisation.

A School Canteen Committee is formed, composed either of members of the Education Authority or of such members acting in combination with the committee of any voluntary association for the provision of school meals. To this committee parents and teachers have the right to apply concerning children requiring to be fed. The school medical officer will, of course, have discovered many children needing better food, and such children will receive special attention.

Each case should be carefully investigated as to circumstances, and the ability of the parent to pay must be determined in accordance with a definite scale. A common method is to deduct the rent from the total family income, and then determine the income per head from the balance. Where this is less than three shillings per head it is usually regarded as a case for free meals, but of course some elasticity must be possible, especially in very small families. It is essential for all cases to be examined by the school medical officer as to physical condition, etc., and all applications should be endorsed by him. Unfortunately, however careful the administration may be carried out, it is obvious that many children who would greatly benefit from regular meals at school do not get them. The chief

difficulty is the parent who can afford to pay for such meals, but will not do so. The result of such difficulties is that the child may be permanently injured and stunted, or severely handicapped on account of deficient education, for life.

Rooms in constant use for teaching are hardly suitable for serving meals, and so some room in the neighbourhood should be obtained for the purpose. In future schools it is hoped that a special room will always be provided for medical inspection, and if this is made sufficiently large it would do admirably for a dining-room as well. If several feeding centres are found to be necessary in a town, it will probably be best and most economical to prepare the food at a central kitchen and distribute it to the dining rooms. Where one dining room only is necessary for a small town the economical plan would be to prepare the food on the spot.

Serving the Meal.

The mere supply of the necessary food to ill-fed children is, of course, the essential idea that has led to the provision of meals for school children, but such value can be doubled by making the meals have the greatest possible educational value. Many of the children are utter strangers to a well-ordered meal, with its accompaniments of clean table cloth, clean crockery, and proper behaviour. To such children the school meal can be made a means of enlightenment and real education of even greater value than the ordinary school work. These beneficial effects can only be secured by adequate supervision and by very careful and thorough organisation.

In the report of the Royal Commission occur these sentences :—

"We consider that the question of the proper and suffi-

cient feeding of children is one which has the closest possible connection with any scheme which may be adopted for their physical and equally for their mental work. It is evident that among the causes which tell against the physical welfare of the population, the lack of proper nourishment is one of the most serious. The subject demands special notice, not only as regards the existing state of affairs, but still more in view of any increase of physical training throughout the State-aided schools which may commend itself.

"We are aware of the danger of further encroaching upon the independence of parents, and of entering upon the wide question of how far the State should go in relieving them of their primary responsibility. But we are not on that account deterred from calling attention to the necessity for better feeding, which, in our opinion, has been fully demonstrated, nor from considering a practical remedy. We have no desire to give encouragement to any inclination of the parent to abandon any of his duties and responsibilities in regard to the feeding and clothing of his children; but it must be remembered that, with every desire to act up to their parental responsibility, and while quite ready to contribute in proportion to their power, there are often impediments in the way of the home provision of suitable food by the parents. The proper selection, cooking, and preparation may often be matters of serious difficulty to many parents. It would be in many cases an inestimable advantage could regular and sufficient meals—such as broth, porridge and milk, or bread and milk—be provided at a minimum cost. The preparation and cooking of these meals, where it is found necessary to provide them, ought to be regarded as one of the charges incident to school management.

"In like manner we think that an obligation for the

proper supervision of the feeding of those who come for instruction should be regarded as one of the duties of school authorities, and that teachers should be instructed to take note of all children apparently ill fed. Unless children receive sufficient nourishment, they cannot be expected to profit by the mental or physical training provided for them."

As an initial effort the mere provision of a glass of good milk during the morning and also the afternoon school would produce a most gratifying effect upon the underfed scholars.

The report of the Inter-departmental Committee appointed on March 14th, 1905, contains a number of details with regard to schemes which have been instituted in various towns for the feeding of children attending public elementary schools, and concludes with a summary of recommendations for better organisation. The scope of these recommendations is limited by the statement that they are to be taken to apply only where arrangements are made for feeding school children. The Committee did not consider it within the terms of the reference to recommend that such arrangement should be made, nor to express any opinion as to the wisdom from an economic or social point of view of relieving children, apart from their families, by the provision of school meals.

The recommendations, distinguished mainly by the omission to touch upon the vital parts of the question or the points of most serious difficulty, are as follows:—

1. The local education authority, or some central body authorised for the purpose by them, should be kept regularly informed of any feeding of scholars which is in any way organised in connection with the schools maintained by the authority, and of all funds received by managers or teachers for that purpose.

2. The local education authority should cooperate as far as practicable with any feeding agency established in its area, and unless there is any good reason to the contrary, should be represented thereon, though such representation may not be feasible or even desirable in London and the county areas.

3. Any organisation for feeding school children should be of a permanent character—that is to say the framework of the organisation should be kept continuously in existence, notwithstanding that its operations may be in some cases properly intermittent.

4. Provision should be made for enabling meals to be given, where necessary, throughout the year, though summer needs will generally be small.

5. Where meals are provided it is desirable that they should be obtainable at least as often as every school day.

6. The object of the agency should be to feed the most destitute children regularly, rather than a large number irregularly.

7. The children of families in temporary distress should be made the first care of any feeding agency.

8. It is not desirable that teachers should be required to take part in serving or supervising children's meals.

9. While teachers may properly make the initial selection they should not be made responsible for the final choice of the children to receive meals.

10. A "relief committee" should be formed for each school or group of schools, and provision should be made for placing on such committee an adequate number of women.

11. In selecting children to receive meals (*a*) the information in the possession of the school attendance officers should be utilised; (*b*) the cooperation of Poor-law

guardians and relieving officers should be invited; (*c*) as far as possible the cooperation of religious and philanthropic agencies in the district should be enlisted; (*d*) where there is a school medical officer or nurse, their advice and help should be obtained.

12. Care should be taken to give adequate notice beforehand to their parents when children are to receive meals; sufficient notice of the discontinuance of meals should similarly be given.

13. The parents should be told clearly that they are in receipt of charitable relief for their children where such is the case, and greater effort might be made to obtain payment from parents for the whole or part cost of meals supplied to their children.

14. Care should be taken to make the meals orderly, and to give them a civilising and educative effect upon the children.

15. Registers should be kept showing exactly what children have received food and on what days.

16. Schoolrooms and classrooms should not be used for meals, if other convenient rooms can be found.

17. Cookery centres may in some cases be usefully employed for the provision of children's meals. But a cookery centre can only provide for a few children, and it should be remembered that its essential purpose is the provision of cookery instruction.

Growth.

The important questions involved in the discussion of nutrition, growth, and development of children are somewhat beyond the scope of this book, but the following table from the report by the Royal Commission on Physical Training may be useful:—

		British Population (Roberts).	Boston School Children (Bowditch).	Edinburgh Schl. Children (Mackenzie).
	Ages.	Inches.	Inches.	Inches.
Height, Boys	6 to 9	45·67	46·15	44·52
„ Girls	6 „ 9	44·64	45·89	44·51
„ Boys	9 „ 12	51·68	52·10	50·20
„ Girls	9 „ 12	50·96	51·72	49·93
„ Boys	12 „ 15	57·07	58·34	55·26
„ Girls	12 „ 15	57·74	58·74	55·65
	Ages.	lbs.	lbs.	lbs.
Weight, Boys	6 to 9	49·6	49·68	46·60
„ Girls	6 „ 9	47·1	48·25	45·62
„ Boys	9 „ 12	66·6	66·32	59·53
„ Girls	9 „ 12	61·8	63·95	57·76
„ Boys	12 „ 15	83·7	89·12	74·02
„ Girls	12 „ 15	86·7	90·95	78·36

There is no doubt that the rate of growth is greatly affected by the surroundings, by exercise, and by food. During the physical examination of school children many questions present themselves, involving issues of tremendous importance to the well-being of the race. Concerning every scholar it should be asked whether the child is fully grown for his age. If he is not it should be ascertained whether the arrested development is due to hereditary causes, congenital defects, or such causes as lack of food, improper food, use of drugs, bad sanitary conditions at home, &c.

CHAPTER VI.

HOW TO TAKE CARE OF THE BABY.

In view of the growing feeling that some definite instruction on the care of babies should be given to the children attending elementary schools, especially the elder girls, with a view to dissipating some of the appalling ignorance that prevails upon the subject, and thereby reducing the mortality among infants, it has been thought advisable to add a brief chapter on this important subject. The following notes consist mainly of the matter prepared some years ago by the author in consultation with Dr. J. R. Kaye, for printing and distribution over the administrative area of the West Riding County Council. Some twenty thousand similar leaflets have been issued in Hampshire by the County Council and by the various District Councils within the administrative area.

The Baby.

The eyes of the newly-born baby should be promptly cleansed and frequently examined. Should any redness or discharge appear, the doctor should be sent for at once, because affections of the eyes in newly-born babies, if neglected, often lead to blindness. On no account drop milk into the eyes, but use clean tepid water applied with a clean rag.

Suckle the baby after it has been washed and dressed. If the mother has no milk at first it will be sufficient until the milk comes to give three or four teaspoonfuls of a mixture of one part of fresh milk and two parts of warm water. Do not give butter or gruel.

The Baby's Food.

Breast-feeding is best for the baby *and* the mother. Children fed in this way are stronger than those fed artificially (by hand or bottle), and are less liable to disease.

If the mother's milk is sufficient the baby should be breast-fed entirely until seven months old. After that age the feeding may be assisted by milk and milk preparations as mentioned hereafter.

When the mother's milk is not sufficient the child should be given prepared cow's milk *in addition to* the mother's milk. For example, the mother's milk may be sufficient for the morning and evening meal, and the remaining meals can be supplied in accordance with the directions given hereafter. It is better to feed a child even partly on the breast than entirely by the bottle.

Times of Feedings.—Up to three months of age suckle every two hours during day, and every four hours at night. Do not waken the child for food.

After three months the intervals between the meals should be increased, so that at nine months of age the child has five meals during the day, and none at night.

Weaning.—Breast-feeding should be continued until the child is nine months old, but not much longer. Avoid weaning when the infant is ailing, or in the hot months when there is risk of diarrhoea.

Artificial Feeding.

If the mother has sufficient milk the child should not be given any other food at all for seven months. If the mother's milk is insufficient it may be assisted by using cow's milk modified as directed below.

The milk should be obtained from a reliable dairy, and should be absolutely fresh at the time of being used. There is no advantage in using the milk from one cow only.

To prepare the milk.—Put the milk into a clean jug. Place the jug in a saucepan containing water, and boil on the fire for fifteen minutes. The water in the saucepan should boil all the time. The milk will not boil. The jug should be covered over, and kept covered afterwards to exclude dust and flies.

To prepare the food.—The milk which has been treated as above is mixed with the required proportion of water, according to the age of the child, and a teaspoonful of sugar is added to each pint of the mixture. No more food than is sufficient for one or two meals should be prepared at one time.

Rules for Dilution.—Use 1 part of milk to 2 of boiled water for the 1st month; use 1 part of milk to 1 of boiled water for the 2nd and 3rd; use 2 parts of milk to 1 of boiled water for the 4th, 5th, and 6th month.

After the sixth month the undiluted milk may be used.

The addition of one tablespoonful of cream from the household milk to each pint of the mixture is an improvement and will greatly benefit the child.

The amount at each meal.—During the 1st month the child should have 4 tablespoonfuls; during the 2nd and 3rd, the child should have 6 tablespoonfuls.

Then gradually increase the amount given so that the child is receiving 12 tablespoonfuls (*i.e.* six ounces) at

each meal by the end of the 7th month. Of course all food should be given at a proper warmth, *i.e.* very little warmer than the body.

Time of Meals.—First month, feed every 2 hours by day and 4 hours by night; 2nd and 3rd, feed every $2\frac{1}{2}$ hours by day and 4 hours by night; 4th, 5th, 6th, feed every 3 hours by day and twice during night; 7th, 8th, 9th, feed every $3\frac{1}{2}$ hours by day and not during night unless the baby wakes.

TABLE SHOWING HOW MUCH AN INFANT SHOULD BE GIVEN AT A TIME AND HOW OFTEN.

Age.	How often in day.	How often at night.	How much each time.	Strength.
Up to 4 weeks old	Every— 2 hours	Every— 4 hours	4 (Tablespoonfuls.)	One-third milk.
4 to 12 weeks	$2\frac{1}{2}$ hours	4 hours	6 (Tablespoonfuls.)	One-half milk.
3 to 7 months	3 hours	Twice	8 to 12 (Tablespoonfuls.)	Two-thirds milk, or all milk.
From 8 to 12 months old	5 meals a day	—	12 (Tablespoonfuls.)	Two meals of milk thickened with baked flour or bread-crumbs and boiled.

N.B.—The "tablespoonful" should equal half-an-ounce.

Variation of Diet.

Some variation of the diet may be obtained by using barley water instead of boiled water during alternate weeks. To make barley water take a tablespoonful of pearl barley and wash it in cold water. Cover it with a pint of water

and boil for 15 minutes. When cold it is ready for use after straining.

Where artificial foods are considered by the doctor absolutely necessary be careful to choose the one he recommends.

Artificially fed children should be given a teaspoonful of sweetened juice of orange or lemon or apple each day. If real constipation exist, castor oil may be necessary, but careful feeding will obviate drugs.

Care of the Food and the Bottle.—The best form (the boat-shaped bottle) has a teat at one end and a plug at the other, so that a stream of water can be run through. Long rubber tubes are dangerous and should never be used. Wash the bottle and the teat thoroughly with boiling water and soda after each meal, turning the teat inside out.

The exact amount of food for one meal should be put into the bottle each time, and if any is left it should not be kept for a second feed, but the bottle should be emptied at once and cleaned.

It is a good plan to have two bottles and use them alternately. Keep the bottles, teats, and plugs immersed in clean cold water when not in use.

The baby must not have ordinary food.—It is highly dangerous to give a baby ordinary food. Before it is seven months old it must have nothing but milk in one form or another, and it is best to continue the milk diet longer. A baby less than eight months old should not have bread, sop, cornflour, potatoes, biscuits, or rusks. Beer, spirits, and pickles act as poisons to a baby.

Condensed milk should not be used if fresh milk can be obtained. Never give skimmed milk.

Dummy teats, soothing syrups, and teething powders should be avoided as harmful.

Signs that Baby's food is not agreeing.—Vomiting; diarrhoea, green stools, or undigested food in motions; flatulence, windy spasms, or colic; emaciation, wasting; redness about buttocks or between thighs; abnormal appetite; perspiration, particularly of the head.

Food after the Ninth Month.—From nine to twelve months the child may have bread and milk, milk and egg, bread-crumbs and gravy.

After the twelfth month the baby may have bread and milk, gravy and bread-crumbs, milk puddings, eggs, bread and treacle, porridge, bread and butter, bread and jam.

General Notes.

Clothing.—The baby should be loosely and warmly clad. The clothes must not hinder the free movements of the arms and legs. Tight binders greatly injure the child.

Ordinary pins are dangerous for fastening baby's clothes.

Washing.—The baby must be bathed all over daily in warm water. There should be great care given to drying those parts of the body which are liable to be left wet, such as behind the ears, and between the legs, fingers and toes. These parts must be wiped quite dry with a warm towel. Puff-powder is useful.

Sleep.—A baby should be encouraged to sleep after every meal. Babies require a large amount of sleep if they are to thrive. No baby should sleep with the mother. A basket, or box, or cot should be prepared for it.

Put the baby to bed early each evening at a fixed time. Babies should not be kept downstairs at night.

Fresh Air.—Some part of every day should be spent in the open air. The window of the room in which the baby sleeps should never be completely closed.

Posture.—Perambulators in which the baby has to sit

upright should be condemned, and no baby should be nursed in the upright position. Deformities and defects of development are easily caused by the baby sitting up before it is sufficiently strong to do so of its own accord, which is not before the seventh or eighth month.

Weight.—The average weight of a healthy baby at birth is just over $6\frac{1}{2}$ lb., increasing to over 7 lb. at the end of the first month, and then adding about 1 lb. monthly, until at the age of twelve months the baby should weigh between 18 and 19 lb. The actual weight is not so important as the fact that the increase should be progressive.

The Mother.

To rear a healthy child the mother must herself lead a quiet, healthy life, both before and after the child is born.

A nursing mother's nipples should be carefully sponged and dried after each feeding. If they become sore a doctor should be consulted at once.

The mother should obtain an abundance of plain, nourishing food. Milk and foods prepared with milk, such as cocoa and milk puddings, are particularly valuable. Oatmeal porridge, eggs, meat, fish, etc., are excellent foods. No spirits or any alcoholic drinks should be taken by the mother. Alcohol in any form injures the mother and the baby.

The mother should obtain regular exercise every day, and should spend as much time as possible in the open air. The window of the bedroom should always be a few inches open, and the position of the bed so arranged that there is no exposure to draught.

Warm, loose clothing should be worn.

The bowels should act regularly every day, but no drugs should be taken if they can be avoided, and only under the doctor's directions.

CHAPTER VII.

RESPIRATION.

THE RESPIRATORY SYSTEM.

On its way to the lungs the air passes through (*a*) the mouth or nose, (*b*) the pharynx, (*c*) the larynx, (*d*) the trachea, (*e*) the bronchi and their branches.

Pharynx and Larynx.

The **pharynx** is a wide funnel-shaped cavity, four inches long, at the back of the nose and mouth. It divides below into two tubes, one behind the other. The posterior tube is usually collapsed, as it has only soft flabby walls: this is the oesophagus, or the tube to convey the food from the pharynx to the stomach. The front tube has hard cartilaginous walls, and so is always kept open: this is the beginning of the windpipe, and is called the **larynx**, or voice-box. It is continued below as the **trachea**.

Trachea and Bronchi.

The trachea is a round open tube, about $4\frac{1}{2}$ inches long, and 1 inch wide. It is kept open by C-shaped rings of cartilage, the open part of the C being directed backwards so as to present a continuous cartilaginous ring in front. There are from 16 to 20 of these rings.

It is lined inside with columnar epithelium, on the surface of which are numerous hair-like processes called cilia.

These, during life, are constantly in motion and tend to drive any fluid that is on them outwards towards the mouth. These cilia also line the larynx and all the branches of the trachea. The middle coat of the trachea consists of muscle, cartilage, and fibrous tissue. The external coat consists of connective tissue containing a little fat.

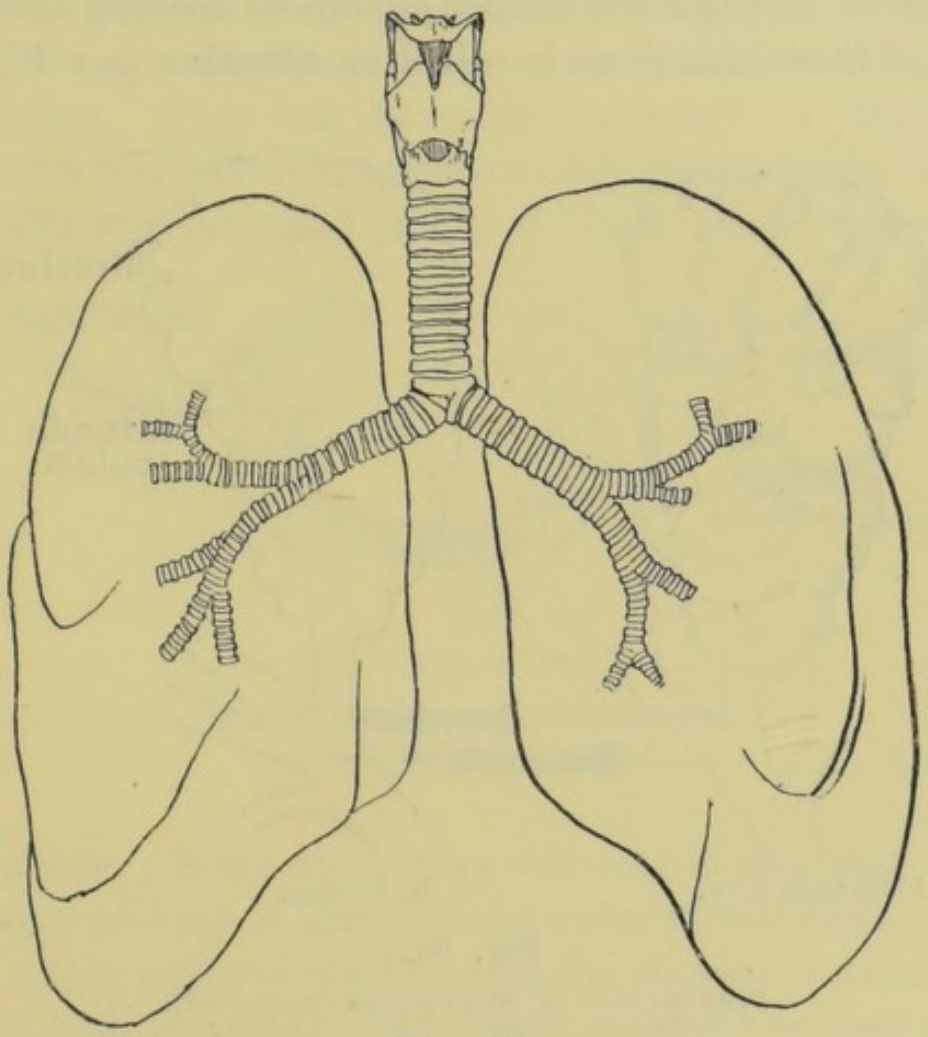


Fig. 95.

TRACHEA AND BRONCHI.

Close to the lungs the trachea divides into two tubes called the **bronchi**, the right bronchus going to the right lung and the left bronchus to the left lung. These bronchi again divide and subdivide, until finally the branches are so small that they can only be distinguished by the microscope. The smallest tubes are called **bronchioles**, or bronchial tubes.

The branches of the trachea have a similar structure to the trachea itself, but the bands of cartilage become less and less complete as the branches get smaller, until they are merely scattered pieces of cartilage; they altogether disappear in the smallest tubes. The bronchioles end in dilated cavities called **infundibula**, which have a large number of tiny balloon-shaped chambers opening into them. Each of these chambers is called an **alveolus** (see Fig. 96).

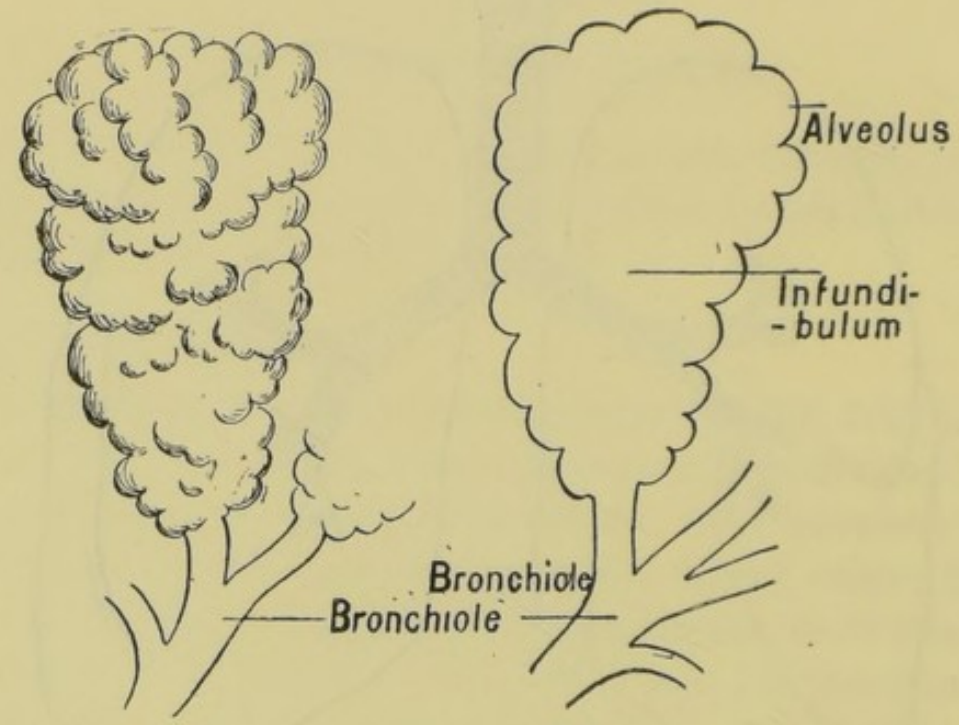


Fig. 96.

TERMINATION OF BRONCHIOLE (magnified).

The Lungs.

The **lungs** are therefore made up of an enormous number of infundibula or dilated ends of the bronchioles. These are connected together by fine connective tissue, and the whole is covered by a transparent elastic membrane, the pleura. The alveoli are lined internally by a layer of flattened cells joined edge to edge. Beneath this is a layer

of elastic tissue, and a close network of capillary blood-vessels. The blood in the capillaries is only separated from the air in the alveolus by a very thin delicate partition. The pulmonary artery breaks up into these capillaries, and the blood is collected again into the pulmonary vein, which takes it back to the heart.

Externally the lungs are of a mottled purple colour, are spongy to the touch, and are covered by the smooth glistening pleura. They may be easily expanded by blowing in air, but when left to themselves they shrink again, because the walls are composed partly of elastic tissue, as we have

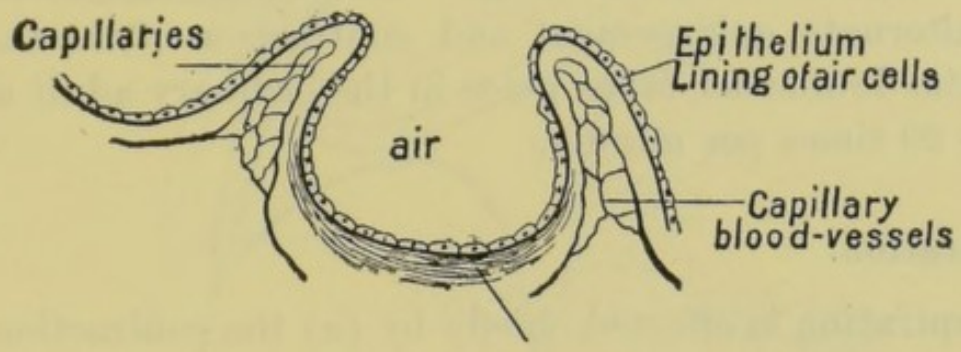


Fig. 97.

Section of Alveolus (Diagrammatic).
(Very highly magnified.)

said above. Some air always remains in the lung, and so if a piece of lung is thrown into water it will float.

In their natural condition in the thorax, the outer surface of each lung is pressed closely against the inner surface of the walls of the chest. The air has no access to the outside of the lungs, and the pressure of the atmosphere is warded off by the muscular and bony walls of the thorax. Inside the lungs, however, the air has free access through the trachea and bronchioles, and so the atmospheric pressure keeps the lungs distended, causing each lung to fill up completely each half of the thorax. When the cavity of the thorax is increased in size the pressure of the

atmosphere expands the lungs by forcing more air into them. On the other hand, if the size of the thorax is decreased, some of the air is forced out. It is important to understand and to remember that the atmospheric pressure can only expand the lungs when, by some means or other, the cavity of the thorax is increased in size.

RESPIRATION.

Respiration consists of two acts: (*a*) **inspiration**, or the drawing of air into the lungs; and (*b*) **expiration**, or the act of forcing air out of the lungs. Respiration is effected by the alternate enlargement and contraction of the thorax, and the double act takes place in the ordinary adult about 16 to 20 times per minute.

Inspiration.

Inspiration is effected chiefly by (*a*) the contraction and descent of the diaphragm, and (*b*) the contraction of the intercostal and other muscles, causing the ribs and sternum to be elevated.

Reference to the figure of the diaphragm will cause the first to be easily understood. If the diaphragm contracts it will become straighter, and so enlarge the cavity of the thorax. This, as explained above, will cause air to rush into the lungs. The other method of increasing the size of the thorax is by elevating the ribs and pushing out the sternum. Each rib describes a greater arch than the one above, and evidently, therefore, if each is suddenly raised into the position previously occupied by the one above, the size of the thorax will be increased.

In men the diaphragm is the more important factor in causing inspiration, while in women the movement of the ribs and sternum is more conspicuous.

Expiration.

Expiration is effected mainly by the natural elasticity of the lungs and the weight of the ribs. The elasticity of the lung tissue tends to force out the air, while the weight of

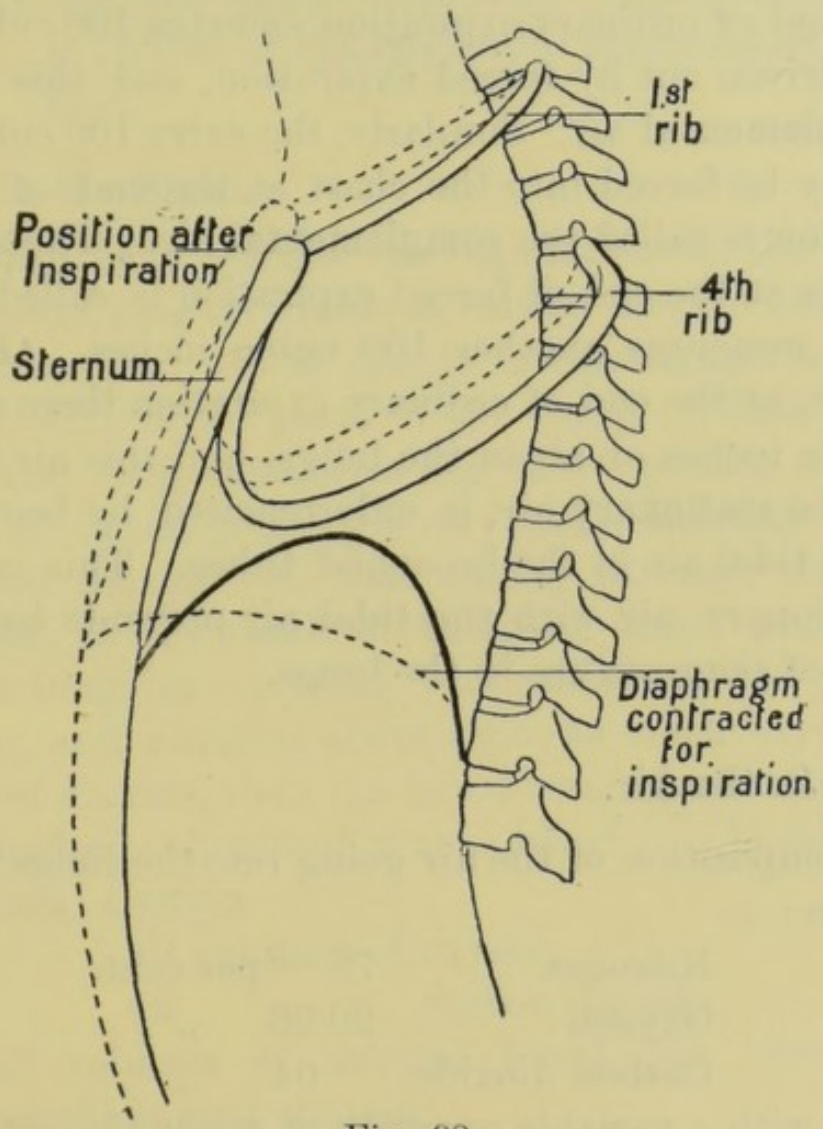


Fig. 98.

MOVEMENT OF RIBS, STERNUM, AND DIAPHRAGM.

The dotted lines show the position occupied by the Sternum, Ribs, Diaphragm, and Abdominal Walls at the end of a full inspiration.

the ribs causes them to fall, and so reduce the size of the chest. In forced expiration, as in coughing or sneezing, the abdominal muscles are used in order to press up the diaphragm, thereby decreasing the capacity of the thorax and forcing out the air.

Quantity of Air.

At each inspiration an adult takes in about 30 cubic inches of air, and breathes out the same quantity during the succeeding expiration. This is called the **tidal** air. At the end of ordinary expiration an extra 100 cubic inches can be driven out by forced expiration, and this is called the **supplemental** air. Similarly, the extra 100 cubic inches that may be forced into the chest at the end of ordinary inspiration is called the **complemental** air. The air left in the lungs at the end of forced expiration is called **residual** air, and measures another 100 cubic inches. Obviously, therefore, at the end of ordinary expiration there are about 200 cubic inches of air in the lungs, and this air, which is called the **stationary** air, is only renewed by being mixed with the tidal air in the bronchial tubes. This mixing of the stationary air with the tidal air prevents too sudden changes of temperature in the lungs.

Changes in the Air.

The composition of the air going into the lungs is, as we have seen :—

Nitrogen	79	per cent.
Oxygen	20·96	,,
Carbon dioxide	·04	,,

together with a variable quantity of water vapour.

Expired air consists of :—

Nitrogen	79·4	per cent.
Oxygen	16·3	,,
Carbon dioxide	4·3	,,

Expired air is always saturated with water vapour, and also contains small quantities of other gases and organic impurities. Expired air therefore differs from inspired air.

(*a*) It contains more carbon dioxide.
(*b*) It also contains more water vapour.
(*c*) The oxygen is decreased.
(*d*) The temperature is raised to about 96° Fahr.
(*e*) It contains organic impurities. These are the most injurious of the impurities produced by respiration.

Changes in the Blood.

The blood that reaches the capillaries of the lung is impure, containing an excess of carbon dioxide and a deficiency of oxygen. It is purple in colour, and is derived from the veins of all parts of the body. When passing through the lung capillaries the blood is only separated from the air in the lungs by a very thin membrane. Oxygen and carbon dioxide can pass readily through this membrane, and, as the result of this, the blood going away from the lungs is "arterial" in character, has a bright red colour, and contains about twice as much oxygen, but less carbon dioxide, than the blood coming to the lungs.

One hundred volumes of venous blood (*i.e.* blood coming to the lungs) contain

10 volumes of oxygen,
46 „ „ carbon dioxide;

while 100 volumes of arterial blood (*i.e.* blood going away from the lungs) contain

20 volumes of oxygen,
39 „ „ carbon dioxide.

This extra oxygen is carried to the heart along the pulmonary vein, and from the heart all over the body by the arteries, and is used up in oxidising the waste matters of the body, thereby producing heat. Part of it returns to the lungs in the form of carbon dioxide and water, and is expired.

Loss from the Lungs.

An adult breathes out about ·6 cubic foot of carbon dioxide per hour. This in twenty-four hours amounts to about $14\frac{1}{2}$ cubic feet. The oxygen in this is derived from the air, but the carbon is derived from the tissues of the body. There are about eight ounces of carbon in this volume of carbon dioxide. The above amount of carbon dioxide is given off when the body is at rest. During work this quantity is greatly increased, being ·9 cubic foot per hour during light work, and 1·9 cubic feet during hard work.

The water lost from the lungs as water vapour during the twenty-four hours may be taken as half a pint.

Suppose, for instance, a concert room contains about 2,000 people and that the concert lasts for two hours. During this time there would be poured into the air in the breath of the people about 11 gallons of water and as much carbon as there is in a hundredweight of coal!

CHAPTER VIII.

EXCRETION. PERSONAL CLEANLINESS.

We have seen that the blood receives various nutrient principles from the intestines. It hands over this nourishment to the different organs, to be disposed of in the ways that we have already discussed. From the air in the lungs the blood receives a supply of oxygen which is used up all over the body in oxidising the foods which have been taken. As a result of these oxidation processes, various waste products (water, carbon dioxide, urea, etc.) are formed, and these are poured into the blood again. The blood, therefore, not only brings up the foods and the oxygen, but it takes away the waste products that are formed. To prevent these injurious waste products from accumulating in the blood, some organs have been given the work of getting rid of them. For example, we have seen that the lungs get rid of carbon dioxide, water, and a small quantity of organic impurities. The other organs which help to clean the blood from the waste matters are the kidneys and the skin.

THE KIDNEYS.

The kidneys are two in number, and are situated in the abdomen, one on each side of the vertebral column, in the lumbar region. They are of well-known shape, and are dark red organs, about four inches long and two and a half

inches across, and each weighs about five ounces. In front they are covered with peritoneum, the back being attached to the body wall.

They are so placed in the body that the concave edges face each other, the outer edge being convex. The depression at the middle of the concave inner edge is called the **hilus**. At this point the renal artery and the renal vein enter and leave the kidney, the one bringing blood from the aorta, and the other taking away blood to the inferior vena cava. Nerves, lymphatics, and a narrow tube called the **ureter** are also found at the hilus. As it approaches the kidney, the ureter expands like a funnel, this dilated part being called the **pelvis of the kidney**.

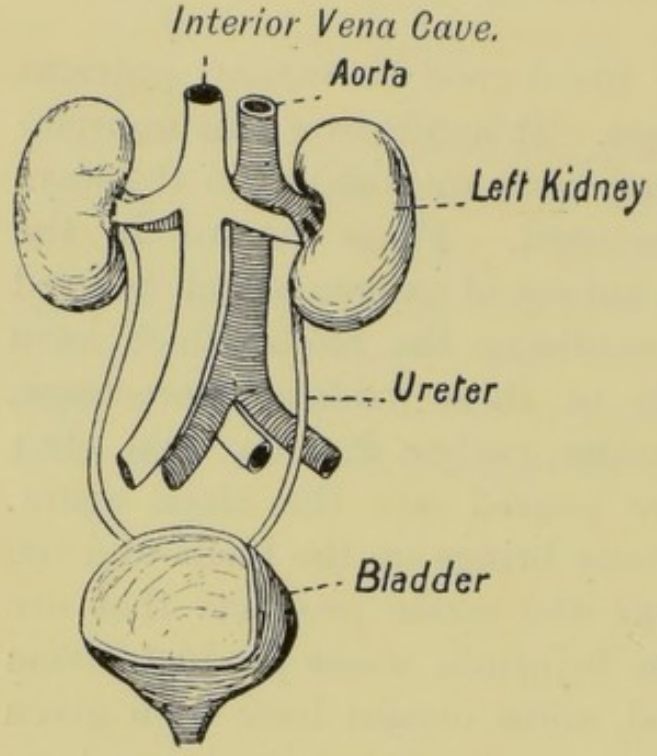


Fig. 99.
THE URINARY ORGANS.

Each ureter is about fourteen inches long. It passes down from the kidney to the bladder, which is situated in front of the bony pelvis. The **bladder** is a muscular bag lined with mucous membrane, and is partly covered with peritoneum.

The ureters enter in an oblique manner, so that a little flap is formed inside the bladder, and this flap acts as a kind of valve, preventing the urine from passing back up the ureter. The function of the bladder is to store the urine which is constantly trickling into it from the ureters,

and to discharge it at intervals. When moderately distended, it will hold a pint.

If a kidney is cut into two, it seems to be formed of two portions: an outer layer, which is dark brown, smooth, and uniform in appearance; and an inner part, which is paler, and is composed of a finely striped substance arranged in several **pyramids**. The outer layer is called the **cortex** of the kidney, and the inner part the **medulla**. The apex of

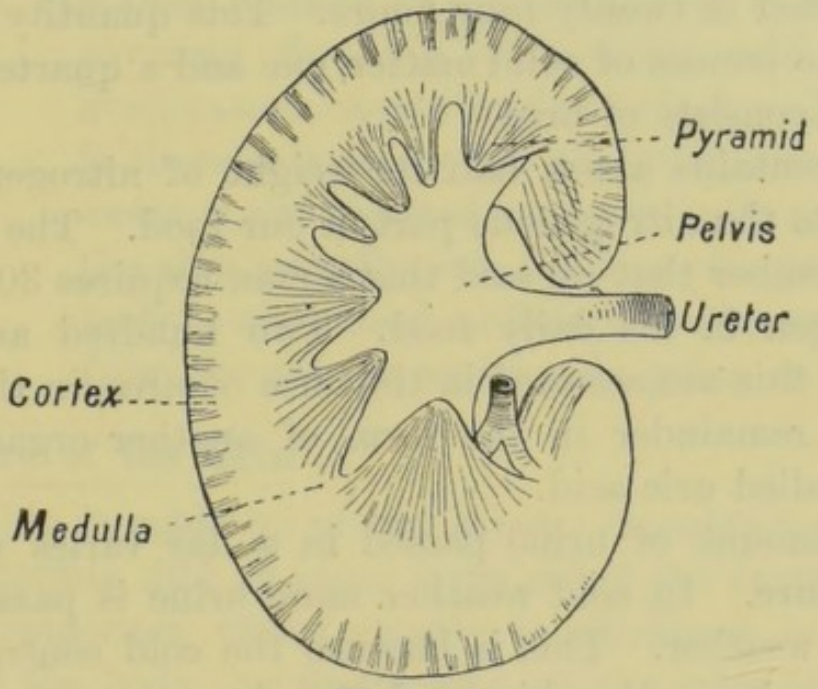


Fig. 100.

SECTION OF KIDNEY (Diagrammatic).

each pyramid—called the **papilla**—projects into the pelvis of the kidney.

The substance of the kidney is composed of an enormous number of minute **tubules**. These are straight in the medulla, and convoluted in the cortex. They are richly supplied with blood-vessels, which form a network all round them. The whole of each tube is lined with epithelium, and the epithelial cells separate the **urine** from the blood. The urine passes along the tube until it reaches a common opening, at the tip of a papilla. It then trickles into

the pelvis of the kidney, and down the ureter to the bladder.

The function of the kidney is to secrete urine from the blood. Healthy **urine** is a clear pale yellow fluid consisting of water in which are dissolved various substances: these are mainly common salt, phosphates and sulphates of sodium and potassium, and an organic substance called **urea**. About 50 ounces—from two to three pints—of urine are excreted in twenty-four hours. This quantity contains about two ounces of solid matter, one and a quarter ounces of which consists of urea.

Urea contains about half its weight of nitrogen, and it represents the nitrogenous part of our food. The student will remember that we said that a man requires 300 grains of nitrogen in his daily food. Two hundred and forty grains of this are secreted in the form of urea, in the urine, and the remainder in the form of another organic substance, called uric acid.

The amount of urine passed in a day varies with the temperature. In cold weather more urine is passed than in warm weather. This is because the cold contracts the blood-vessels in the skin, and thereby causes more blood to go to other parts, including the kidneys. The extra supply of blood causes the extra secretion of urine. In warm weather this is reversed. It is only the water that varies; the solids in the urine do not vary much.

THE SKIN.

The uses of the skin may be classified as follows:—

(1) It serves as a protective layer on the surface of the body.

(2) The skin is really one of the **excretory organs** of the body. By means of the sweat glands that

it contains it gets rid of about one pint of water in twenty-four hours. Small quantities of other substances are also got rid of in the sweat. The skin therefore forms one of the three organs of the body that get rid of water, the other two being the lungs and the kidneys.

(3) By the special arrangement of the nerves in it, the skin serves as an organ of touch.

(4) The sweat glands in the skin have the power of covering the skin with water, which, by its evaporation, causes heat to be lost, and the body is thereby cooled. On the other hand, if the sweat is not secreted so abundantly as to make the skin actually wet, the loss of heat from the body is minimised, although loss by evaporation from the skin is continually going on.

Structure of the Skin.

The skin is made up of two layers: an outer layer, called the **epidermis**, and an inner layer called the **dermis**.

The epidermis varies greatly in thickness in different parts of the body, being thickest on the soles of the feet, the palms of the hands, and on the back.

The deepest, or **Malpighian**, layer of the epidermis is next to the dermis, and is formed of columnar cells lying perpendicularly to the surface of the dermis. These cells are soft and contain a nucleus. The dark colour of the skin of the negro and other races is due to a deposit of dark pigment in the lowest cells of the Malpighian layer.

The cells above the Malpighian layer are shorter and rounder in shape than those in the lowest layer. The layers still nearer the surface of the skin consist of cells which have lost their nucleus and become flatter and flatter as they approach the surface, until those on the outside are

merely scales. The superficial layers are hard and horny and form the **corneous** layer. This is the part of the skin which is raised as a blister. The epidermis forms the protective layer of the skin. It is transparent, and is impermeable to liquids. There are no nerves or blood-vessels in it.

The **dermis**, or true skin, consists of a strong network of connective tissue, which contains blood-vessels, nerves,

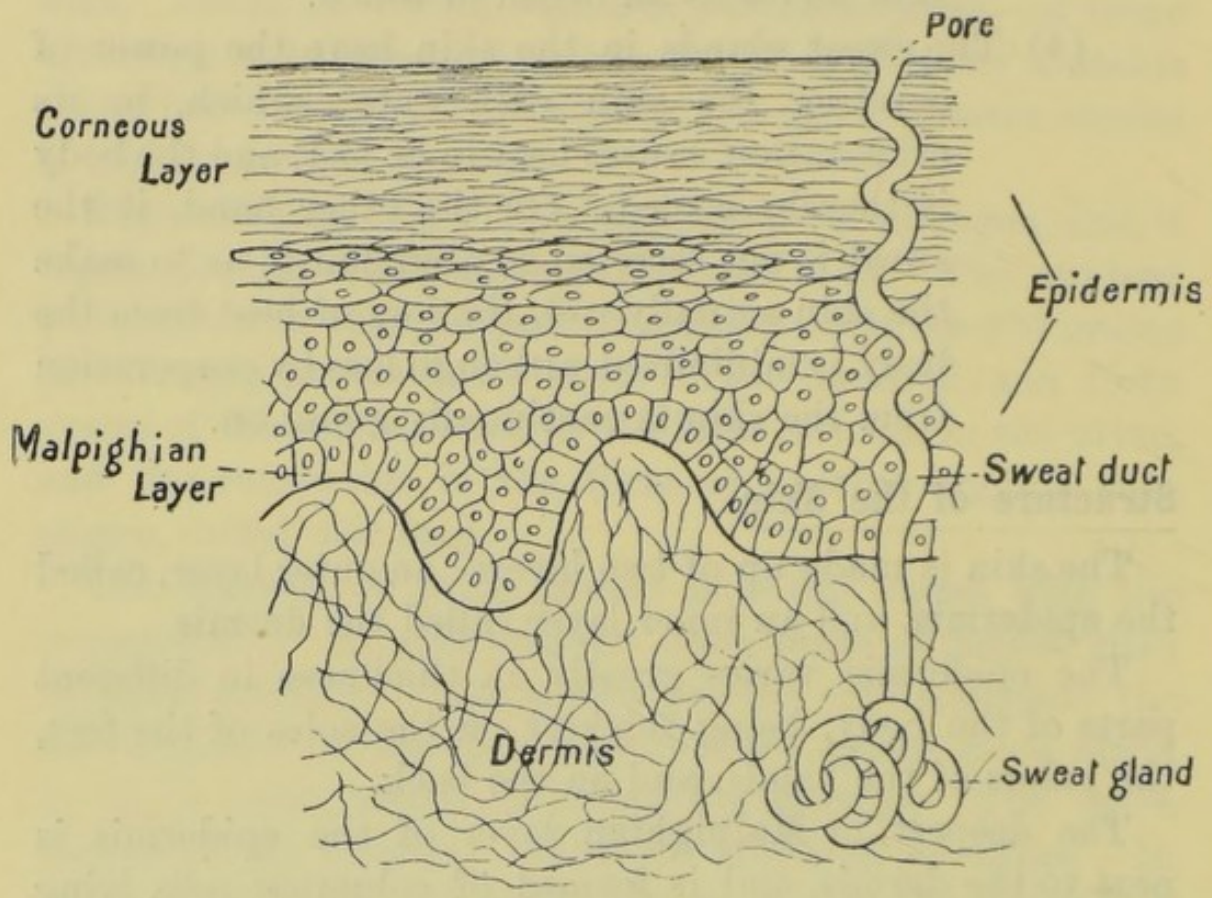


Fig. 101.

SECTION OF SKIN (Highly Magnified).

glands, and the roots of hairs. The surface of the dermis is thrown up into small conical processes which project into the epidermis. These processes, called **papillae**, are highly developed in those parts where the sense of touch is acute, and so probably they represent that part of the skin which acts as the organ of the sense of touch. They are well supplied with blood-vessels and nerves. The deeper part

of the dermis is connected to the bone or muscle underneath by loose connective tissue which usually contains a considerable quantity of fat.

The Glands of the Skin.

These are of two kinds: the **sweat glands**, and the **sebaceous glands**. The sweat glands secrete the sweat, while the sebaceous glands secrete a fatty substance which serves to soften the skin and hair. The sebaceous glands are usually connected with hairs.

Sweat Glands. On the surface of the epidermis may be seen small openings called **pores**. These are easily visible through a small magnifying glass. The number of pores varies greatly in different parts of the body, there being about 3000 per square inch on the palms of the hands, and only 600 on the back and legs. They are the openings of the tubes which convey the sweat from the glands to the surface. If one of these tubes is followed downwards, it is found to lead through the epidermis in a spiral or corkscrew fashion, and then to the lower part of the dermis. where it becomes coiled into a kind of a knot, forming the sweat gland. Among the coils are numerous blood-vessels, The cells lining the sweat glands secrete the sweat from the blood.

Perspiration. Usually the sweat is secreted continually, but in small quantities, so that it evaporates from the skin as fast as it reaches the air. This is called **insensible perspiration.** During exertion, or in hot weather, the sweat is poured out in large quantities, so that it is visible on the surface of the skin, and is called **sensible perspiration.** As the water evaporates it absorbs heat from the body, thereby lowering the temperature.

Composition of Sweat. The sweat consists mainly of water with a very small amount of substances dissolved

in it. The dissolved substances are chiefly common salt, some organic bodies, and a little carbon dioxide.

Hairs and Nails.

Hairs are formed of horny cells from the epidermis. Each hair lies in a deep pit called the **hair follicle**. The pits are lined with epidermis, which forms a sheath for the root of the hair. At the bottom of the follicle is a papilla covered with cells of epidermis, and by the multiplication of these epidermal cells the hair grows. As the new cells are formed, the older ones are thrust outwards and form the shaft of the hair.

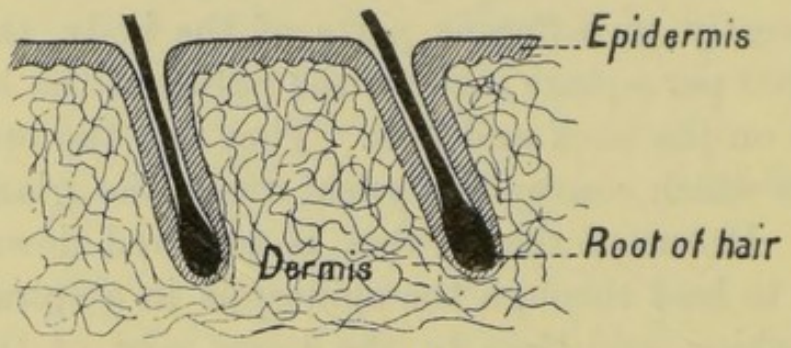


Fig. 102.
SECTION OF SKIN WITH HAIRS.

Nails are another form of specialised epidermis. They consist of two parts, a root and a body. The root is that part of the nail which is covered by the skin; the body is the external part which ends in the free edge. A nail grows in much the same way as a hair, *i.e.* by the multiplication of the epidermal cells at its root.

Cleanliness.

The surface of the skin is constantly receiving sweat from the sweat glands, and greasy matter from the sebaceous glands. These keep the skin moist and greasy,

causing the dead scales of epidermis to remain sticking to it, and also rendering the skin liable to accumulate dirt, dust, and particles of clothing. If the skin is not regularly cleaned, a cake or plaster forms upon it consisting of dried sweat, dirt, scales of dead skin, and grease. This **uncleanliness** leads to injurious and disagreeable results, the chief of which are :—

1. The sweat glands are obstructed by the dirt. This puts an end to their use in getting rid of some of the waste matters of the body, and throws an extra amount of work on the other organs, *i.e.* the kidneys and the lungs.
2. The sebaceous glands also may become stopped up, giving rise to little black spots, called black heads.
3. The cake of dirt upon the skin lessens the sensibility of the skin.
4. The cake is a good soil for germs to grow and multiply in, and these may give rise to all kinds of skin diseases.
5. The dirt may putrefy and cause the stench that always surrounds dirty people.
6. Dirty people are always liable to have parasites living upon them.

The use of water alone is not sufficient to remove this greasy dirt, but something must be used that will combine with the grease and make it soluble. Such a substance is soap.

PERSONAL CLEANLINESS.

The test of the cleanliness of the children in our elementary schools is the condition of their heads. The condition of the hair and scalp of the girls is usually infinitely worse

than the boys'. It should be compulsory that the hair of all the children be cropped short. In France and other countries such a cropping of hair in the elementary schools is universal. The cleaner the parents are the more energetically they should support such a suggestion, because it would help to prevent their children being contaminated by dirty schoolmates.

Dirt and neglect constitute two of the primary evils of child life. Much of the disease and injury to health is the result of personal uncleanliness. Defects of vision, ulcerated corneas, inflamed eyelids, and other conditions are often the direct results of dirtiness, while wounds and sores, chilblains and discharging ears are aggravated by such conditions.

Unclean heads are unfortunately only too common in our schools. It is nothing short of a public scandal that most large towns are taking no steps to prevent this. Under the present conditions it is almost impossible for a clean child to attend our public elementary schools without being infected with parasites on the scalp. It should be the duty of the education authority to insist upon clean heads among the children attending school. The following is Dr. Kerr's scheme adopted by the London County Council:—

"The nurses visit the schools and select all children with unclean heads. A card, enclosed in a sealed envelope, with a part easily separated (line of perforation) is given to each child to take home.

"The card has on it simple directions for treatment and a statement that children not treated after a few days will be separated from the others. The parent is requested to read the instructions and sign and return the attached portion, or the child will be separated from the other children forthwith.

"On the front of the card there is printed :—

Private Notice.

Your attention is drawn to the condition of this child's head, which has been noticed in school. The school nurse has examined it and states that by attention to the directions given on the other side it can be rendered permanently clean within a week. If cleansing is not effected by that time the child will have to be kept separated from the others in school until the unclean condition is remedied.

"On the back of the card :—

Instructions for Cleansing Heads.

Where there are sore places, scabs, or enlarged glands, these will generally get better on removing all lice and nits.

It is possible to effect a cure in about a week.

All hairs with nits and all hair within a quarter of an inch of a sore must be cut off.

The head must be washed and scrubbed daily with paraffin oil, to which an equal quantity of olive oil may be added. If there are scabs, these when softened should be removed.

Repeat this treatment daily for a week, then weekly till all signs of lice are gone.

Where there is difficulty in keeping a child's head clean the hair should be worn cut short.

Iron the collar of the clothes with a hot iron.

Caution.—Do not use paraffin near a fire or naked light.

"The attached portion reads :—

I have read instructions on the back of the card and will endeavour during the ensuing week to get ——— into a healthy and clean condition.

Signed ———

"At the end of a week from the nurse's first visit all cases not treated or not returning the card are separated from the other children, and cases not returning the card signed by the parent have a home visit by the nurse ; if at the nurse's fourth school visit no attempt at treatment has been made, the case is notified to the School Attendance Officer, and a

second card left at the house by him on which the treatment is again set forth, the failure to adopt remedy pointed out, and a statement that if at the end of a week (nurse's sixth visit) the child has not had treatment it will be excluded from the school, and that the parents or guardians will be liable to immediate prosecution. The Medical Officer visits the school and personally examines these children, as far as possible, at or between the nurse's fourth or sixth visit.

"On the front of the second card there is printed:—

Second Warning.—To the Parents or Guardians of ———.

A Private Notice regarding the condition of this child's head having been sent you, and as this condition, which could be remedied in a week, is still allowed to persist, the child has now been separated in school as unfit to be in the ordinary class. You are required to take steps to cleanse its head within the next week, failing which the child will be excluded from school and you will be liable to prosecution and fine for not sending it in a fit state to school. The means for cleansing these heads is given on the other side of this card.

"On the back of the second card the instructions on the first card are repeated.

"By the end of three weeks the habitual offenders are weeded out for prosecution, and the others have been cleansed. The whole treatment was much resented by many mothers, but with tact and patient explanation their good sense asserted itself and few children remained unclean."

The results of this scheme in eight of the schools are as follows:—

Department.	Number Examined.	Clean.	Verminous.	First Notice.	Second Notice.	Partly Cleansed.	Proposed for Exclusion.
Boys	2492	2450	42	22	2	—	2
Girls	2422	1355	1067	740	183	163	15
Infants	2593	2207	386	269	55	99	4

Probably most towns and districts have found it possible to arrange similar schemes without employing any nurses at all, or at all events without allowing the nurses to play quite so prominent a part as they appear to do under the London County Council schemes. The author's experience is that the average teacher is quite as skilful and probably at least as intelligent as the average nurse. In most schools there are some members of the staff who have made a special study of the hygiene of child life. For a great deal of the work the employment of such teachers will be more economical and quite as effective as the employment of nurses.

The plan adopted by the author for the cleansing of heads of children from vermin is to instruct the parents to give the child on the first night a hot bath, using plenty of soap, and paying particular attention to the thorough cleansing of the scalp and hair. Paraffin oil is then thoroughly rubbed over the hair and scalp, after careful drying. This treatment is repeated on each of the two successive evenings, *i.e.* the scalp and hair are thoroughly soaped, washed, and dried, and then paraffin rubbed on. These three applications result in a complete cure in practically every case.

Verminous heads are comparatively rare among the shorter-haired boys, while about one in three or four girls is usually found to need attention in this respect. In many cases the clothing and body are badly infected, and vermin are to be found in every seam and clinging to the skin. A great source of the spread of vermin is second-hand clothing and the pawnshop. The houses from which such children come are usually infected in the same way. If only the home could be disinfected and cleansed a splendid work would be carried out.

In all towns the children attending schools in the poorer

districts are nearly all more or less infected with vermin. This should at once receive the attention of all education authorities, as the bodily cleanliness of the children should be regarded as the essential commencement of all school hygiene.

"There are among the teachers a few, excellent and enlightened, who give practical teaching; who insist in every possible case upon the children wearing collars and pinafores; who insist on tidy hair and clean faces. But unfortunately some are easily discouraged, for it is uphill work, and what they do is often done during their well-earned leisure."

All teachers should insist upon each child appearing with clean face and hands. If they fail to do this they should be obliged to wash in the school lavatories. The quantity of towels supplied in most school lavatories is grossly insufficient.

School Baths.

The problem of the personal cleanliness of the children can only be satisfactorily solved by the provision of school baths. These are neither costly to provide nor to maintain, and the real difficulty is not the trivial expense, but whether all responsibility in this direction should be removed from the parent, and also who is to superintend the bathing. Professor Shaw quotes an excellent plan adopted in a school in Chicago. A bath, soap, towels, and hot and cold water were all provided. "Pupils who came to school unclean were sent to the principal, and the principal sent for the parent, usually the mother, and talked with her of the child's condition, explaining to her what was necessary, and then asked her to use the facilities provided and render the pupil fit to take his or her place in the class. This plan in its effect upon the district had proved, it is claimed, most salutary.

It gave the parents an object-lesson in cleanliness; it heightened their appreciation of its necessity; and in the best way the school reacted upon the homes of a certain part of the population without taking upon itself the duties which belong to the home."

The provision of baths for schools is essential for the purpose of educating certain portions of the community in bodily cleanliness. The institution of school baths and more or less compulsory cleaning is followed by an increase in the self-respect, an improvement in discipline, cleaner clothing, and the formation of habits which cling to the child for life.

In Berlin there are many schools with baths. A bath is allowed each scholar once a week, and it usually takes five minutes. Bathing is not compulsory. Similarly at Zürich, In a Boston school of 800 children 125 are bathed daily, and the children have a bath once a week throughout the year. There is no compulsion, but practically every scholar welcomes the bath. A matron has charge of the girls' baths, and a man looks after the boys'.

CHAPTER IX.

PERSONAL HYGIENE.

CLOTHING: HABITS: SLEEP.

CLOTHING.

The value of a material for clothing depends upon its non-conducting properties with regard to heat. By a good conductor of heat we mean a substance through which heat rapidly travels. In other words, if one part of a good conductor becomes warm, then the heat will rapidly spread over the whole of it. A bad conductor of heat, or a non-conductor, has the opposite properties, so that if one part of a non-conductor becomes heated, the heat spreads very slowly to the other parts. The application of this to clothing is easily understood when we remember that the temperature of the body is always about 98·6° F., while the external temperature rarely exceeds 90° F. in Great Britain. The temperature of the body is therefore higher than that of the surrounding air, and so the inside of our clothing will be warmer than the outside. Now if the clothing material is a good conductor of heat, the heat will rapidly pass from the inside to the outside, and on the outside it will be lost in warming the air in contact with it. On the other hand, if the material be a non-conductor, the heat will only very slowly pass to the outside and very little will be lost.

As a matter of fact the body loses heat in several ways, *e.g.* (1) By the skin. This is probably about 90 per cent. of the total loss. (2) By respiration, the expired air being warmer than the inspired air. Moreover, heat is lost by evaporation in the breath, the expired air being saturated with water vapour. (3) With the excreta. The first of these, the loss by the skin, is the only one that we can in any way control.

The loss of heat by the skin takes place in three ways:

1. By conduction, as we have explained above. This loss is very greatly augmented by wearing clothes made of a good conducting material.
2. By radiation of the heat. The result of radiation is best illustrated by the warmth experienced when sitting near a bright fire. In this case the body receives the heat which is radiated from the fire. Similarly the body itself radiates heat.
3. By evaporation. When the body is heated by exercise the surface of the skin becomes covered with moisture, which evaporates more or less rapidly according to the circumstances. In doing this it absorbs a large amount of heat from the body. It is at these times that the body is particularly liable to take a chill. The absorption of heat by evaporation is well illustrated by pouring a little spirit or ether on the hand, when a feeling of cold is experienced which is increased by blowing across the liquid. The loss of heat by the skin is greatly influenced by the weather. In hot weather very little heat is lost by conduction or radiation, but a large quantity is lost by evaporation. In cold weather this is reversed.

The chief objects of clothing are—(1) To prevent loss of

heat. (2) To protect parts of the body that are especially liable to injury, *e.g.* the feet. (3) For ornament. The following rules should be observed with regard to clothing:—

(1) It should be light. If proper attention is paid to material, there is no need for heavy clothes. In fact light clothes made of a non-conducting material are much warmer than heavy clothes made of material which conducts heat well.

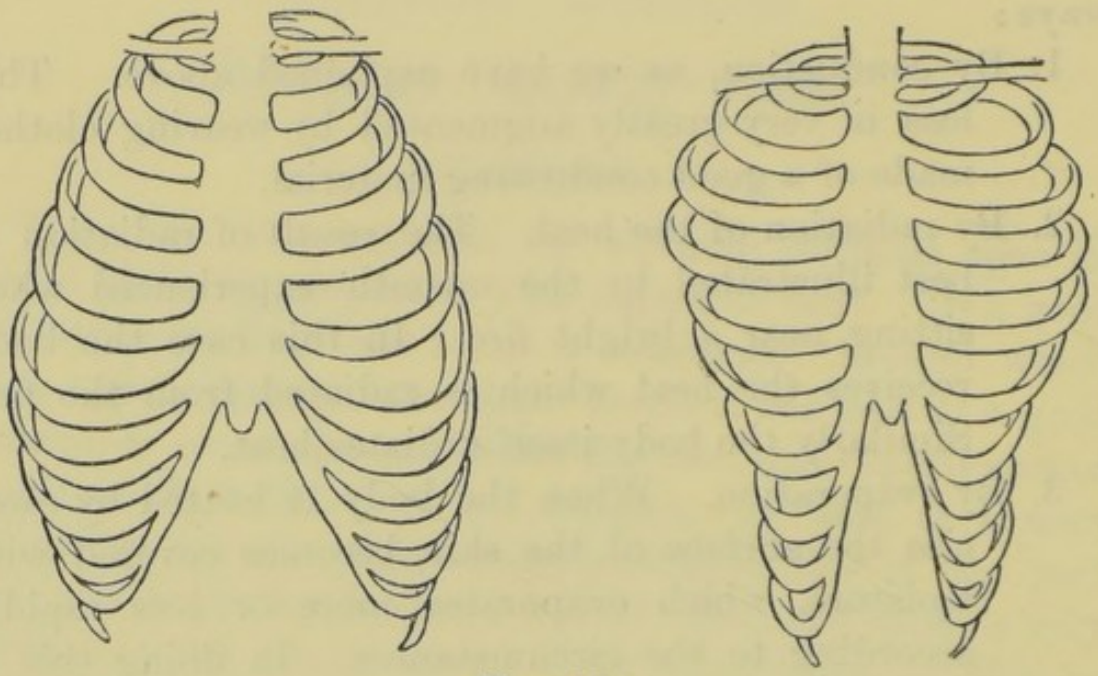


Fig. 103.

NATURAL THORAX. THORAX DEFORMED BY CORSETS.

(2) It should be loose. Every one knows how cold a pair of tight gloves are on a cold day. Air is a bad conductor of heat, and fluffy materials which contain much air in their interstices are far warmer than those which are closely woven. In the same way loosely fitting clothes are much warmer than those which fit tightly. Certain parts of the body are peculiarly liable to be constricted by clothing. For instance, the head is often surrounded with a tightly fitting hat which must press upon the blood vessels

and prevent the proper circulation of blood, thereby increasing the tendency to baldness. The neck is often constricted by a tight collar which interferes with the circulation and gives rise to headache. In women the lower part of the chest and the upper part of the abdomen are habitually constricted by corsets in order to produce the "waist." As a result of the constant pressure—which is often begun at a very early age—the ribs are permanently distorted and displaced inwards, causing compression and displacement of the lungs, heart, liver, stomach, and

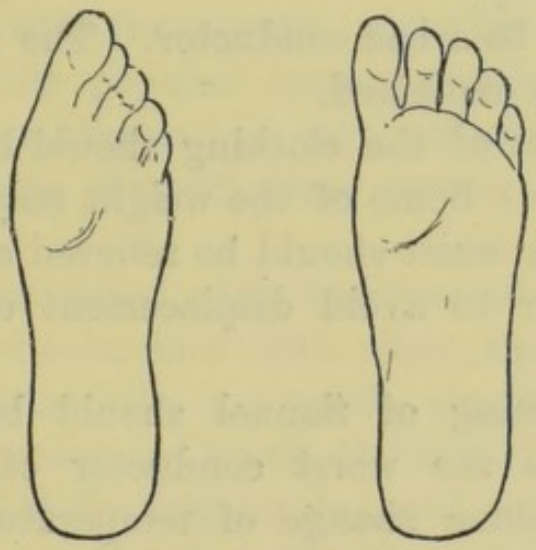


Fig. 104.

FOOT DEFORMED BY POINTED BOOTS. NATURAL FOOT.

intestines. The natural waist is below the ribs and above the hips.

The knee is often constricted with garters. The pressure here prevents the return of the blood through the veins, giving rise to varicose veins. The foot is almost always distorted by misshapen boots. In a properly made boot the great toe should be in a straight line with the inside of the foot, whereas it is usually bent towards the other toes in order to make the foot come to an unnatural point.

In summing up we may say that tight clothes possess the following disadvantages:—(*a*) They are less warm than loose clothes. (*b*) They are also less comfortable, and prevent the free movements of the limbs. (*c*) Any tightness across the chest will interfere with free respiration. (*d*) They are very liable to displace internal organs and produce various ill effects in different parts of the body.

(3) It should be porous. If clothing is not porous it will interfere with the evaporation resulting from perspiration. For this reason waterproof materials should never be worn habitually.

(4) It should be a bad conductor. The reason for this has already been explained.

(5) The weight of the clothing should be mainly borne by the shoulders. Some of the weight may be thrown on the hips, but the waist should be relieved of the weight of clothes, in order to avoid displacement of the internal organs.

An underclothing of flannel should be worn by all children. It is the worst conductor of heat, and so prevents any sudden change of temperature of the skin. It is also the best absorber and retainer of moisture. This underclothing should be worn by day throughout the year, but its consistency may be varied in winter and summer according to the temperature. It is just as important to remember that children may easily be overclothed. It is by no means uncommon to find several layers of flannel (even four or six) on some children. The result is that their skin becomes excessively sensitive and delicate, is never dry, and loses its power of reaction when chilled Such children are continually catching cold, and are subject to all kinds of ailments.

Many parents at present fail to recognise any disgrace in sending children to school with torn and dirty clothes.

It is by no means a question of poverty only; in fact the worst instances of child neglect that the writer has met have come from homes where the father is earning plenty of money to keep his home decent and his children respectable, but the mother is either drunken or grossly incapable, or both. If the kind of sewing taught during the last thirty years in our elementary schools is ever to bear fruit, surely it is time now for it to appear. What these people require is to be taught to patch their clothes and to darn their stockings, and there is no reason why this should not be done in school, instead of wasting these children's time with fancy work. Another important point is to educate the popular taste towards hygienic, neat, durable garments, instead of torn soiled cheap finery that so often forms the ideal of dress among this unfortunate class.

Intimately associated with the dress of children attending primary schools, and with their squalor, filth, and untidiness, is that vile institution the pawnshop. Any decent apparel possessed by the children is regarded, and is used, as a kind of floating capital, and many of them outgrow a good garment before they have had the chance of wearing it out. To the pawnshop largely should also be attributed the sinking of the individual and the spread of disease and vermin, and until pawnshops are put down and a regular school uniform made compulsory, a great battle will have to be waged against untidiness, rags, and dirt in children.

All children in attendance at an elementary school should be required to wear some simple, neat, hygienic dress. This would not only be a great advance from a hygienic point of view, but would also be economical and becoming. As things are at present the clothing of a large proportion of the children can only be described as a miscellaneous

collection of rags. The atmosphere of an elementary school on a wet morning is usually sickening. The woollen clothes have been worn for months or years, are perspiration-soaked, and reek with unhealthy miasm. These exhalations continue until the clothes are dry. It has been suggested that "a school uniform should be kept at the school for each scholar, and the children would change their out-of-school attire on reaching the cloak-room. Here any wet garments could be thoroughly dried. The uniform might be quite simple and light; it should consist of linen in summer, of woollen in winter, and should be provided by the parents as a part of the school outfit, unless they are absolutely poor, in which case the State should provide it."

Boys should wear a flannel vest and a simple blouse or woollen jersey, fitting loosely, and the material varying according to the season. The knickerbockers should be suspended round the hips, and if these fit properly above the thigh bones with an elastic band there will be no need for braces. The girls should wear a flannel chemise, blue serge knickerbockers fitted upon the thigh bones with an elastic band, and no stays, or any substitute for stays, of any kind. Next there should be a woollen jersey (or a cotton blouse in summer), and an overdress with shoulder straps fastened into the waist. In summer the children require no head covering.

If some simple dress as the above could be universally adopted what a revolution would take place in the appearance, comfort, and health of our schools! The children would gain self-respect, and the whole tone of the schools would be altered.

The boots of children, in our climate, are important articles of clothing during more than half the year, Careful attention to the fitting of boots and shoes during

childhood will save a lot of trouble in after life. Children should be taught that it is a sign of weakmindedness to wear boots that are too tight, or that hurt the feet in any way. Unfortunately a majority of the children in our elementary schools have no choice, and are compelled to wear anything that comes to hand. If they do get a pair of good boots they rarely wear them, because the inevitable pawnshop has intervened. Proper boots should be of sufficient length and breadth, should be practically straight along the inner edge in order to prevent distortion of the great toe, and should have low broad heels. Shoes are far better than boots. Dry boots, and warm woollen socks or stockings—never cotton—are requisite for the preservation of health.

Clothing for Games.

The boys should be encouraged to obtain special clothes for the games, both on the ground of economy and health. A loose flannel shirt and a short loose pair of knickers are all that are required (except for Rugby football, which requires a tight woollen jersey). Immediately after the game these clothes must be changed again, and the playing clothes carefully dried. The wearing of any tight band or belt round the waist should be discouraged, as it greatly increases the possibility of a "rupture." This should be definitely taught the boys, as the popular belief is to the contrary. If no tight belts and no corsets were worn the number of ruptures would be decreased by more than fifty per cent.

HABITS.

Habits are formed and deep impressions made very early in life. Children are singularly imitative, and school impressions are often of lifelong endurance. The teacher

should therefore be an example of personal cleanliness and neatness, with hair, linen, and finger nails neat and beyond reproach. The children should be directly encouraged to be neat and clean, and no capable teacher will submit to teach children in a room with dirty floors and dim, closed windows.

Definite direct instruction, preferably distinct and apart from the teaching of any scientific details and reasons, should be given to all children concerning the care of the teeth, cleanliness of the skin, regularity in the action of the bowels, sufficient sleep, and the avoidance of such bad habits as spitting.

Parents constantly neglect to teach their children that the daily regular action of the bowels is a necessity for health, and that absolute regularity can only be ensured by keeping to the same hour (best just before or just after breakfast) each day. If children were only reared with such habits the necessity for aperients would disappear, and many of the intestinal disturbances so common among town children would disappear. Teachers should instil this thoroughly into the minds of the children, and explain that to allow refuse to accumulate inside the body, which it does if not removed daily, will cause it to putrefy and poison the whole system. In fact such a practice should be regarded as a mark of personal uncleanliness. Sir Lauder Brunton has well said, "As a rule, people are now fully alive to the risks they run from poisoning by sewer gas, or, to put it more widely, from poisoning by products of decomposition outside the body; but perhaps we do not all of us keep so clearly before us as we ought the fact that inside the body there are all the conditions for the formation of putrefactive products, and the most favourable arrangement for their rapid absorption."

One of the most objectionable of the early acquired habits is that of spitting. The children should be taught that, apart from the filthiness of it, there is considerable risk of thereby spreading disease, so that it is to everyone's advantage to assist in suppressing the habit. The dual lesson of self-control and duty to one's neighbour should be taught. It is extremely likely that in the schools we have the primary source of infection of a vast number of consumptives, and there is no doubt that here there are the most promising possibilities of prevention. This dreadful disease is discussed elsewhere and other means are mentioned which ought to be employed to cope with the scourge, but it is evident that the responsibility rests with the school authorities not only to prevent already infected children becoming a source of infection to others, but also to give all children definite instruction with regard to the prevention of the disease.

Many teachers will find it very interesting to experiment with some left-hand exercises for the children. The formation of the right-hand habit leads to unequal development of nerves and muscles. It is therefore much to be desired that children should be encouraged to practise exercises of all kinds with the left hand as well as the right. Occasional practice in writing with the left hand is beneficial. Some people find that a few minutes' writing with the left hand will relieve the nervous tension and headache set up by overwork and study.

SLEEP.

Most town children suffer from an insufficient time for sleep. The results upon the organism of the child are most disastrous, both physically and mentally. To cut down a child's sleep is as cruel as to deprive him of food. Dr. Dukes gives the following table:—

Age.	Number of hours.	Time.
Under 6 years	13	6 p.m. to 7 a.m.
„ 7 „	12½	6.30 „ „ 7 „
„ 8 „	12	7 „ „ 7 „
„ 9 „	11½	7.30 „ „ 7 „
„ 10 „	11	8 „ „ 7 „
„ 13 „	10½	8.30 „ „ 7 „
„ 15 „	10	9 „ „ 7 „
„ 17 „	9½	9.30 „ „ 7 „
„ 19 „	9	10 „ „ 7 „

These amounts should certainly be taken as minima, and probably they should be increased so as to give the child of thirteen a rest of twelve hours.

Not only should the amount of sleep be graduated according to the age of the child, but also the hours of work. In practically all schools the younger children do far too much mental work, and get a totally inadequate amount of sleep, so that if it were not for the long holidays that succeed the terms of work most children would be seriously handicapped for life. The vacations save a complete breakdown. Dr. Dukes gives the following table:—

THE Hours of Work and Sleep adapted to the various ages of children.

	Ages.	Hours of Work.	Hours of Sleep.
Nursery	From 0 to ½ ...	0 ...	20
	„ ½ „ 1 ...	0 ...	18
	„ 1 „ 2 ...	0 ...	17
	„ 2 „ 3 ...	0 ...	16

Infant School	From	3 to 4	...	0	...	15
	„	4 „ 5	...	0	...	14
Primary School	From	5 to 6	...	1	...	13½
	„	6 „ 7	...	1½	...	13
	„	7 „ 8	...	2	...	12½
	„	8 „ 9	...	2½	...	12
	„	9 „ 10	...	3	...	11½
	„	10 „ 12	...	4	...	11
	„	12 „ 14	...	5	...	10½
Secondary School and University	From	14 to 16	...	6	...	10
	„	16 „ 18	...	7	...	9½
	„	18 „ 19	...	8	...	9
	„	19 „ 21	...	8	...	8½
	„	21 „ 23	...	8	...	8

Many of the mental breakdowns that are so common among young students would not occur if during their childhood and boyhood an extra allowance of sleep had been given. At the meetings of the British Association at York Dr. Acland exhibited a chart from which it seemed that, whereas in some schools small boys get ten hours sleep, in other schools boys of the same age get only 7¾ hours, and he quoted the testimony of the headmaster of a well-known preparatory school to the effect that more sleep for the boys had been attended by indubitable success, and all that had been done was to change the breakfast hour from 7 a.m. to 8 a.m. Then Dr. Acland gave his own experience of a boy who came under his notice, and he threw upon the screen specimens of the boy's writing when he entered the school. Soon, however, a change came over the boy's caligraphy. It was more careless and slipshod in style, words were written wrongly, and then corrected, and in some cases he had actually scored out words that were

spelt correctly and had inserted the same spelling over again. On Dr. Acland's advice the boy was given more rest, and the result was at once seen in clear handwriting, which as nearly as possible resembled his "fist" when he entered the school.

Children as a rule require at least as long a period of rest as they have of work and play, for most of their growth takes place in bed, and therefore to stint them of sleep is to hinder their development. A common fallacy is that physical exercise acts as a compensation for long hours of mental application. Nothing could be more mischievous in its results. It is perfectly true that mental fatigue is prevented to some extent by intervals of physical recreation, but the only true rest to the body and mind is obtained by sleep. "There is no ground for supposing," says Dr. Acland, "that hard physical exercise is a sufficient compensation for hard brain work, but on the contrary it should be followed by an increased amount of rest." Children appear to need more sleep in winter than in summer. The most effective part of the night's sleep is during the first hours, and in order to get the best results it is important that the children should not have any hard mental work just before going to bed.

According to Dr. Clouston there is a decreasing degree of staying power manifest during the last thirty years, *i.e.* since the Education Act of 1870, on the part of the brain to the extent of about 40 per cent. It is a question for us all to consider what share, if any, schools have in this terrible fact, with their excessive hours of work in the early years of childhood, and the inadequate amount of sleep during the same period of life.

CHAPTER X.

THE NERVOUS SYSTEM. MENTAL DEVELOPMENT.

The Nerve Cell.

The physiological unit of body tissue is the cell, and the nerve cell is the unit of the nervous system. Its structure is specially suited to the work of bringing distant parts of the body into relation with each other, so that excitations arising in one part may influence many widely distant parts.

The distinctive feature of the nerve cell is the prolongation of its protoplasm into numerous branching, thread-like "processes." One such process in each cell is distinct in structure, and probably in function, from all the others; it is called the **nerve fibre** or **axis cylinder**. At intervals the nerve fibre sends out lateral branches, and both fibre and branches end in branching "fibrils," *i.e.* little fibres, of extreme delicacy. The nerve fibres of the cells vary in length. Some are very short; others very long, stretching in some cases from the brain to the bottom of the spinal cord, or from the cord to the ends of the limbs.

The other processes, called **dendrites**, radiate from the cell in all directions and are marked by an immensity of branching ramifications. So frequent and intertwining, and so delicately fine is the branching of the dendrites and

the endings of the nerve fibres that, in the central system, the cell bodies seem to be embedded in a continuous fibrous network that knits the whole into a compact organ, from which issue collections of fibres, called the nerves, going to various parts of the body.

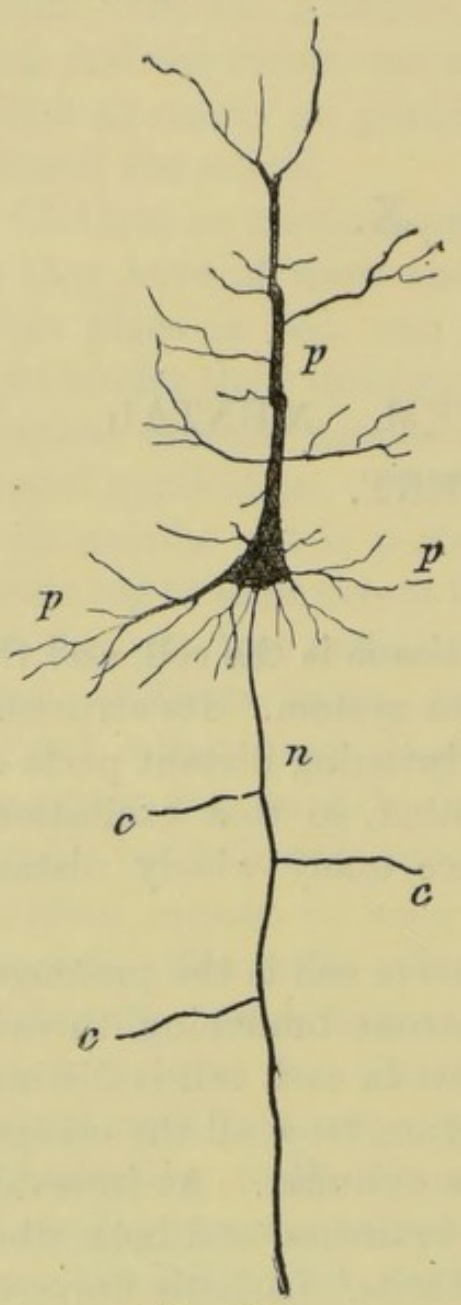


Fig. 105.

PYRAMIDAL CELL FROM THE CEREBRAL CORTEX, STAINED BY THE SILVER METHOD. (After Ramon Y. Cajal.)

pp, Dendrites; *n*, Nerve Fibre; *cc*, Collateral Branchings of the Nerve Fibre.

Copied from Wundt: *Principles of Physiological Psychology*. (Sonnenschein.)

The health and activity of the body depend upon the health and activity of the nerve cells, and *vice versâ*. These cells, like all others, require nourishment and oxygen, and excrete waste products, and they share in the general health or ill-health of the body. Their vigour depends on the amount and character of the blood that is supplied them. They will obviously therefore be beneficially affected by the good food, exercise, fresh air, and any other factors which are likely to produce a vigorous circulation of healthy and normal blood. On the other hand, such factors as poor food, foul air, sedentary life, etc., are calculated to produce bad circulation and abnormal blood (anaemia), leading to deterioration of

the nerve cells and the diminution of mental and physical power.

Before considering the interesting and important matters

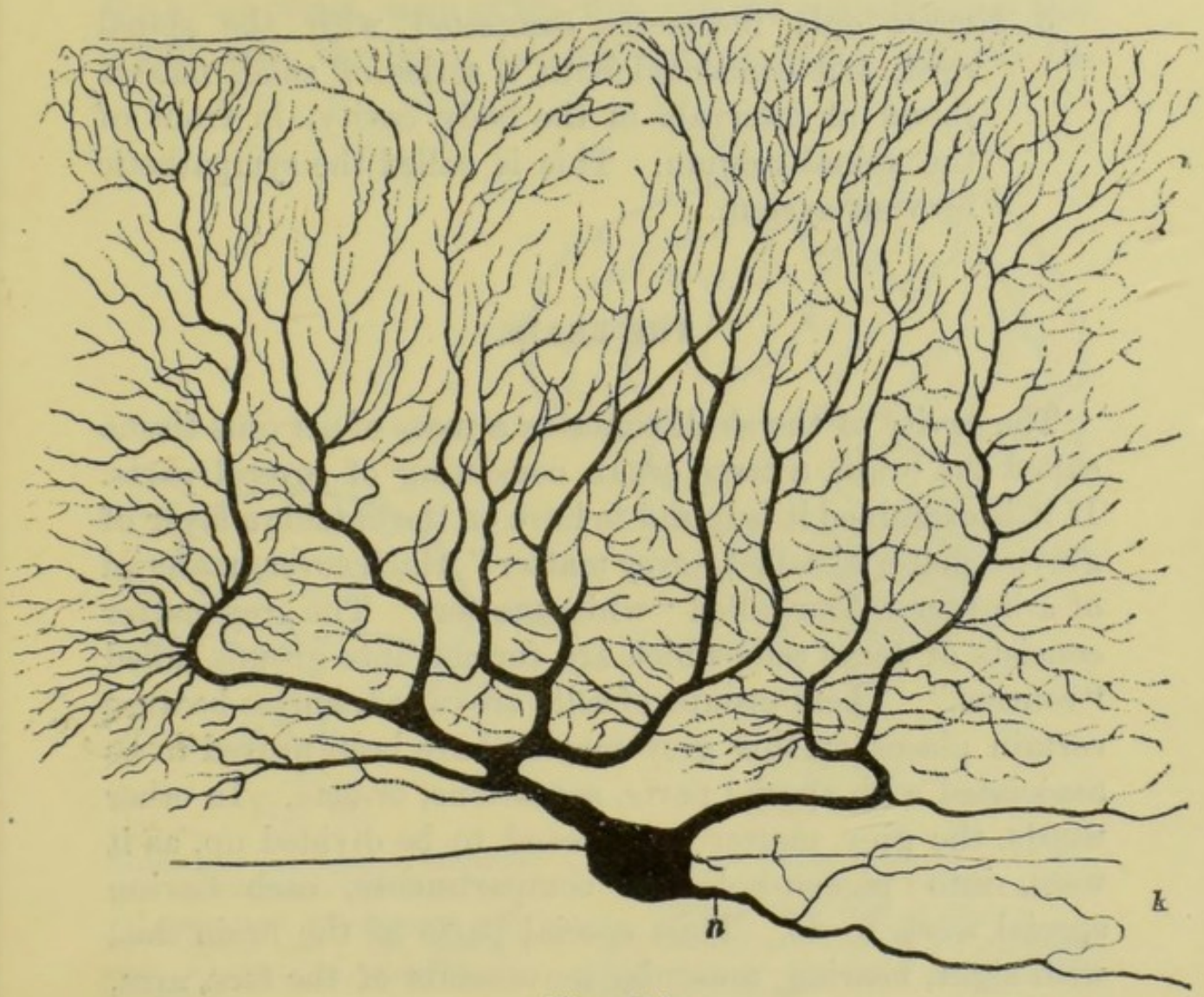


Fig. 106.

NERVE CELL FROM THE CORTEX OF THE CEREBELLUM, WITH RICHLY BRANCHING DENDRITES. (After Köllicker.)

n, Nerve Fibre; *k*, Collateral Branches.

Copied from Wundt: *Principles of Physiological Psychology*. (Sonnenschein.)

concerning mental development and mental deficiencies of school children, it is necessary to give a brief description of the nervous system. The nervous system includes :—

1. The brain and spinal cord, called the central nervous system.
2. The nerves directly connected with the brain and spinal cord, called the peripheral nervous system.
3. Nerves only indirectly connected with the spinal cord, but connected with a series of small masses found at intervals in the body cavity, in front of the spinal column. This is called the sympathetic nervous system.

THE BRAIN.

The cavity of the skull contains a mass of nervous tissue called the brain, a large organ consisting of several parts. If it is examined it is found to have on the outside a layer of greyish material called "grey matter" which covers material of a lighter colour called "white matter." The grey matter consists of nerve cells which are formed into groups called "centres." These groups of cells are called centres because certain places on this grey matter have been proved to be associated with special parts, sensations, or acts. In other words, the grey matter is believed to be divided up, as it were, into pigeon-holes or compartments, each having special work to do. Thus special parts of the brain deal with sight, hearing, muscular movements of the face, arm, leg, etc.

The brain receives messages from the organs of sense, and transforms them into sensations such as sight, sound, or touch. Thus the eye can do no more than send messages to the brain. If these messages reach that part of the brain dealing with sight, and if that part of the brain is properly developed, is healthy, and is educated to interpret these messages, then, and only then, does the indi-

vidual see. It is the same with the ears and the other organs of sense. The full possession of any one of the senses therefore is only possible when the three essential parts and their connections are perfect. These are (1) the sense organ, such as the eye, (2) the connection of this organ with the brain, *i.e.* the sensory nerve, and (3) the

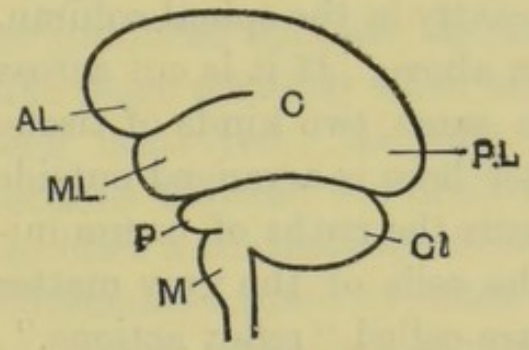


Fig. 107.

DIAGRAM OF THE GENERAL DIVISIONS OF THE BRAIN (left side).

C, cerebrum; AL, anterior lobe; ML, middle lobe; PL, posterior lobe; P, Pons; M, medulla; Cl, cerebellum.

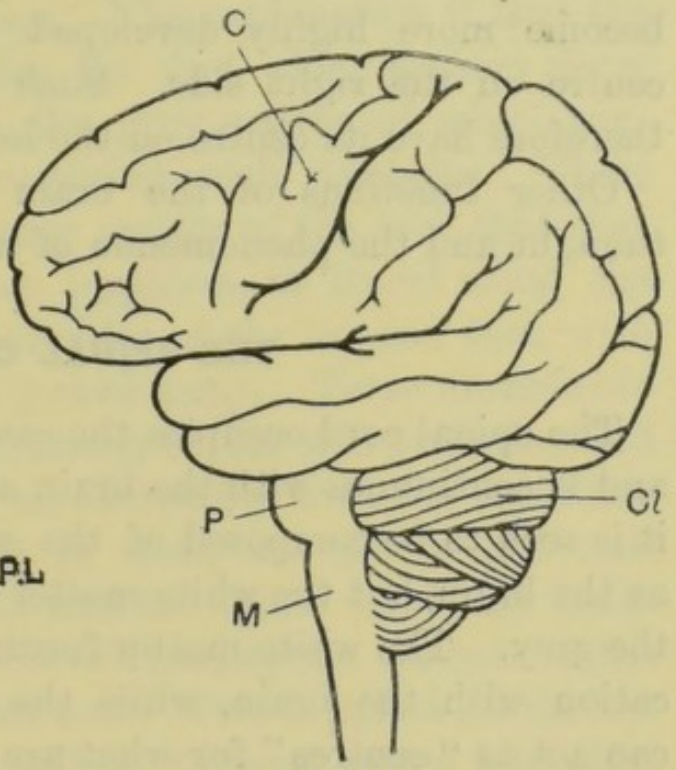


Fig. 108.

DIAGRAM OF BRAIN SHOWING CONVOLUTIONS AND FISSURES OF EXTERNAL SURFACE OF LEFT SIDE OF BRAIN.

The line from C leads to the place near which most of the motor areas of the brain are situated.

centre of the brain, whose special function it is to deal with and properly interpret these messages. Of such sensory centres the positions of those concerned with smell, taste, hearing, sight, and ordinary sensation are known.

The brain also contains centres, called motor centres, concerned with movements. The positions of the centres

concerned with movements of the face, tongue, lips, arms, legs, trunk, and head are known. Such centres are double, one on each side of the brain, and, curiously enough, centres on the right side of the brain govern movements on the left side of the body, and *vice versa*. Thus, in an ordinary right-handed individual, the arm centre on the left side of the brain would be more frequently used, and would become more highly developed than the corresponding centre on the right side. Such an act as writing would therefore have its centre on the left side of the brain.

Other functions of the brain include the process of thought and the phenomenon of memory.

THE SPINAL CORD.

The spinal cord occupies the cavity in the spinal column, and is continuous with the brain above. If it is cut across it is seen to be composed of the same two kinds of tissue as the brain, but the white matter here is arranged outside the grey. The white matter forms the paths of communication with the brain, while the cells of the grey matter can act as "centres" for what are called "reflex actions."

THE NERVES.

Connected with the brain there are twelve pairs of nerves, and from the spinal cord there pass thirty-one pairs. Nerves carry impulses either to the central nervous system or from it. If a nerve brings impulses from the skin or from the organs of special sense, such as the eye or the ear, to the brain or spinal cord it is called a sensory nerve. Those which convey impulses from the central nervous system to the muscles are called motor nerves. If a nerve contains both sensory fibres and motor fibres it is called a mixed nerve. All the spinal nerves are mixed.

REFLEX ACTS.

If the foot of a sleeping person is tickled it is jerked away. If the soles of the feet of a man whose spinal cord is injured anywhere above the sacral region be tickled, it often happens that his legs will be suddenly drawn up, although he can neither feel the tickling nor is able, of his own will, to draw up his legs. The explanation is that the sensation is conveyed from the foot along sensory nerve fibres to the spinal cord, the grey matter of which constitutes a "centre" for receiving such messages. These impulses so act upon the grey matter of the cord that they cause new impulses, motor impulses, to travel along the motor nerve fibres to the muscles of the leg and foot, with the result that the foot is jerked away. These movements are produced without the action of the will or brain, and take place perfectly when all connection with the brain has been destroyed. As long as there are the proper connections between the brain and the spinal cord, the brain exercises a controlling effect in limiting the violence of the movements caused by reflex acts. This is called inhibition. Also, when conscious, the will, or volition, comes into play, and the brain can limit or prevent the motor impulses being sent in response to a sensory stimulus. Thus, by an effort of the will, it is possible to prevent the foot being jerked away when the sole is tickled.

For a purely reflex act there are therefore three necessary parts: (1) a sensory nerve, (2) a nerve centre, and (3) a motor nerve. Many of the ordinary acts and movements of human beings are reflex acts. Some of them are involuntary or automatic, and take place with or without the will. Some acts that originally required considerable effort and a good deal of will control become more or less automatic afterwards. Thus we can go on walking

without thinking about it. Among the purely automatic centres which require no stimulus from the outside are those concerned with circulation and respiration. These acts are continually performed during life, but the rate at which the work is done is constantly varied in response to impulse.

The start that one gives in response to a sudden noise; the jerking away of the hand if it touches a hot body; the closing of the eyes in response to a sudden flash of light; these are common reflex acts.

SYMPATHETIC NERVOUS SYSTEM.

Lying on each side of the front of the vertebral column is a row of small beads or ganglia connected together by a greyish-coloured cord. This is called the sympathetic chain, and extends from the base of the skull to the bottom of the spine. The ganglia are connected by fibres with the spinal nerves, and therefore with the spinal cord, and immense numbers of nerve fibres pass from the sympathetic chain to the various internal organs, such as the heart, lungs, stomach, intestines, and also to the walls of the blood vessels all over the body. These sympathetic nerves chiefly carry impulses which govern the muscular tissue of the internal organs and the muscular coat of the blood vessels.

THE NERVOUS SYSTEM OF THE INFANT.

The automatic centres, such as those concerned with circulation and respiration, are well formed in the infant at birth. Other centres that need no control from the brain are also in working order, such as the centre for sucking —a reflex act set going when the mucous membrane of

the mouth encounters any foreign body. Other centres rapidly develop and acquire power and control, and the child reacts more readily to external stimuli, obviously noticing differences and alterations in its surroundings. Then the child begins to be able to possess muscular control, and coordinates its muscles in order to produce the coarser movements by an effort of will. The power for finer movements is acquired later on, and is part of the education of the brain.

Similarly the receptive centres have to be educated. Very early in life it is probable that neither light nor sound affects the child in any way. Afterwards a child will obviously notice a bright light or a sharp sound, but it is still unaffected by gradations of light or sound. Then light and shade become recognised, sight and touch teach each other, and gradations of light and shade are associated with special forms and shapes. Objects that are continually seen are sending the same impressions time after time, until at last these impressions become familiar and are remembered. The child is then able to recognise familiar faces and things. In a similar manner the centre for hearing is educated until it can differentiate and analyse sounds. Then the impressions produced by continually recurring sounds are stored up and are remembered.

So far we have traced the development of centres separately, as if each developed alone and independently of the others. This is not the case. As each centre develops so do its connections with other centres begin to be brought into being. Thus sounds begin to be associated with the pictures of certain objects that produce the sounds. Then an object begins to be coupled in the mind with sounds that are continually repeated while the attention is being called to the object, and the child eventually associates certain sounds with objects

that are familiar. At this stage the repetition of a certain sound will call up in the child's mind the picture of the object connected with it, and the child learns to associate words with objects and ideas.

SPECIAL CENTRES.

From an educational point of view some centres are of special importance. These are the centres concerned with speech, of which there are four, viz.:—

1. The auditory word centre.
2. The motor speech centre.
3. The visual word centre.
4. The writing centre.

The first and third are sensory centres, *i.e.* they deal with impulses received, while the second and fourth are motor centres, and have control of speech and the act of writing.

These special centres are not on both sides of the brain, but on the left only. The auditory word centre, which develops as the child is showing signs of being able to distinguish special words and appreciate their meaning, is part of the hearing centre on the left side of the brain. Similarly the left visual word centre is part of the left centre for sight, and deals with the impulses caused by the images of written words. This centre is often developed entirely at school while the child is being taught to read words. From the above it will be understood that the left centres for sight and hearing each develop a special extra centre to deal particularly with words—written and spoken. Similarly the left centre which controls the movements of the lips and tongue develops a special centre for dealing with speech (the motor speech centre), and the centre

controlling the movements of the right arm develops an additional one to control the particular act of writing.

All these centres have fibres connecting each with the others, *i.e.* the two sensory centres are connected together and also with the two motor centres, and *vice versâ*. By means of such connections we can immediately speak or write a word that we hear or see.

DEVELOPMENT OF SPECIAL CENTRES.

An infant learns, as we have already pointed out, to associate words with ideas, a process which is brought about by the development of the auditory word centre. This is followed by the development of the motor word, or speech, centre. Connections are then formed between the auditory word centre and the one for speech, and the child now attempts to imitate sounds that it hears, and educates its centre for speech by means of its auditory centre. Its first attempts are naturally wide of the mark, because not only are the muscles concerned with speech not properly under control, but also the child's hearing is not very acute, and it is unable to distinguish small differences between its own efforts and the sounds that it hears.

The connections of the centre for sight with the auditory word and the speech centre are also being developed, and the child now becomes capable of complicated mental processes. Thus an object is seen, the sound (or name) associated with it is remembered, and the motor speech centre reproduces the remembered sound more or less accurately, *i.e.* the child can give the name to an object that is in view. This is a tremendous advance upon any previous mental process. Similarly a name is heard, the visual centre reproduces the mental picture associated with

the word, and the child is able to pick out the object bearing the name.

Associated with the development of these connections between centres is the increase in the capacity of each centre for storing up impressions, and so memory develops.

In this stage of mental development the ordinary child reaches the teacher. At school the above centres should continue their growth, and their connections with each other should be gradually improved and strengthened. Two new centres, the writing centre and the visual word centre, have to be developed entirely at school, and these in their turn have to establish connections with each other and with other centres before they can attain their full usefulness and play their proper part in the education of the child.

A proper appreciation of the above phenomena of development should be considered indispensable to all teachers and all people who profess to be interested in education. If this were so it would not be necessary for medical officers to have to spend so much time in trying to persuade teachers and well-meaning "experts in education" that it is quite hopeless to try to teach a child to read or write when there is no available visual word-centre; or to write when there is no working centre for writing; or to speak when there is no available speech centre, although such children may, in all other respects, possess good faculties.

DEFECTIVE CHILDREN.

Great lack of development of the various centres and connections that are used in education gives rise to idiot and imbecile children. Such children rarely reach school

at all, as they are obviously incapable of being educated by the ordinary school methods. But there are children who, while suffering from lack of development of some centre or centres, are not obviously abnormal before their education is attempted. It is convenient to describe the lower type of such children as "feeble-minded," and the higher type as "defective." Such children reach the schools in large numbers, but gain little or no advantage from the ordinary school teaching, usually remaining year after year in the lower standards of the school, learning little or nothing, and eventually receiving no attention at all. The ordinary school methods are wasted upon such children, and they need practically individual instruction. Specially treated they often make considerable improvement, and in many cases become sufficiently normal, after a time, to go back to the ordinary schools. It is obvious that so long as defective children are being educated together with normal children they are subjected to severe strain and hopeless competition which can only result in making the defect worse. Such children placed among those of similar mental calibre occasionally show a wonderful improvement in quite a short time.

In 1895 a report was issued by the Committee, Parkes Museum, upon the result of examining a large number of children. About 100,000 children were reviewed, 9,777 showed certain developmental defects (abnormalities of skull, ears, eyelids, palate, nasal bones), abnormal nerve signs in 10,355 cases, and 7,391 were mentally dull. The "exceptional" children included 2 idiots, 51 imbeciles, 275 children feebly gifted mentally, 19 mentally exceptional, 110 epileptics, and 5 deaf mutes. About 1·26 per cent. of the total number of children were found to require special instruction, while 7 per cent. of the total number were mentally dull.

VARIETIES OF DEFECTIVES.

There are many varieties of defective children. If one or more of the special centres, *i.e.* the auditory word, motor speech, visual word, and writing centres, are affected, or if the communications between them have failed to become established, certain typical and easily understood results will follow. Thus if the auditory word centre is affected the condition known as "word deafness" results, and the child is unable to understand or remember what it is told. Such children do not recognise their own name when called, and are occasionally supposed to be deaf, or imbecile, which they are not. Instruction at a deaf school often does no good at all. Instruction by articulating and writing must be attempted, and is usually attended with excellent results. Many of these children are not mentally abnormal in any other direction.

If the connection between the auditory word centre and the writing centre has failed to develop the child is unable to write to dictation, while an affection of the writing centre itself will prevent writing altogether.

Affections of the visual word centre cause "word blindness," the child being unable to remember or recognise letters or words. These children can write from transcription, but not to dictation. They can draw and can recognise pictures, and can often do ordinary arithmetic, but it is quite hopeless to attempt to teach a word-blind child to read or write. They cannot read a word, and they write rubbish. Other imperfections in the visual centre result in inability to perceive colour, and to acquire notions of form, size, extent, distance, and relief.

In the same way any imperfection in the motor speech centre will affect the child's speech.

DETECTION.

The proper detection and classification of mentally defective children can only be done by medical men experienced in school inspection, and the necessity for the early recognition of such cases constitutes one of the many reasons why systematic medical inspection and supervision of all school children should be enforced. If the child is to be rescued from a life of utter uselessness and dependence it is of vital importance that the condition should be recognised early in childhood. It is then possible, by special methods of teaching, to bring about wonderful improvement in some of these children by slowly and carefully encouraging the development of the defective centres and their connections. Nevertheless it should be remembered that many children are backward and appear dull simply because the sight or hearing is defective, or because they have adenoid growths. When these physical defects are remedied the mental condition is found to become more nearly normal. Adenoid children in particular are liable to be looked upon as defective. They are often very dull and many cases have been found where it has been impossible to teach them even the simplest matters.

Although the actual diagnosis and classification of these mental conditions is essentially a matter for medical men, yet a good deal of the preliminary inspection, with a view to detecting abnormal conditions, may be carried out by a specially trained teacher. Simple tests, such as those known as Dr. Warner's methods, are as follows:—

1. The children are asked to hold out their hands in front of them. It is then easy to notice the balance of the hands, arms, spine, and shoulders, any peculiarities being noted.

2. By placing one's hand on the child's head the size, form, bosses, etc., can be noted. Then measurements of the head may be taken.

3. Another test is to hold in front of the child some small bright object which is held in the observer's hand. By telling the child to keep his eyes fixed on this, and by moving it to and fro, it is possible to obtain some idea as to the coordination of the eye muscles and the muscles of the face and neck, as well as a good view of the features and expression.

4. The shape of the hard palate is another important observation.

Special notes should always be made regarding the form and size of the head, general nutrition, abnormalities of feature, open mouth, nervous movements of the face, forehead or fingers, etc.

A good rule to bear in mind is that, in the majority of cases of marked deviation from the normal in formation or in development, or in the nervous system, such defects are accompanied by mental irregularity. As a result there should always be carefully noted the following conditions :—

Hare lip.
Cleft or high palate.
Irregular and decayed teeth.
Deficient ear lobes.
Abnormally placed earlobes.
Indented nose.
Blue lips.
Peculiarities of skin.
Open mouth.
Dull vacant expression.
Twitchings and tremors.
Signs of feeble circulation.
Peculiarities of skull.
Defective powers of attention.
Irritability.

SCHOOLS FOR DEFECTIVE CHILDREN.

By the Elementary Education (Defective and Epileptic Children) Act 1899, the local education authority is empowered to provide special schools for these children. The Act is permissive only, but it enables school authorities to obtain grants towards the education of defective and epileptic children. In order to gain admission to such schools the children must be certified by the Education Medical Officer to be incapable, by reason of some mental or physical defect, of deriving benefit from the ordinary methods of teaching. It is not sufficient for the child to be merely backward or dull, nor are imbeciles to be admitted. The greatest care is necessary if any real good is hoped for. To fill such schools with obviously feeble-minded children is to waste public money and to effect very little improvement. The promising cases for such treatment are children with one or more defective centres, which by careful teaching may develop to almost a normal degree.

It is not advisable to admit children under seven years old to the special schools, because good infant school teaching is often very beneficial to such cases. They may be retained in the special school until the age of sixteen, unless they develop sufficiently to return to the ordinary schools before reaching that age. The instruction at the schools should be given by teachers who have special aptitude for the work, and for successful results it is necessary to give individual attention and instruction, so that only small classes are possible. All the work should be under constant medical supervision.

Great attention should be paid to articulation, and excellent results are obtainable even in bad cases. Speech of as normal a kind as possible is of the highest importance

to such cases. Manual instruction is of special importance to them, the teaching being of the kindergarten type for younger scholars, and technical instruction for the older ones. Physical exercise also demands extra time and attention, breathing exercises and eye movements being particularly useful. Judicious open-air exercise should be encouraged in every possible way, and all special physical defects should be duly considered in the plan of exercise for each scholar. It is of vital importance to remember that the best results are obtained by finding out what powers these children already have, and educating them on these lines. A great deal of valuable time is often wasted in attempting impossibilities in the way of reading, writing, and spelling. In Copenhagen various grades of defectives are received either in day classes or in residential institutions. For the teachable cases there is usually one teacher for eight or ten scholars. The older boys learn farming, brush, broom, and basket making; the older girls being taught dairy and laundry work, or some form of weaving.

Special schools should be situated in as good a position as possible, on a gravelly soil, and with a good elevation. The diet of the children should be plain, but liberal. Milk, oatmeal porridge, cocoa, bread, eggs, vegetables, fruit, and a little meat (except in epileptic cases) should be the main articles of diet. Warm clothing is indispensable, and special attention to the hands and feet is necessary.

Parents' Position.

Parents very often offer objection to the attendance of their children at special schools, and under the Act the parent has the right to request the school authorities to examine from time to time (intervals not less than six months) any child attending such schools, in order to ascertain whether the child has improved sufficiently to be

fit to attend the ordinary schools again. As a matter of fact every authority should arrange for all such children to be examined at far shorter intervals than six months. Medical examination is desirable at least every three months. Improved cases are sent back to the ordinary schools and degenerating cases are excluded as imbeciles. It is desirable that some special method of dealing with these degenerated cases should be devised.

EPILEPTIC CHILDREN.

It is estimated that 1 per 1,000 children is epileptic, and that one-sixth of these are severely afflicted. If the attacks are rare, and not violent, there is no reason why such children should not attend ordinary schools, provided that the intelligence is normal. Unfortunately the disease often causes rapid deterioration of intelligence, so that special teaching is frequently necessary. Severe cases should be treated in residential homes, and should receive constant medical attention. It is desirable that each house of residence should be of one storey only, and should contain not more than 20 cases.

CAUSES OF MENTAL DEFICIENCY.

Among the causes of mental deficiency in children one of the most important is undoubtedly heredity. A family history of mental weakness is traceable in about 21 per cent. of the cases, while the taint of consumptive tendency is found in nearly 30 per cent. Alcohol probably plays the greatest part of all, parental intemperance being found in about 24 per cent., and a much larger number probably suffering as the result of the effects of alcohol upon the offspring even when taken in moderation. The common habit of women, during the period of pregnancy, to partake

somewhat freely of such alcoholic liquids as stout, etc., undoubtedly tends to cause deterioration of nerve tissue in the child.

Circumstances, surroundings, parental neglect, deficient and injudicious food, all play important parts in the production of the stunted, dull, and mentally feeble child—a fairly common type in town schools. Occasionally the condition is the result of injury, particularly injury at birth, while in others it is said to be caused by a fright or shock. Convulsions or epilepsy are well known forerunners of mental deficiency, and occasionally it follows as a result of a severe attack of scarlet fever, measles, or whooping cough.

It is difficult to give a satisfactory classification of the various causes and conditions associated with mental deficiency. A common method is to divide them into the congenital and the non-congenital.

CONGENITAL CONDITIONS.

1. **Microcephalus**, or the congenitally small head. In its extreme form it is characteristic of a low type of idiocy. Such heads are not only small in circumference (17 inches or less), but also have a characteristically narrowed and rapidly receding forehead. Above this type there are all grades of deficiency up to the ordinary mentally defective child. Between 18 and 19 inches in circumference is a common measurement in imbeciles. Nineteen or 20 inches is a common measurement in the feeble-minded.

2. **Hydrocephalus or Macrocephalus**, or the abnormally large head (sometimes of non-congenital origin). Associated with this condition are varying degrees of intelligence, from a low form of mental defectiveness up to an unusually high degree of intelligence.

3. **Tubercle.** Tubercle plays a very decided and important part in the causation of mental deficiency. Some hereditary taint of tuberculosis is commonly found, while in other cases there is actual personal infection, such as tuberculosis of joints, glands, or serous membranes.

4. **Cretinism** (absence or atrophy of the thyroid gland). This is another congenital taint or condition associated with mental defects. Some cases are normal at birth, but gradually develop the characteristic signs, viz.:—Coarse, dry, thin hair; low and narrow forehead; swollen eyelids, hands, and feet; full and flabby cheeks; large mouth; large and distended abdomen. Cretins remain almost stationary as far as physical and mental development are concerned, so that adult age is reached while the appearance and mental powers are those of an infant.

5. **Neurotic conditions.** Many of these are hereditary, and the mental deficiency dates from birth. Alcoholism in either or both parents is a common cause of these conditions.

NON-CONGENITAL CONDITIONS.

These are subdivided into the developmental and the accidental or acquired.

Developmental.

This term is applied to cases where actual mental deficiency supervenes upon a brain originally imperfect in development, although not noticeably so. These forms of mental weakness become evident at some crisis of development, such as dentition or puberty.

1. **Convulsions.** A history of convulsions during infancy, especially during dentition, is common in cases of mental weakness.

2. **Persistent epilepsy.** A gradual deterioration in mental power usually accompanies persistent epilepsy.

Accidental or Acquired.

1. **Injury.** Inflammation of the brain or its membranes may be set up by injury.

2. **Shock.** All kinds of events, such as the bite of a dog, likely to give a sudden fright or shock, have been said to commence the history of mental weakness in many cases.

3. **Poisons.** The administration of poisons, such as alcohol or opium, to children always produces deterioration of the mental powers.

CHAPTER XI.

EAR, THROAT, VOICE, SMELL, TOUCH.

The ear is divided into three parts, the external, middle, and internal ear. The external ear is that structure which is usually described as "the" ear. It serves as a means of collecting waves of sound. An open tube, called the auditory canal, leads inwards from it. The canal is about an inch long, and is set near its mouth with fine hairs, while within, embedded in the walls, lie some small glands, which secrete wax. The hairs help to prevent the entrance of insects. The wax serves to entangle bacteria and insects that have gained admission. If the wax collects in too great quantity it will block the passage and cause deafness. This can easily be removed by syringing with hot water.

The external auditory canal ends at the tympanum or ear-drum. This is a membrane, like the top of a drum, and vibrates to the sound waves that reach it. On the other side of the drum is a small cavity called the middle ear. This contains three small bones, whose functions are to pass on the vibrations of the drum, and the remainder of the cavity is filled with air. From the floor of the middle ear there passes downwards a tube (the Eustachian tube) which opens into the pharynx. The walls of the middle ear, and the blood in the capillaries there, absorb the air, and would cause a decrease in pressure in that cavity if the Eustachian tube did not admit air, and so equalises the pressure on both sides. If the tube gets blocked, by a severe cold, or by the pressure of adenoid

growths, for instance, this absorption takes place, the pressure in the middle ear falls, the tympanic membrane becomes tense and is unable to vibrate, and deafness results.

The internal ear has a complicated structure which it is not necessary to consider here.

Deafness.

The deafness of a child may be due to some comparatively simple cause, such as an accumulation of wax in the external auditory canal, or adenoids blocking up the Eustachian tube; but on the other hand it may be due to

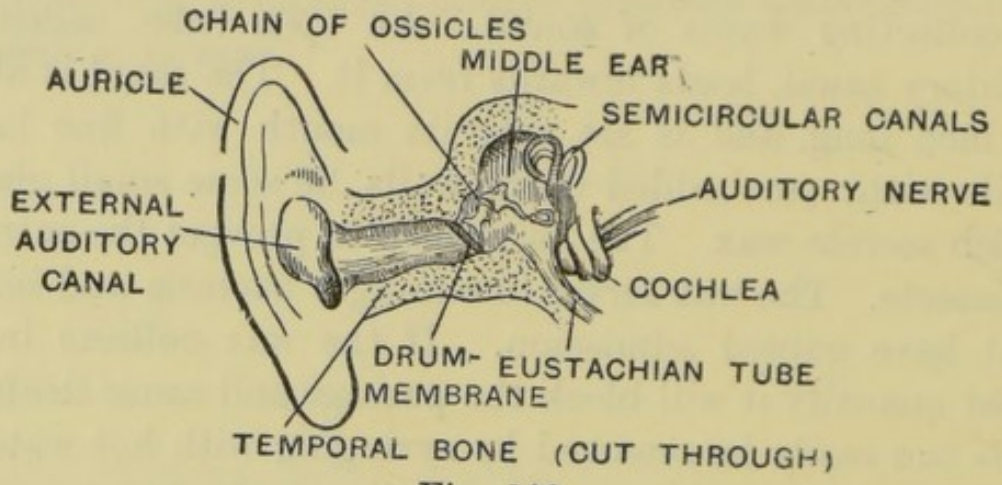


Fig. 109.

more serious and complicated defects, such as diseases of the middle or inner ear, interference with the auditory nerve, or defective development of, or damage to, the hearing centre situated in the brain. All cases of deafness should be selected by the teacher and presented for medical examination when opportunity occurs. At the very lowest estimate such a defect will cause part of the instruction given to the child to be wasted. Hearing is sometimes apparently deficient when the real deficiency is that of attention. Mentally feeble children often hear perfectly well, but will not take the trouble to listen and to distinguish sounds. Patience and the presentation of pleasant

musical sounds will often work wonders in developing this important sense.

Earache and Ear Discharge.

These are unfortunately of frequent occurrence in school children. At least one per cent. of the children have discharging ears. Earache should always receive attention, because it is the first signal that some mischief is being done. In many cases it is due to inflammation in the middle ear. This part of the ear is liable to bacterial invasion along the Eustachian tube. If the inflammation is severe it may lead to the formation of matter or pus in the middle ear. Then the drum is perforated, and the pus trickles down the external auditory canal as "ear discharge." It is of the utmost importance that such a discharge should be medically treated and cured at once. A child with an ear discharge should be likened to a person living on the edge of a precipice: it may continue for years, but disaster may occur at any moment. If treated at once the discharge will stop, and the hole in the drum will probably heal up, and the loss of hearing will only be very slight. If it is neglected it will become chronic and the ear may be permanently damaged. If it is treated afterwards it is very difficult to cure, and the hole in the drum will not heal up, so that some loss of hearing is inevitable. Moreover the trouble may cause death at practically any time. There is only a thin plate of bone separating the middle ear from the brain, and this may be attacked and perforated by the inflammatory process. The next step would be the formation of an abscess in the brain, and death may be rapidly brought about.

In the case of children who have recently been away from school on account of an attack of scarlet fever or diphtheria, a discharge from the ears may be of a highly

infectious character, and may cause a school epidemic. In such cases the child should be sent home at once, and the matter reported. The discharge in other cases may not be capable of setting up any definite disease in the other children, but if some of the matter finds its way into the eyes, ears, throats, or noses of other children, it may cause a great deal of injury. At all events it is desirable that all children suffering from ear discharge should be excluded from school.

TESTS OF HEARING.

Statistics are available to show that about twenty per cent. of school children possess some defect of hearing, either in one or in both ears. It is impossible to estimate the real meaning of apparent dulness or inattention until the hearing has been tested.

The test may be made in one of two ways, either by a watch or by the voice. For the older scholars the watch method gives good results, but for younger children the voice test is more reliable.

The same watch should be used for all the children. It is first of all tested with some good ears, and its correct ticking distance ascertained. Members of the staff may test each other for this purpose. Watches vary in the loudness of the tick, but the average one can be heard by the normal ear through a distance of about 4 feet. A very loud one may be heard 10 feet. A stop-watch is to be preferred, because the ticking is then under control. The quietest room in the school should be selected for the test. The child should be seated, and a tape measure is stretched horizontally backwards from the back of his head. The child's eyes should be closed. The person who is making the test brings up the watch (which we will suppose to

have a 48-inch tick) from a distance to the 48th mark on the tape. If the child can hear the ticking at this distance it has normal hearing, and is passed on. If the ticking cannot be heard the watch is moved inch by inch nearer until the ticking becomes audible. The tape must touch neither the child's head nor the watch, because it will convey the sound better than the air. The tape is provided simply as a convenience for reading off the distances and for providing a level. In order to get reliable results it is necessary to repeat the tests several times. If a louder watch is used a chalk line on the floor, with divisions, representing half a foot each, will be sufficiently exact for recording distances.

For testing by the voice the ordinary speaking voice is not sufficiently exact to give good results. For instance, it would be difficult to be quite sure that one is giving exactly the same test in six months' time as one is to-day, *i.e.* to be sure of the exact pitch and tone, etc. But if a forced whisper is used the test is much more exact. By a forced whisper is meant a loud whisper with a forced expiration helping it. This is fairly constant in the same person, and can be heard a considerable distance (varying from 30 to 60 feet about). One person must test the whole school, and the hearing distance of his forced whisper is first ascertained by testing good ears. Suppose it is found to be 60 feet. The test should be made in a quiet playground or room. A line 60 feet long, marked in feet, is chalked or painted on the floor: the child stands at one end with the back to the observer; the one performing the test stands at the other end, and an assistant stands by the child. The observer whispers various words (single syllable numbers are the best), and the child tells the assistant what he has heard. If the child cannot hear at all at this distance, or makes a mistake, the observer moves foot by

foot nearer and repeats the test. Finally, the distance at which the child can hear this sound is ascertained and recorded. The advantage of this method is that it is independent of the child's possible misinterpretation of the sound. In the watch method mistakes are constantly made by the child saying it can hear the ticking when it really does not. All children showing a deficiency of hearing should be presented for medical examination.

Deaf and Dumb Children.

Children born deaf are also dumb, because they do not hear words spoken, and so do not learn to speak. By training a dumb child to watch carefully the shape and movements of the teacher's mouth when the latter is naming an object, he may learn to imitate these and so come to speak. If a child becomes deaf before he is six years old, he tends to forget the language he has learned and is in danger of becoming dumb.

THE THROAT. AFFECTIONS OF THE THROAT.

On examining a child's mouth there can be seen the tongue, teeth, and gums in front, the hard palate above, and at the back the soft palate spanning over the root of the tongue like a fleshy arch, and dipping down at its highest point in a little process called the uvula. On each side of the arch are the pillars of the throat, enclosing the tonsils. The tonsils are variable in size, and it is not at all uncommon to find about 30 per cent. of the children in a school with tonsils which practically meet in the middle line. Such schools are often situated in country places, but usually where the housing conditions are poor.

The opening at the back of the mouth leads into a funnel-shaped cavity called the pharynx. The openings of the

nose lead into the same cavity, but the part of it at the back of the nose is sometimes called the naso-pharynx. These cavities are lined with a smooth covering called mucous membrane. When healthy this membrane is smooth and shining, and a bright pink in colour. In this condition it can resist the attacks of disease germs, but when it is unhealthy, as shown by it becoming rough and red, or rough and abnormally pale, it offers an excellent breeding place for bacteria. The membrane is rapidly affected by impure air, and if the child continually breathes vitiated air the lining of the nose and throat are certain to be injured. Liability to take cold in the head is one of the early indications of an abnormal condition of these parts.

ADENOIDS.

From an educational point of view the most important condition for diagnosis in this region is the presence of adenoid growths. These are very common in children under 14 years. After that age they tend to dry up and disappear, but the injuries that they have caused are permanent. They are fleshy growths produced by hypertrophy of the adenoid tissue which is so abundant in this neighbourhood, and are usually situated in the naso-pharynx, quite out of sight. To the finger thrust behind the palate they feel soft, pulpy, and velvety, "like a bag of earthworms." All classes of the community appear to be equally affected, and they are found about equally in the better class and the poorer schools. Heredity undoubtedly plays some part in their appearance, and there is no doubt whatever that the number of the children affected by this condition is rapidly increasing in the schools.

Effects of Adenoids.

The effects of these growths, by which means they can usually be easily identified, are numerous, and are of great importance. The obstruction to the natural breathing process is accompanied with and followed by dulness, stupidity, peculiarities of appearance, expression, and speech, as well as characteristic deformities. These are fully discussed in Chapter V. of Part III.

SORE THROATS.

A sore throat is the common beginning of an attack of scarlet fever, measles, or diphtheria, as well as acute inflammation in that region, and quinsy. Of course it is quite possible that any sore throat may be a simple local inflammation that will rapidly subside, but that does not affect the rule that no child with a sore throat should be admitted to school under any circumstances. It should be remembered that it is quite impossible to distinguish a simple sore throat from a mild attack of diphtheria except by bacteriological methods, and the epidemics of mild sore throat that are quite common among school children are often mild diphtheria. The infection will be handed from one to another, keeping its mild characteristics for a time, but occasionally developing an extreme virulence and causing a number of deaths in rapid succession. An instructive case has just occurred in the writer's district. A boy attending school contracted a sore throat. Soon afterwards his mother and the servant also had mild sore throats. A week later the father was very ill with inflamed throat, and the doctor who was summoned pronounced this case to be typical severe diphtheria. The throats of the boy, the mother, and the servant were then examined bacteriologically, and were found to be swarming with

diphtheria bacilli, although they had apparently quite recovered from the attack of "sore throat."

A morbid and enlarged condition of the tonsils always offers a resting-place to bacteria. The germs of consumption, or tubercle bacilli, often gain their first foothold in the body either through the tonsils or bad teeth. The bacilli next invade the glands in the neighbourhood of the jaw and throat, and give rise to a great amount of suffering and disease.

THE VOICE.

At the bottom of the funnel-shaped pharynx the windpipe and the gullet pass respectively to the lungs and the

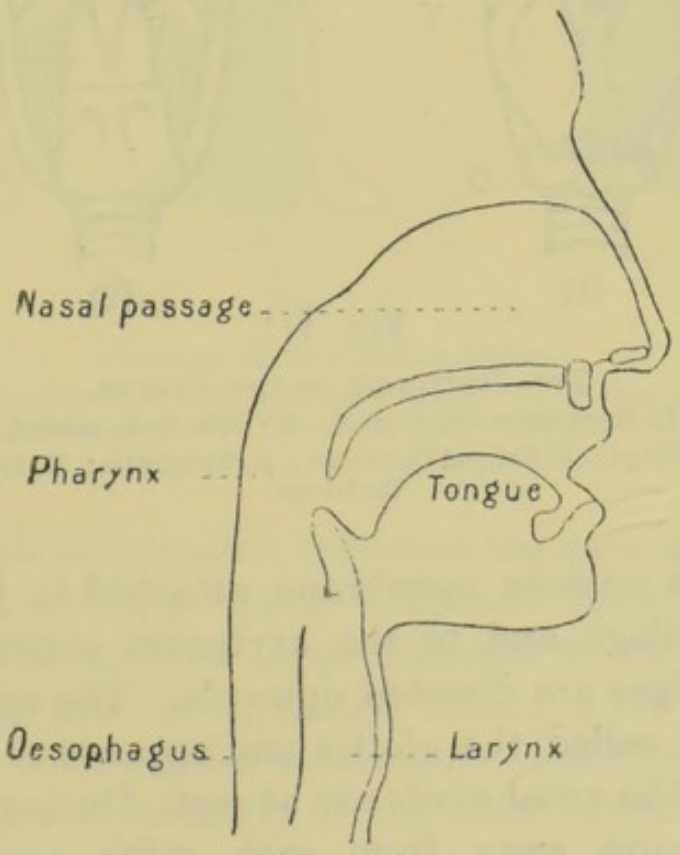


Fig. 110.
THE PHARYNX.

stomach. The windpipe is placed in front of the gullet. At the top part of the windpipe lies the larynx or voice-box.

The opening into the larynx lies at the root of the tongue; this is known as the glottis, and over it there projects a valve-like flap, the epiglottis. The larynx consists of cartilages, various muscles, and ligaments. The cartilages are called the thyroid, the arytenoid, and the cricoid. The thyroid cartilage in front forms the projection in the neck called "Adam's apple." The vocal cords—so called from their being concerned in the production of the voice—are two bands of yellow elastic tissue

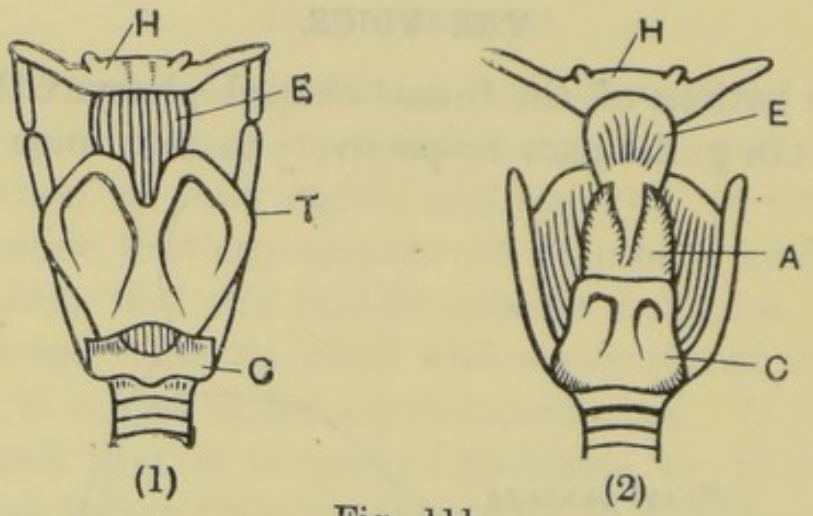


Fig. 111.

THE CARTILAGES OF THE LARYNX.

1. Seen from the front. 2. Seen from behind.

A, Arytenoid Cartilage; C, Cricoid Cartilage; E, Epiglottis; H, Hyoid; T, Thyroid Cartilage.

covered with mucous membrane, attached in front to the thyroid cartilage, and to the arytenoid cartilages behind. Their free edges are directed upwards. The space between the cords is called the glottis and appears as a V-shaped chink when the vocal cords are at rest. During inspiration the cords move away from each other and the space widens, and during expiration the glottis becomes narrower. During the utterance of a sound they are brought closely together. These movements are produced by the muscles of the larynx.

Production of the Voice.

The sound of the voice is produced by vibrations of the vocal cords. The note given out by a vibrating cord depends upon its length and its tension. The greater the tension or the shorter the cord the higher is the note sounded. Conversely the note is lowered by lengthening the cord or decreasing the tension. Thus individuals with tenor voices have shorter cords than those with bass voices, and the vocal cords in men are longer than in women or

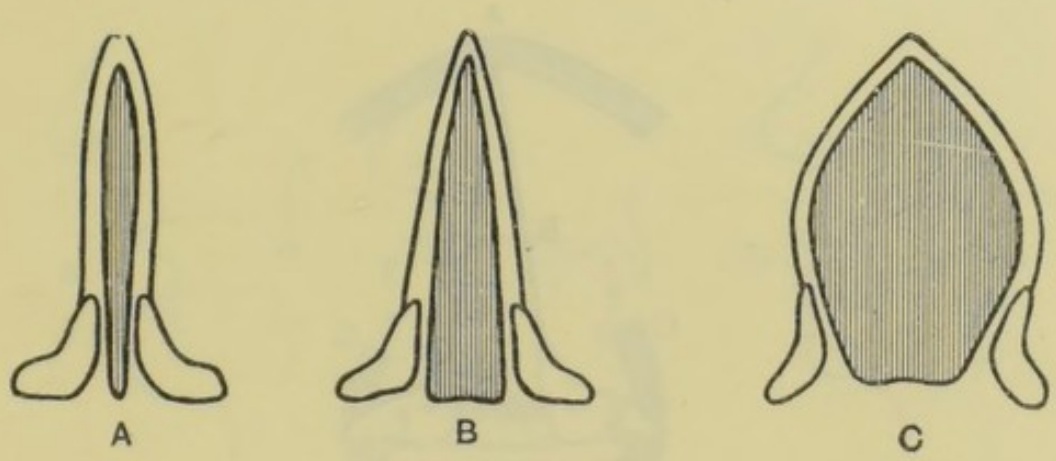


Fig. 112.

POSITION OF THE VOCAL CORDS.

A, during the emission of a high note in singing; B, during easy inhalation; C, while taking a deep breath. The shaded part represents the space between the cords.

boys. Length and tension influence the rate of vibration of the cords, and the "pitch" depends upon the rate of vibration. The cords are approximated where a high note is being made, and are separated during a low note. The range of the voice seldom exceeds two and a half octaves.

The loudness or intensity of the voice depends upon the amplitude or range of vibratory movement, which in its turn depends upon the force of the expiratory blast.

The quality or timbre of the voice depends upon the smoothness, elasticity, and thickness of the cords, as well as the form and size of the air passages, larynx, pharynx,

and mouth, which act as resonating cavities. We distinguish one voice from another, or the sound of the harp from that of the violin, by means of the quality of the notes. Adenoids, or any cause of obstruction in the nose, throat, or pharynx alters the quality of the voice.

Production of Speech.

It is possible to speak without using the vocal cords. When one speaks in whispers the slight sound produced

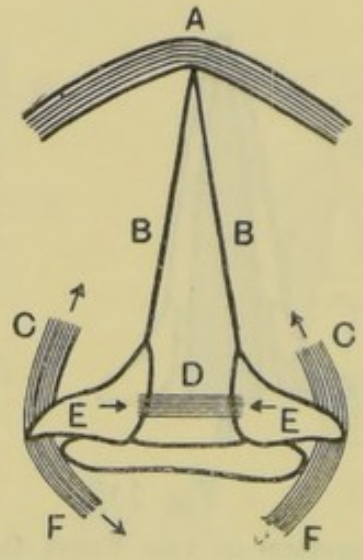


Fig. 113.

DIAGRAM SHOWING THE ACTION OF THE MUSCLES THAT ALTER THE POSITION AND TENSION OF THE VOCAL CORDS.

A, Front of Thyroid Cartilage; B, Vocal Cords; C, Muscles which move the Arytenoid Cartilages (E) as on a pivot and so bring together the Vocal Cords and increase their tension; D, Muscle that by its contraction pulls the Arytenoid Cartilages (E) nearer together and so approximates the cords also; F, Muscles which move the Arytenoid Cartilages (E) as on a pivot and so separate the cords.

by the air passing through the air passages is modified into speech by movements of the tongue and lips. In the same way ordinary speech is produced by modifying and modulating the sounds produced by the vibrating vocal cords.

Vowel sounds are produced by varying the form of the cavity of the mouth and the shape of the opening. This

is easily verified by producing the pure vowel sounds, *A* as in *ay*, *E* as in *he*, *O* as in *oh*, *Oo* as in *coo*, and *A* as in *ah*. The consonants, with the exception of *H*, which is pronounced by increasing the expiratory force with which the vowel is spoken, are produced by closing, more or less, certain of the exits of the expiratory blast. Aspirates are pronounced by partly closing the outlet, so that the air rushes through with a hiss. Thus *F*, *V*, and *W* are produced by partial closure with the lips, *S*, *Z*, *L*, *Sch*, and

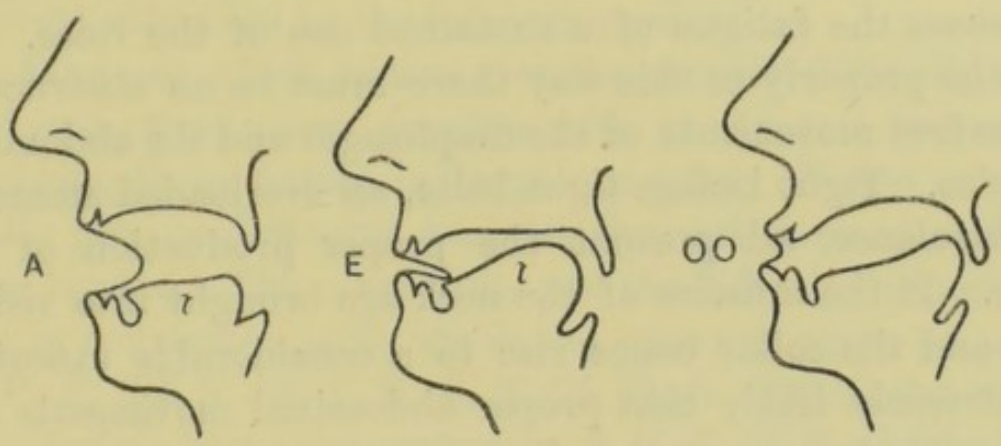


Fig. 114.

The Position of Lips and Tongue in producing Vowel Sounds.

Th by the tongue and hard palate, and *Ch* by the tongue and soft palate.

The "resonants" *M* and *N* are formed by sending the current of air through the nose, the lips being closed in the case of *M*, and applied to the palate to pronounce *N*.

The consonants *B*, *P*, *T*, *D*, *K*, *G* (hard) are called "explosives," because the mouth is first closed and then suddenly burst open. In the case of *B* and *P* the lips close the mouth; for *T* and *D* the tongue is applied to the teeth or the front of the palate; while for *K* and *G* (hard) the middle or back of the tongue is forced against the back of the palate.

Care of the Voice.

As puberty is reached the vocal organs enlarge and there is an alteration in the voice. This change occurs at about 12 or 13 years in girls and 14 or 15 in boys, and is complete in one or two years. While the voice is "breaking" there should be no sustained vocal exercise. For clear articulation the manner of breathing is important. Children should be encouraged to use their abdominal muscles for respiration quite as much as those which raise the chest. Breathing by means of the abdominal muscles decreases the fatigue of a sustained use of the voice. To breathe properly in this way there must be no obstruction to the free movements of the diaphragm and the abdominal muscles. Tight lacing, tight belts, an overloaded stomach, or flatulence, all prevent the proper production of the voice. If the muscles of the neck are brought into visible play and the collar bones rise to a considerable extent, it is extremely likely that proper abdominal movements are impossible for one of the above reasons.

Children should be taught to speak up and articulate clearly, and to use their natural voice when reading aloud. It is possible by habitual exercise to educate the voice so that continued speaking is not painful or injurious.

STAMMERING.

A common nervous affection, interfering with the proper enunciation of words, is stammering or stuttering. This is much more common among boys than girls. As a result of a lack of proper coordination of the various acts involved in fluent speech these children exaggerate the movements concerned with articulation, and under-estimate the force of the expiratory blast necessary to produce the

voice. The muscles of the tongue and lips (and sometimes those of the neck and face as well) are overstimulated and get out of control by being thrown into a condition of irregular spasm. Stammerers usually have no difficulty in singing, partly owing to the fact that the expiratory blast is stronger and the lips are not used so much as in speaking, and partly because the attention is diverted from the consideration of the possibility of stammering.

For the successful treatment of such cases it is necessary to devote attention to the following points :—

1. Find out which letters give the greatest difficulty, and insist upon continuous practice with words and sentences containing these letters in large numbers. Vowel sounds usually give no difficulty because they are formed mainly in the larynx. The consonants are the difficulty, especially those in connection with which the pharynx plays no part, viz. *P*, *F*, *Th*, *S*, *Sh*, *T*, *K*, *B*, *H*, *Ch*, *D*, *G* (hard), the most difficult of all being the explosives *B*, *P*, *T*, *D*, *K*, *G* (hard).

2. Insist upon the chin being raised and the chest being fully inflated before beginning to speak. All speaking should be performed with a full resonant voice. In bad cases the child may be encouraged to adopt a sing-song or intoning method of speech.

3. In order to assist the acquirement of proper nervous control the child should be encouraged in every way to use the vocal apparatus continually. In many cases mimicry and teasing by other children have made the child lose all its confidence.

SMELL.

The upper part of the cavity of the nose is lined with special epithelium, which contains rod-shaped cells connected with branches of the olfactory nerve. The roof of the nose cavity is formed by a plate of bone which is

perforated by numerous holes, through which pass the branches of the olfactory nerves on their way to the part of the cerebral hemispheres called the olfactory bulb.

During ordinary inspiration through the nose sufficient air passes over this special epithelium for rather strong smells to be detected instantly. To detect faint smells we usually sniff more air into the upper parts of the nose cavity, and then any odoriferous particles in the air will act on the rod-shaped cells, causing impulses to be sent along the olfactory nerves to the brain. Some movement of the air appears to be necessary in order for stimulation to take place, and the air containing the odour must be drawn against the membrane. The process of sniffing increases the speed at which the air travels, and also increases the proportion of the air that travels along the upper parts of the nose cavity.

TOUCH.

In some of the papillae of the dermis there is an oval structure composed mainly of nucleated cells, and called a **tactile corpuscle**. These are connected with a sensory nerve. In addition there are fine fibres of sensory nerves between and in connection with some of the cells in the deeper layers of the epidermis. The skin, together with its papillae, its tactile corpuscles, and its nerve terminations, is the organ of touch. By its means we are enabled to recognise the shape, the hardness, the size, the roughness or smoothness of the various things with which we come in contact.

The sense of touch is most delicate at the tips of the fingers, on the face, and at the tip of the tongue. In other parts of the body, where the epidermis is thicker and sensory nerve-endings less plentiful, it is less delicate. Two points, one-tenth of an inch apart, can be distinguished if applied to the tip of the finger, whereas if applied to other

parts they feel like one point. On the back, where the sense of touch is least developed, two points separated by three inches feel like one.

Sensations of Pain.

Excessive stimulation of, or actual injury to, any sensory nerve gives rise to the sensation of pain. The stimulation may be either by direct impact, or by heat, or electricity. When any part of the skin area is inflamed the area becomes very sensitive, and the slightest touch may give rise to severe pain.

Sensations of Temperature.

In addition to feeling the nature of bodies in contact with the skin, we are also able to determine whether they are hot or cold. The sensation is entirely due to the effect that the bodies have upon the skin. If they are warmer than the skin they feel warm, and *vice versâ*. This is illustrated by the well-known experiment of placing one hand in cold water and the other in hot water, and afterwards dipping both hands into lukewarm water. The hand that had been previously in hot water will send the sensation of cold, while the other, in the same surroundings, will feel warm. The skin is valueless as a judge of actual temperature, because good conductors of heat appear hotter or colder than bad conductors, apart from the fact that the sensation depends on the condition of the skin at the time.

Muscular Sensations.

Sensory nerves from the muscles tell us the condition of the muscles, whether contracted or at rest, and if contracted they inform us as to the degree of contraction. This enables us to judge of the weight of a body placed on the hand, especially if the hand is raised and lowered so as to lift the body up and down.

CHAPTER XII.

THE EYES AND EYESIGHT.

During school life it is important to realise that the body of a child is an organism highly susceptible to the effects of injurious influences. Also that while a child is at school it is surrounded by influences that are more or less injurious to its physical well-being. Most of the parts of the child's body, however, although highly susceptible to injury, have a wonderfully great recuperative power, so that although injury is undoubtedly produced during school hours it is recovered from during the intervals. Some of the organs unfortunately have little of this power of recovery, and the eye is one of these. If the eye of a child is injured by the school conditions there is little possibility of repair. The defect may, of course, be remedied by proper glasses, but these do not repair the mischief. The greatest care should therefore be taken in order to prevent injury to the eyes of school children. Under modern conditions it is a serious thing for the worker to show signs of advancing age, and the wearing of spectacles does not improve a man's chances. At all events no one will deny that it is better to remove the initial causes of eye strain as far as possible rather than to attempt to correct the effects. With regard to children suffering from eye defects it should be remembered that they are not only handicapped in the struggle to keep the

educational pace with children of normal vision, but in many cases suffer from the nervous results of defective vision—headaches, irritability, exhaustion, loss of interest, feebleness of will.

Before describing how eye strain affects the eyes, it is necessary to have an elementary knowledge of the structure of the eye.

STRUCTURE OF THE EYE.

The human eye is often likened to a camera, and, as most people have had to do with photography either in the active or the passive sense, the comparison is a convenient one. The essential parts of a camera are a box to give and maintain the necessary shape to the instrument, a convex lens to produce the picture, and a sensitive plate to receive and record it. In addition to this the box must be blackened inside to prevent reflection of light, and there must be some mechanism for focussing if pictures of objects at varying distances are to be photographed.

Coats.

The eye has three coats or layers—

1. The sclerotic and cornea.
2. The choroid and iris.
3. The retina.

The sclerotic or the white of the eye is a tough, dense, fibrous membrane forming the greater part of the substance of the eyeball. It is the only part of the eye that is capable of resisting any strain, so that if by any chance it stretches or gives way the rest of the structures will at once follow suit. In front it is continued as the cornea, which, being transparent, forms the window of the eye.

The choroid lies internal to the sclerotic, and is a network of blood-vessels. Its inner surface is black in order

to prevent reflection, which would cause confusion of the images. This layer of black pigment is absent in albinoes, who, in consequence, are almost blind in bright daylight. Under the cornea the choroid is represented by a specialised structure called the iris, which is a circular contractile diaphragm. The central hole is called the pupil. Varying proportions and distribution of pigment deposited here give the different colours to different eyes.

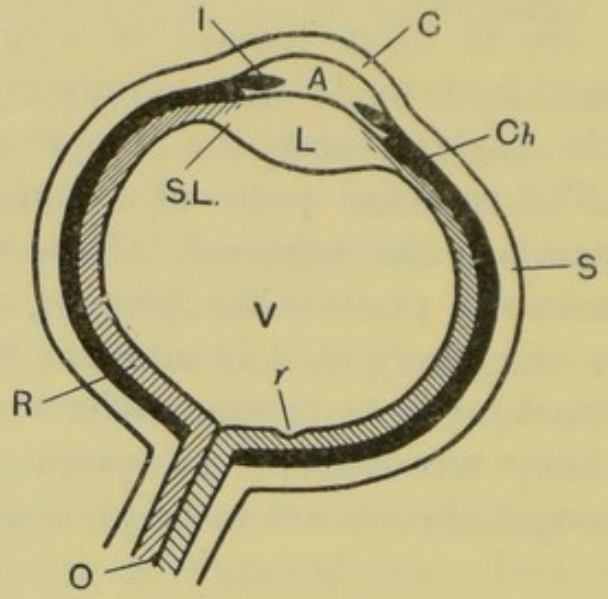


Fig. 115.

DIAGRAMMATIC SECTION OF EYE.

A, Anterior chamber filled with aqueous humour; C, Cornea; Ch, Choroid, I, Iris; L, Crystalline lens; O, Optic nerve; R, Retina; S, Sclerotic; SL, Suspensory ligament; V, Vitreous humour; Y, Yellow spot.

The retina forms the inner coat of the eye, and represents the sensitive plate of a camera. It is extremely delicate and thin, averaging only about $\frac{1}{80}$ inch in thickness. It has a complicated structure, being made up of a vast number of minute bodies, placed together side by side like the squares of a mosaic, and is really an elaborate signalling apparatus for sending signals to the brain referring to the kind of impressions that it is receiving. One spot of the retina, called the yellow spot, differs

from the remainder in its structure. It is the region of most distinct vision—*i.e.* the spot upon which objects are focussed when they must be seen distinctly, as in the case of all special work such as reading, writing, or sewing. The enormous number of tiny nerve fibres from all parts of the retina are collected together at the back into a large trunk or cable called the optic nerve. The messages pass along these fibres to the part of the brain that has to deal with them. This part of the brain is best regarded as a kind of central office for receiving and interpreting these multitudes of messages.

Contents.

The contents of the eyeball are:

1. The aqueous humour.
2. The crystalline lens.
3. The vitreous humour.

The aqueous humour is a watery liquid occupying the chamber between the crystalline lens and the cornea. The crystalline lens is a translucent solid body, composed of soft gelatinous living tissue, situated immediately behind the pupil and partly imbedded in the vitreous humour. It is convex on both sides, but more so behind. In early life it is nearly spherical and soft, but becomes more flattened, firmer, and amber-coloured with advancing age. The lens is held in position by its capsule and suspensory ligament. The vitreous humour is a jelly-like material lying at the back of the lens and occupying about four-fifths of the interior of the globe. The above three substances are transparent, and with the cornea constitute the refractive media of the eye, which conjointly act as a converging lens, the function of which is to bring the rays of light to a focus upon the retina.

Muscles.

Attached to the outside of the eye are six muscles, four straight and two oblique. The four straight muscles

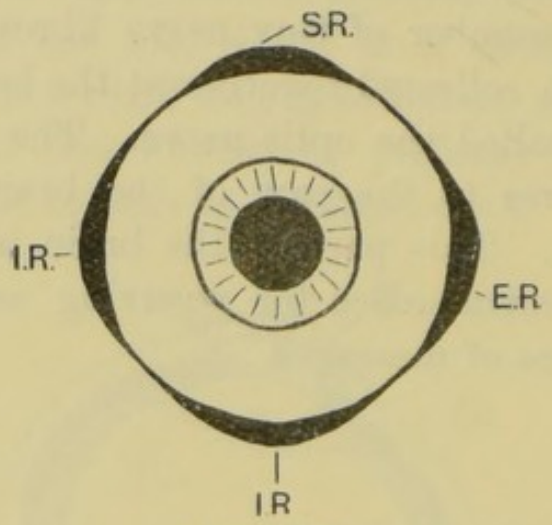


Fig. 116.

INSERTION OF THE STRAIGHT MUSCLES

SR, Superior Rectus; IR (below), Inferior Rectus; ER, External Rectus; IR, Internal Rectus.

are attached symmetrically round the globe, above, below, right, left. These muscles, by their contractions, enable us to direct the eye towards different points. It is obvious that by the single action of one, or the combined action of two, the eye can be turned towards any direction. The two oblique muscles are inserted, slantwise, one above and one below the eye. By their contraction they can rotate the eye on its axis. Their action is best understood if a mark in the iris be watched while the head is moved from side to side. It will be then seen that the eye does not rotate with the head,

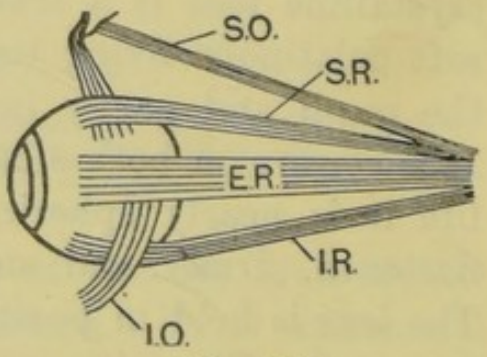


Fig. 117.

MUSCLES OF THE EYE.

SO, Superior Oblique; IO, Inferior Oblique; SR, Superior Rectus; IR, Inferior Rectus; ER, External Rectus.

but keeps its vertical meridian always vertical, during moderate movements of the head, by the contraction of its oblique muscles.

ACCOMMODATION.

If a candle, a convex lens, and a screen are held in line it is easy, by adjusting the distances separating them, to get a clearly defined image of the candle flame upon the screen. The image is then said to be *in focus*. If the candle is moved further away or nearer to the lens the image on the screen will become indistinct and is out of focus. In the same way it is necessary to adjust, or focus, a telescope or field-glass in order that the desired object

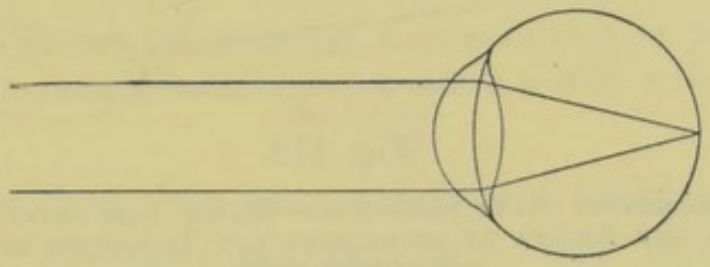


Fig. 118.

NORMAL EYE RECEIVING PARALLEL RAYS (FROM DISTANT OBJECTS) AND BRINGING THEM TO A FOCUS ON THE RETINA.

may be seen clearly. Now we know that the normal eye has the power to direct its attention to a distant object and see it clearly, and then immediately to turn its attention to a near object and see that equally clearly. This is called accommodation. It is accomplished by altering the convexity of the lens. The convexity of the lens is increased by the contraction of a small muscle inside the eye. The more convex the lens the greater the power it has of turning the rays of light out of their original path and causing them to come to a focus. When the eye is looking at distant objects it is receiving light composed of

rays that are practically parallel to each other, and the normal lens is capable of bringing these to a focus on the retina. Rays are practically parallel when springing from a point 20 feet or more distant. From near objects, however, the rays are divergent, and need more turning to bring them to a focus. In order to focus such rays the convexity of the lens is altered to the necessary extent by the contraction of the muscle already referred to. So that when looking at distant objects there is no muscular strain, and hence no fatigue, but looking at near objects involves contraction of the muscles and is liable to bring

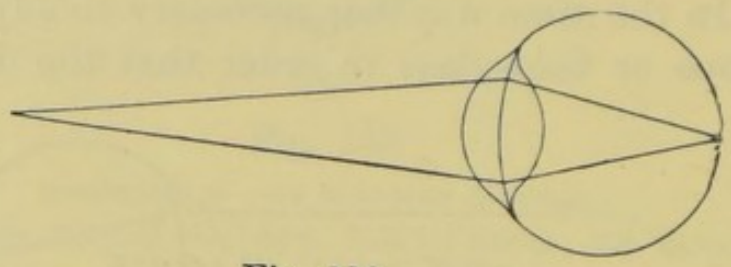


Fig. 119.

NORMAL EYE RECEIVING RAYS FROM NEAR OBJECT AND BRINGING THEM TO A FOCUS ON THE RETINA BY INCREASING THE THICKNESS OF ITS LENS (ACCOMMODATION).

about strain and fatigue. Also when looking at near objects there is necessarily contraction of the external muscles of the eye in order to pull the eyes towards each other, and so that the axis of each eye is directed towards the object to be seen. It therefore follows that the nearer the object is that we look at the greater is the muscular strain inside the eye, the greater the tension on the sclerotic by the muscles pulling outside, and the greater the pressure exerted by the semi-liquid contents of the eyeball. These strains are likely to distort the shape of the eye. Looking at near objects involves muscular effort and exertion, and if unduly prolonged will cause fatigue, a condition which still further increases the tendency towards distortion.

DEFECTIVE EYES.

Short-sighted Eye.

When the strain upon the sclerotic coat becomes too great for it to withstand it stretches. Like all materials it stretches at its weakest part, which happens to be at the back. Stretching in this region will cause the eye to become longer than normal in its axis from front to back.

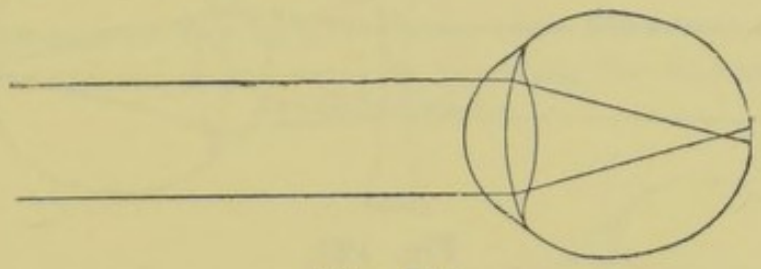


Fig. 120.

SHORT-SIGHTED EYE RECEIVING RAYS FROM DISTANT OBJECT.

These rays are focussed in front of retina and so produce a blurred picture on the retina.

The result will be that when this eye is looking at distant objects, *i.e.* receiving parallel light, the usual amount

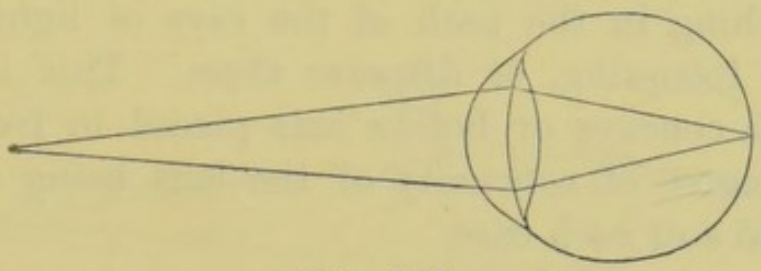


Fig. 121.

SHORT-SIGHTED EYE RECEIVING RAYS FROM NEAR OBJECT.

These rays are accurately focussed on the retina and produce a clear picture.

of focussing will form the image in front of the retina (because the retina is farther back than usual). The picture thrown upon the retina will therefore be blurred and indistinct. But when this eye looks at near objects the light that it receives consists of divergent rays which

require more turning to bring them to a focus, and which therefore tend to come to a focus farther back. The result is that a clear picture is formed on the retina in this case and the eye sees the near objects quite well. Such an eye is therefore called short-sighted (or myopic). It is important to remember that a child is never born

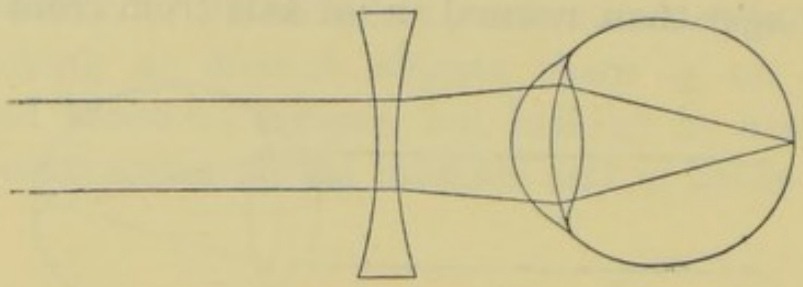


Fig. 122.

SHORT-SIGHTED EYE WITH SUITABLE LENS IN FRONT.

The hollow lens disperses the rays of light before they enter the eye. The eye then brings them to a focus on the retina.

with this elongation of the eye. It is always an acquired defect, and is very rare even at the age of five.

The remedy is fairly obvious. It is only necessary to put something in the path of the rays of light that will delay the focussing, or disperse them. This is brought about by a concave or hollow lens placed in front of the eye, the degree of concavity of the lens being accurately adjusted to suit each case.

Long-sighted Eye.

This is a congenital defect. The eye is developed with its axis from front to back shorter than usual, and the child is born with the eye in this condition. The result is that a picture of a distant object formed in the usual way would be focussed behind the retina, and only a blurred impression would be received. In order to see such a distant object clearly the eye then accommodates and

brings the rays more quickly to a focus, and so produces a clear picture on the retina. But if this eye now turns its

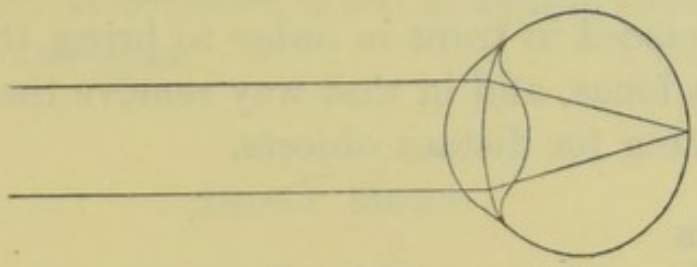


Fig. 123.

LONG-SIGHTED EYE RECEIVING RAYS FROM DISTANT OBJECT.

These rays are focussed on the retina by increasing the thickness of the lens (accommodation).

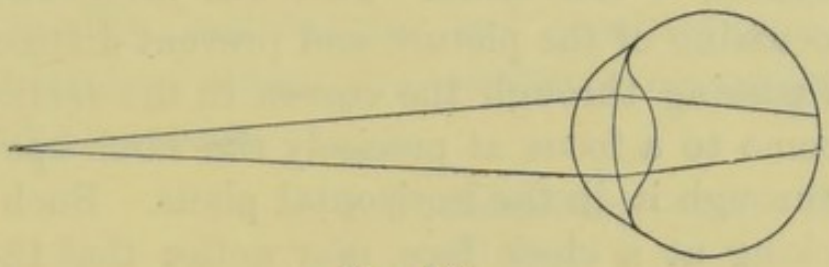


Fig. 124.

LONG-SIGHTED EYE RECEIVING RAYS FROM NEAR OBJECT.

These cannot be focussed on the retina because the eye has already used its power of accommodation.

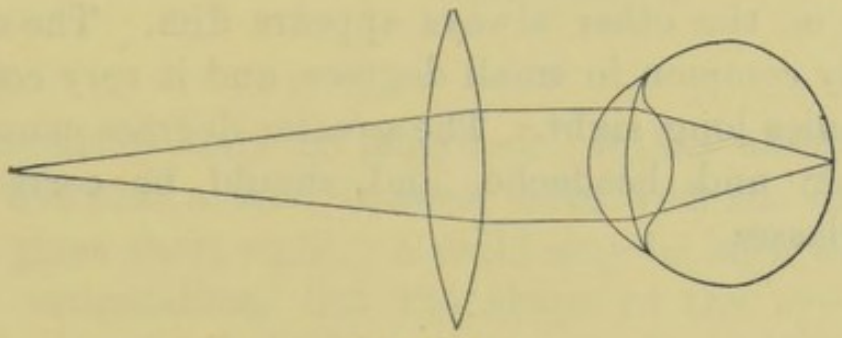


Fig. 125.

LONG-SIGHTED EYE WITH SUITABLE LENS IN FRONT.

This lens assists the lens of the eye to bring the rays to a focus more quickly.

attention to near objects it cannot possibly see them clearly because it has already used its powers of accommodation to view distant ones. The result is that such an eye fails to

see the near objects distinctly, and is therefore called long-sighted.

The remedy is simple. A convex lens (like the one in the eye) is placed in front in order to bring the rays more quickly to a focus, and in that way remove the necessity of accommodating for distant objects.

Astigmatism.

This is another congenital defect. Some children are born with the surface of the cornea unequally convex, the convexity being greater in the vertical meridian than in the horizontal, or *vice versa*. This will interfere with the proper focussing of the picture and prevent distinct vision. The rays passing through the cornea in the vertical plane do not come to a focus at precisely the same spot as rays passing through it in the horizontal plane. Such a child, when looking at a clock face, may notice that the figures XII. and VI. (vertical) are clear and black, while the IX. and III. (horizontal) are dim and grey, or *vice versa*. If a cross is held in front of the child the vertical and the horizontal sticks cannot be focussed at the same time, so that one or the other always appears dim. The defect is extremely common in small degrees, and it very commonly accompanies long sight. The greater degrees cause severe eye strain and headache, and should be corrected by proper glasses.

Squint.

Squint is the term applied when the eyes are not both directed towards the object looked at. One eye may turn inward more than the other, or one eye may turn outward. Occasionally one meets a case where one eye squints at one time and the other at another. The recognition and treatment of these cases is very important, because an eye that

habitually squints from any cause, muscular or nervous, tends to deteriorate and become useless, and may eventually become blind. A common cause of squint is inequality of vision in the two eyes.

SHORT SIGHT.

Short sight is rarely congenital, it is always acquired as the result of certain injurious influences. The causes, like the causes of any disease, are best classified into the predisposing and the determining. The predisposing causes include heredity, malnutrition and constitutional disease. The determining causes are excessive convergence, eye strain, and congestion.

Causes of Short Sight
- Predisposing—
  - Heredity
  - Malnutrition
  - Constitutional Disease
- Determining—
  - Excessive Convergence
  - Congestion

Heredity.

The tendency only is inherited. It has already been pointed out that a child is never born with the elongated eye that gives short sight. A child may be born with long sight or astigmatism, but the shape of the eye of the future short-sighted child is not elongated at birth. But a weak sclerotic may have been inherited from one or both parents, and this will, of course, predispose to short sight. Such a child may grow up with perfectly normal eyes; in fact, if it never went to school it would almost certainly do so, but the chances are in favour of the strains of school life stretching the abnormally weak sclerotic. On the

other hand, although many myopic children have parents who suffer from the same defect, it is usually found that the parents of nearly half the short-sighted children are not themselves myopic. It is a significant fact that myopia usually first begins to become troublesome at the age of eight or nine, *i.e.* when the strain of school conditions have had time to produce the necessary distortion. Myopia once acquired tends to increase if the causes which produce it are allowed to continue.

Malnutrition.

Defective nutrition plays another important part as a predisposing cause of short sight. It is usual to find more defects among weakly and underfed children than among the more healthy and better fed. In these cases the sclerotic simply shares in the general deterioration of tissue, and is less capable of withstanding strain than the normal sclerotic.

Disease.

Constitutional disease may be a factor in any case of myopia. A commonly occurring case is that of a healthy child with normal vision in attendance at school. Some acute illness supervenes, necessitating absence from school for some weeks. The child recovers and returns to school, still with normal vision, but in a comparatively short time the strain of school life has caused the sclerotic to stretch, and the child becomes short-sighted. The previously healthy sclerotic was able to withstand the strain, but when it was suffering, with the other tissues of the body, from the defective nutrition caused by the illness, it could no longer resist the pulling and straining that it received.

Professor Priestley Smith says: "A sound physique, a healthy, vigorous condition of the body generally is antagonistic to the working of almost every morbid process, and even in the case of short sight, the causes of which are mainly local rather than constitutional in their operation, it has a powerful deterrent influence. An ill-nourished, pale, and lax condition of the body lowers the resisting power of the eye, as of every other organ; an impaired physique brings with it, among other evils, an impaired resistance to the active causes of short sight."

Eye Strain or Excessive Convergence.

It has already been pointed out that when the eye is looking at objects 20 feet or more away it is at rest, and no muscular effort is required. On the other hand, in looking at a near object, the eyes assume a position of convergence. Each eye is pulled towards the other by the muscle which is attached to its inner side. The nearer the object the greater the pulling required. The object of convergence is to bring the yellow spot of each retina to bear on the same point. This pull puts the sclerotic coat on the stretch, and is the direct mechanical cause leading to the production of short sight. If the twenty-first year, or perhaps to be quite safe it should be the twenty-fifth year, is reached without any stretching of the sclerotic coat it is extremely unlikely that short sight will ever be developed. By that age the coat is sufficiently tough to resist all ordinary strain.

It has been proved beyond all doubt that our educational methods are chiefly to blame for the production of short sight. Dr. Seggel, for instance, examined the eyes of 1600 soldiers, and divided the men into classes according to their previous histories.

Previous History.	Percentage of Short-sighted Men.
Countrymen, educated in village schools ...	2
Labourers, porters, etc., from towns	4
Artisans	9
Tradesmen, clerks, compositors	44
University students	58—65

Another observer, Dr. Cohn, as the result of extensive and laborious investigations, found that short sight was present in one per cent. of the children in village schools, in six per cent. of elementary town schools, and rose to twenty-six per cent. in the advanced schools. Statistics also tend to prove conclusively that the proportion of children suffering from myopia steadily increases from the lower to the upper classes in schools. Among children between seven and nine years of age about two or three per cent. are short-sighted, while among those between ten and eleven years about eight per cent., and of those between twelve and thirteen years about fifteen per cent. Dr. Kerr, on examining infants, found that fifteen per cent. of seven-year-old children had a moderate deficiency of vision, and four-and-a-half per cent. had bad vision. At the age of eight these numbers had increased to sixteen and seven respectively. The chief factors in the production of eye strain are fine work, bad light, improper attitudes, bad methods of writing, and small and indistinct type.

Small print, fine stitches, small writing, and all such work should be regarded as unnecessary torture for children. Nothing could possibly have been devised to do more harm than the needlework that is usually taught infants. It is undoubtedly the cause of the excess of short sight among girls. Mr. Priestley Smith found myopia in $7\frac{1}{2}$ per cent. of the girls and $4\frac{1}{2}$ per cent. of the boys he examined.

Type.

For school books a plain legible type of the proper size should be used. For children under seven years old there should be no smaller type than English, and larger type is preferable, while for older children the best type is Pica.

[English.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns

[Pica.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns

[Small Pica.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to

[Long Primer.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to think themselves

[Bourgeois.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to think themselves excused. He now reprinted

Clearness and spacing are quite as important as size. All type in school books should be leaded. The great effect of this in increasing legibility is shown by the following examples :—

[Solid Type.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to

[Thin Leaded Type.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures ; a duty, from which he warns the busy part of mankind not to

[Double Leaded Type.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures ; a duty, from which he warns the busy part of mankind not to

The intervals between words should be not less than double the width of a single letter, and for beginners it is an advantage to have still greater intervals.

The length of the line of print is also important. The shorter the line the less fatigue it produces, because the eyes have to be moved less. The maximum length of line should be from 3 to $3\frac{1}{2}$ inches, and no double column arrangement should be allowed. The printer's habit of splitting a word at the end of a line is trying to the eye.

and should not be allowed in school books. It is a further advantage for the page to be well broken up into sections and paragraphs.

The kind of paper must be considered. It should be opaque and sufficiently stout to prevent the print on the other side showing through. In fact there should be no indication whatever that there is printed matter on the other side of the paper. The surface must be dull and smooth, and the best colour is a faint neutral cream or grey.

The colour of the ink, both for writing and printing. should be jet black. The question of handwriting has already been discussed, but it should be noted here that children under seven years of age should not be expected to write letters less than half an inch in height.

There is undoubtedly far too much reading and writing inflicted upon young children. All fine work should be avoided, if it is desired that the child should grow up uninjured by its educational experience. Map-reading and map-drawing are common tortures for the eyes, most of the print and writing thereon being necessarily very small. Most maps present a mass of bewildering detail that no young child should be expected to decipher. The sprawling of the names of districts and provinces among the names of the towns, the shading which is intended to represent mountains, and the winding in and out of the rivers unite to produce utter confusion. Small maps should be abolished, and large wall maps and those drawn on blackboards, by teacher or scholars, substituted.

Congestion.

Congestion, or overfilling of the small blood vessels in the neighbourhood of the eye, is an active cause of the stretching that brings about short sight. It is produced

by many of the conditions common to school life. Bending, either due to bad desks, bad light, or very fine work, or a combination of two or more of such common conditions, quickly causes congestion in these regions. In girls' classes it is often brought about rapidly by tight collars, while a cause which is common to all the standards, but particularly infants, is mental fatigue.

Signs of Short Sight.

The signs of short sight are very obvious when the deficiency is pronounced, but only very careful testing will detect it at the early stages. The pronounced signs are that the child holds its work close to the eyes, and can read easily from a book held near, but makes mistakes when copying work from a diagram or from the blackboard at a distance. The child often acquires a habit of peering, and knitting its brows. Headache and pain are also common indications of eye trouble.

Signs of Long Sight.

Long sight usually does not give rise to such obvious symptoms as short sight. These eyes can distinguish distant objects with ease, and often manage nearer ones if the effort is not prolonged. Such a child in a reading lesson will read accurately for a few lines, then stop or make a mistake, and when questioned as to the cause will complain that "the letters are dancing about." The continued effort at exaggerated accommodation has exhausted the muscles and they refuse to maintain the strain. After a short rest, or a rub, the task can be resumed. Headache, blinking, red and watery eyes are other signs and symptoms of this defect.

Treatment of Eye Defects.

In the majority of cases it will be found that the defective vision can be improved by the proper glasses. The eye is then relieved from much of its strain, and the deficiency may not increase. On the other hand, there could be no greater mistake than to suppose that every child with defective vision requires glasses. A few will regain normal vision in a few years, without glasses, if the eyes are relieved from the strain of fine work. There are considerable numbers of children attending school whose vision is bad and whom glasses will not help. The only way to treat such children is to apply to them a considerable modification of our educational system. Special provision is made for the blind already, but these children are much more worth educating than the blind, and yet are being severely injured by the ordinary school education.

It should be clearly understood that myopia in children, even though not severe at the time, must be regarded as a serious condition, inasmuch as it not only tends to increase in severity, but it also may cause disease of the eye which diminishes the acuteness of vision and may lead to blindness.

To Prevent Injury to Eyes at School.

To sum up, we may say that the essential points to be observed in order to prevent injury to the eyes of school children are :—

1. The room must be well lighted in every part. No room should be deemed satisfactory by a casual inspection. The light ought to be actually tested in those places farthest away from the windows. A simple test that has

been suggested is that a scholar should be able to read at 12 inches distance, and without strain, diamond type. For example :—

In fact, the occasion had brought to light one of the many contradictions in the Roman constitution. On the one hand Cicero, as commissioned to use the dictatorial powers, was within his rights in executing the prisoners; on the other, it was contrary to law to assail the life of any citizen without the sanction of the people. Cicero was at once right and wrong, and moreover, apart from the mere question of legality, the crisis was grave enough—if all was true that Cicero's informants alleged to be the facts—to condone stern measures; but unfortunately it came at the very time when

2. The direction of the light should be from the left if possible. At all events there must be no window or any source of light in front of the children.

3. No unreasonably fine objects should be used. Everything that the children use should be easily distinguished.

4. There should be no stooping over the work.

5. The work must not be held nearer to the eyes than 12 inches.

6. This is the most important rule of all. No child under seven years old should read ordinary book print, nor write ordinary small handwriting, nor should do any sewing whatever. Until this fundamental principle is observed in every school in the country there will continue to be unnecessary damage done to children's eyes.

TESTING OF EYESIGHT.

The usual test type is that for use at 20 feet distance. Under each line of type is a number signifying the distance in feet that the type should be legible to the normal eye. The largest type is usually numbered 200 feet, and the others range down 100, 70, 50, 40, 30, and the smallest 20 feet.

The child should stand, facing the type, at a distance of 20 feet from it. He then reads the letters row by row, beginning at the top. If all the letters are read correctly from top to bottom the child is passed as normal. As a matter of fact a child's vision should be better than what is called "normal." The method of recording results is usually to express them as fractions, all having a common numerator, 20, and having as denominator the figure representing the

U T P V O

20 TYPE.

O L T B

40 TYPE.

distance at which a normal eye could read the smallest letters that were correctly read by the child in question. The normal child would thus be recorded $\frac{20}{20}$. Another child might make a mistake with the "30 feet type," so that the smallest type that he has read correctly is the "40 feet type." His vision, recorded as $\frac{20}{40}$. Some test cards record the distances in metres, the 20 feet type being represented by 6 metres. This causes all the numerators to become 6 instead of 20.

It is, however, desirable that teachers should devote themselves solely to detecting children with eyes below the normal, without trying to determine the exact degree of deficiency. For this purpose the writer (in consultation with Dr. J. R. Kaye, County Medical Officer) drew up the following rules for use in the schools of the West Riding of Yorkshire.

WEST RIDING COUNTY COUNCIL.

SIGHT-TESTING OF SCHOOL CHILDREN.

General Scheme.

It is considered advisable that the teacher should roughly divide the children into three chief classes:—

A. Normal Vision.—Those children who can easily read "20 type" at 20 feet.

B. Moderate Deficiency.—Those children who fail to read "20 type" correctly at 20 feet, but can read "40 type" at 20 feet.

C. More Serious Defects.—Those children who fail to read "20 type" *and* "40 type" at 20 feet.

Directions for Testing.

The Type.—Several selections of "20 type" and "40 type" are provided in order that the children may not acquire any degree of familiarity with the letters and their order. The letters should be hung in a good light, but *not* in direct sunlight, five feet from the floor.

The Scholar.—The child should stand, facing the type, at a distance of 20 feet. No window or any source of light

should be opposite the scholar. Any straining or guessing should be prevented as far as possible.

Method.—All the Scholars are first tested with the "40 type." Those who fail with this test constitute Class C. The *others* are submitted to the test with "20 type" which will serve to divide them into groups A and B. (If time allows, group C may also be tested with the "20 type.")

A Register should be previously prepared with the names and columns ruled as follows:—

Name.	Stand-ard.	(1) Date.	(2) 40 Type.	(3) 20 Type.	(4) Class of Vision.	Remarks.
Jones, John ..			+	+	A	
Robinson, Mary			—		C	
Smith, Thos. ..			+	—	B	

The Register should contain at least four sets of the columns marked 1 to 4, so as to hold the results of four consecutive examinations.

Each child's sight should be tested as soon after entering the school as possible, and twice a year after.

Children Requiring Attention.

Short of actual testing of the eyesight the following list may prove useful in helping the teacher to select suitable cases requiring the attention of the Medical Officer:—

1. All those with sore eyes.
2. All those whose eyes are congested and red.

3. All those who peer and blink when they wish to see anything particularly well.

4. All those who appear to be in difficulty when they are reading from map or diagram or blackboard.

5. All those who complain of headache, or who appear to fear a bright light.

6. All those who turn the head sideways or slanting in order to read.

7. All those who hold the book nearer than one foot when reading. Also those who hold the book at arm's length.

8. All those who squint constantly or occasionally.

CHAPTER XIII.

POSTURES. PHYSICAL EXERCISES.

POSTURES.

Bad positions in writing, drawing, reading, and standing, or sitting on a simple form, are prominent causes of deformity. Twisted spinal columns, malformations in chest, injured eyes, stooping habits, and shuffling gait,

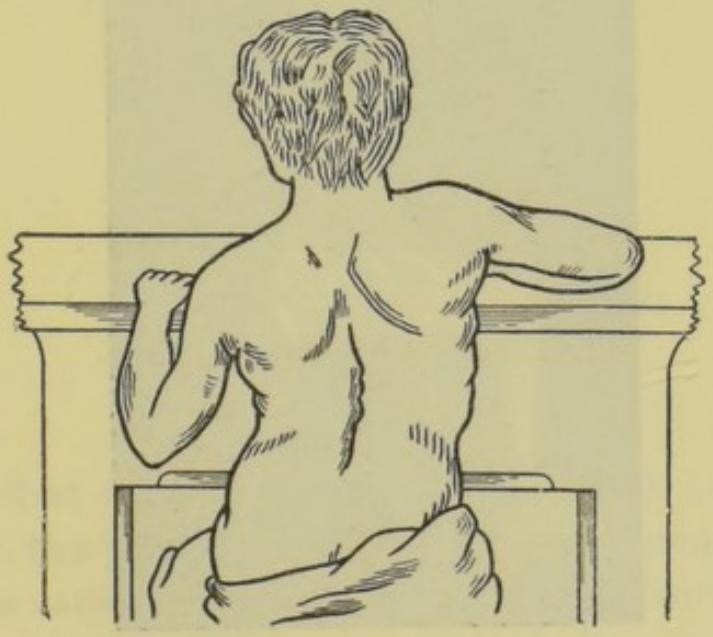


Fig. 126.

with many kinds of bodily ailments, follow a want of knowledge upon these subjects. Fig. 126 illustrates a kind of injurious position which is very common.

The division of postures into four chief classes is convenient, namely the respective positions for reading, writing, receiving instruction, and standing. They might also be divided into (1) correct postures, (2) those caused by bad desks, and (3) those which are simply due to lack of training and proper and intelligent supervision, such as the injurious postures assumed by children owing to inactivity from long confinement.

1. FOR RECEIVING INSTRUCTION.

The ideal sitting posture is the one in which the pupil's body is symmetrically placed and which economises mus-



Fig. 127.

CORRECT POSITION. VERY TIRING IF NO SUPPORT TO THE BACK.

cular effort. In such a position the pelvis rests equally on the seat of the desk, the spinal column is erect and

shows clearly its normal four curves, the head is so poised as to afford relief to the muscles in front and at the back of the neck, the arms balance, and the hands rest upon the thighs, which are horizontal. It is best described as a position of balance, in which the force of gravity largely replaces muscular exertion. It is not one which can be maintained, however, for longer periods than a few minutes unless some support is given to the back and the support to the feet is at the correct level, which is an indirect way



Fig. 128.

Position involving Twist of Spine.

of saying that the height of the seat must be accurately adjusted to the physical needs of each and every scholar.

Positions causing any twist of the spinal column, such as is illustrated in Fig. 128 are very injurious. Here the vertebral column is twisted through 45°, the effect of which is to overstretch some of the ligaments connecting the vertebrae, as well as to put undue pressure and strain upon some of the bony parts.

2. FOR READING.

Faulty positions for reading are potent causes of short sight. Children are allowed and encouraged to read small print at far too early an age, the result being that the eye becomes strained and permanently injured. The greatest possible care and attention is necessary in order to prevent modern educational methods from producing such disastrous results. Reading and writing are liable to be exceedingly

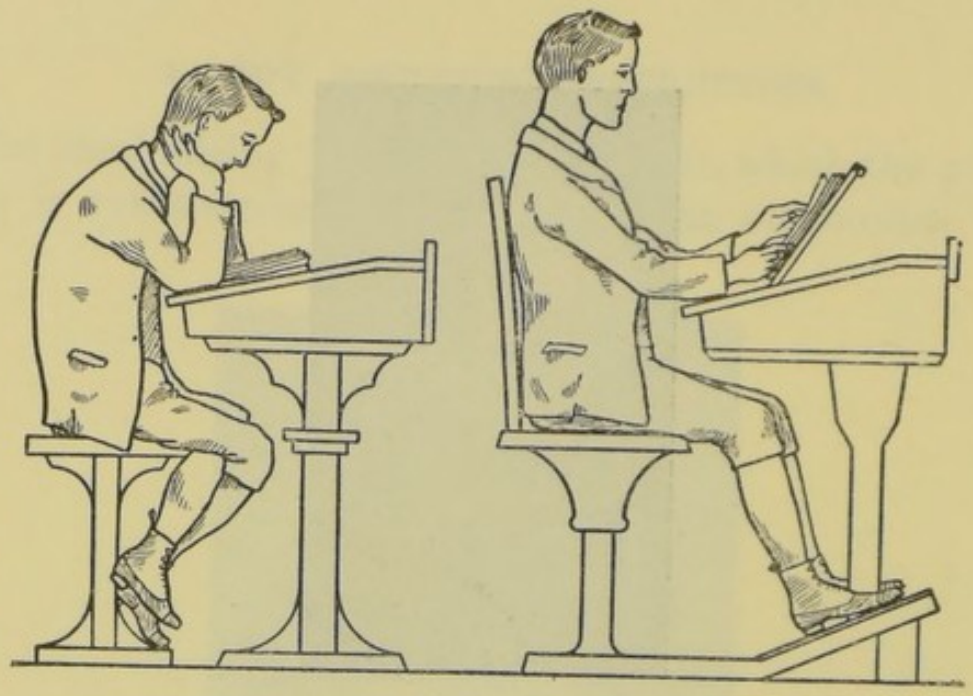


Fig. 129. Fig. 130.

injurious to children under ten. Short sight is rare among people who have not received the present-day "book education," but have been reared among healthy surroundings and have spent a large proportion of their life out of doors. On the other hand the studious individual, and one who has won distinctions at school and college, usually is compelled to rely upon spectacles in order to obtain normal vision. A great deal of this injury received during early education is preventable and should be prevented, but it

will probably continue to exist as long as a university degree or diploma is considered of greater importance to a teacher than a thorough grasp of anatomy, physiology, and hygiene so far as they apply to school life. Such knowledge is of vital importance, and yet it is only acquired by an odd teacher here and there who makes this subject his or her hobby.

It is an undoubted fact that modern life makes great demands upon our eyes, so that it is a national duty to protect the eyes from damage during the early years. The eyes of a child readily give way under strain, and permanent injury is easily produced. It is nothing short of criminal to set a class of children any task that imposes strain on their eyes, and it should be one of the first duties of a teacher to protect his or her scholars from this kind of physical deterioration. Instead of this, it may be said without any exaggeration that school life impairs the eye-sight of more than fifty per cent. of the scholars.

When reading the pupil must sit erect, and the eyes must be at least 12 inches away from the book. When it is held nearer the eyes than this short sight or myopia is likely to be produced. For easy reading the printed matter should be held at an angle of 45° to the horizontal, and not too much below the level of the eyes, if the head is to be kept comfortably in a good posture. The eyes become fatigued much sooner if they are directed upwards or horizontally.

A position often assumed by children is shown by Fig. 131. Here the chest is contracted and respiration becomes shallow. The shoulder-blades are widely separated and, instead of lying evenly upon the ribs, their posterior borders are thrust outwards. The dorsal curve of the spinal column is increased, while the lumbar curve is reversed. An increase in the obliquity of the ribs is also produced, resulting in a

further reduction in the capacity of the chest. Added to this the anterior abdominal wall becomes folded, and the contents of the abdomen are unduly pressed upon. The greater part of the weight of the head has to be borne by the muscles at the back of the neck, and these, in common with many of the back muscles, become weakened and stretched. A frequent cause of this posture is unduly long periods of confinement.



Fig. 131.

Injurious Position.

Another position often assumed by children who have been kept sitting too long is shown in Fig. 132 where the child has slipped forward upon his seat, and nearly the whole of the body weight falls upon the sacrum, coccyx, and shoulder-blades. It is said that prolonged inactivity at the hip joint is the chief factor in causing a scholar to assume this position. Adults are often seen to adopt this posture as affording a relief after prolonged sitting. Such

a position is undoubtedly injurious for children. With the head dropped forward and the chest contracted there can only be inefficient breathing. A decrease in the amount of oxygen inhaled causes an immediate diminution in the vitality and mental activity, so that any position which hampers free expansion of the lungs is to be condemned. The muscles at the back of the neck become tired and

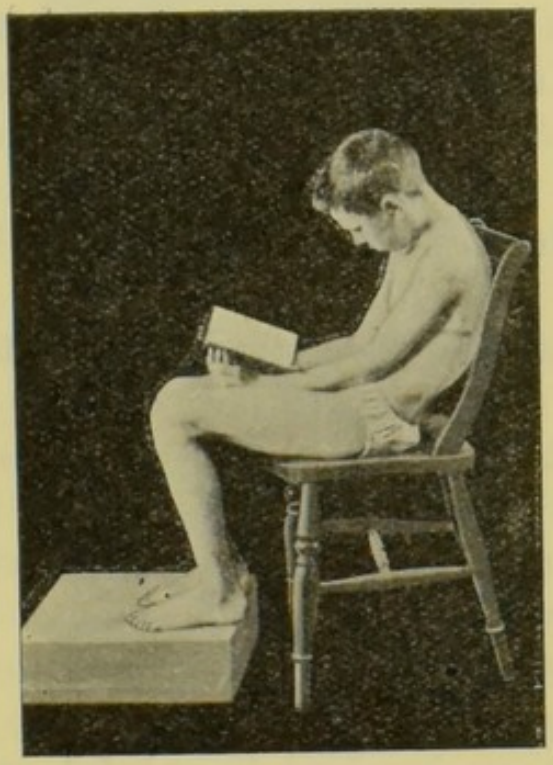


Fig. 132.

INJURIOUS POSITION.

stretched, and the child acquires a stooping and drooping habit. The proper shape of the body is further distorted by the reversal of the cervical and lumbar curves of the spine, thereby reducing the four natural curves to one long one. This again causes undue stretching of ligaments and muscles.

The flattened chest, contracted shoulder girdle, and stooping head are constantly seen in practically every

school. Such postures cause short sight, interfere with respiration and general thoracic development, and throw unnecessary labour upon the heart. The abdominal organs are compressed and forced into unnatural positions, and the production of round shoulders, curved spine, and drooping head is also the effect of such postures.

3. FOR WRITING.

Bad positions for writing are universal still and are the common causes of spinal curvature. The curve thus produced has its convexity to the right, and is produced largely by the fact that the right arm and hand are supported by the desk, while the left arm hangs idle and unsupported.

It is not yet clearly understood that writing is a severe trial to a child. It is easy for a teacher to set a copy and to tell children to imitate it, but he or she is apt to forget that writing is an act which involves a complicated coordination of muscular movement. The child is not yet able to use a few muscles at a time—his tendency is to use groups of muscles together—but writing involves the use of a few muscles from several groups. The result is that he finds the labour involved is painful and very tiring: he uses more muscles than are necessary, and, in order to balance the undesired effect of the unnecessary ones, he brings into use still more of them. The effect of this is to produce an unnatural strain and rigidity of most of the muscles, especially those in the hand and arm, followed by a desire to constantly alter the posture of the body in the vain effort to release the tension and fatigue so produced Writing is an extremely complicated and special act. It not only involves careful control over those muscles which are required for such fine and exact movements, but also inhibition of many muscles which, for other actions, are

accustomed to act in unison with them. This fact should be properly appreciated by all teachers. Many of the injurious postures assumed by children while writing are the direct result of an attempt, on their part, to release the tension and fatigue produced by so complicated an act.

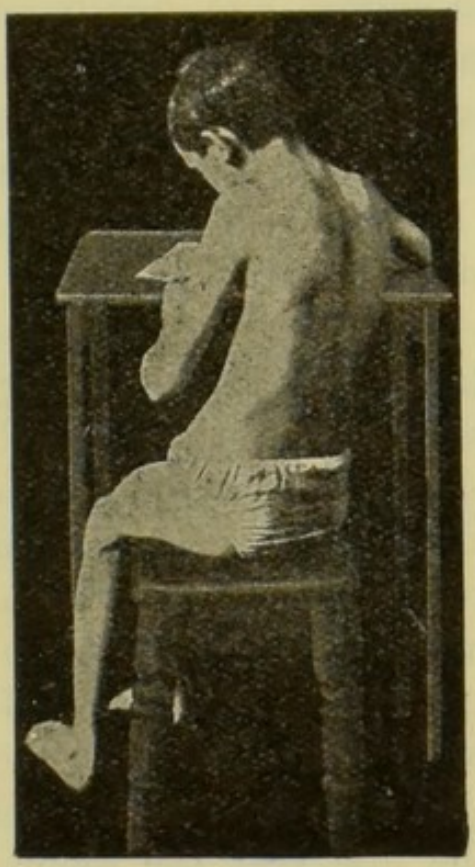


Fig. 133.

COMMON POSITION FOR WRITING. SPINE CURVED WITH CONVEXITY TO RIGHT.

Many of the undesirable results can be prevented by proper attention to the following points :—

1. The method of writing for beginners.
2. The style of writing.
3. The manner of holding the pen.
4. The use of the left hand.
5. The position for writing.

All these points are so closely connected with the subject of posture that it will be best to discuss them forthwith.

Writing for Beginners.

Children should practise strokes, curves, and letter forms upon a blackboard, using crayons, for the first twelve months. Strokes at different angles should first be tried, then simple curves, and finally letter forms. The child should be allowed to draw the letter as large or as small as he desires. Many children succeed best when they first write a letter about 6 inches in height, and smaller sizes should not be practised until considerable facility has been acquired in drawing letters of the chosen size. Ultimately letters of 2 inches in height should be written by first year scholars. By starting under such conditions the child is relieved of part of the strain that is inseparable from writing upon paper at a desk. While he is standing at the blackboard he is using many more muscles than when sitting; thereby removing a common cause of fatigue. Also the movements are coarser and more free, and he can move along as he writes. Further relief from strain and fatigue is afforded by the more convenient position of a blackboard compared with the top of a desk.

At the end of the first year the scholar may commence writing on paper at a desk. Pens and pencils, however, should not yet be introduced: it is best to begin with black smooth crayon. Writing and drawing with these crayons should occupy the second year, or the greater part of it. The use of the pencil should be introduced afterwards, as this involves the additional strain of fixed attention upon a moving point, as well as the production of much finer lines. Lastly the pen should be used, but coarse pens are best at first.

No movements of the fingers should be expected or allowed for several years. The whole arm in motion should produce the necessary shapes, and freedom and ease of

movement are the ideals to be aimed at. These, together with precision, are sufficient to occupy six or seven years.

The Style of Writing.

The choice of the proper style of writing is important because the common injurious postures are connected, to some extent, with certain fashions of letter formation. It is convenient to divide the various scripts into the slanting, the intermediate, and the upright or vertical varieties.

Slanting Style.

In the slanting writing the letters have a slope of about 52°. In order that a proper view of the line to be followed by the writing may be obtained, it is necessary to place the paper to the right of the body and in an oblique position, so that the top and bottom of the paper are not parallel with the top and bottom of the desk. The head is also bent towards the left for the same purpose. Another explanation is that the eye more readily follows vertical strokes than slanting ones, and by these manœuvres the strokes which are slanting to the line on the paper are thereby made almost vertical to the eye. An additional reason is that by the usual method of holding it the fingers would obscure the tip of the pen altogether if the paper were placed squarely in front of the body.

The result is that the right shoulder is raised, the spine is curved to the left, the eyes are at unequal distances from the writing, and there is additional muscular and nervous strain caused by the fact that the child is working up hill.

The Intermediate Style.

In this script the letters have a slant of 75°. From a physiological point of view this is a great advance upon the

slanting style, and has met with much favour in business circles. Unfortunately it possesses practically all the disadvantages, modified in extent, which have been mentioned in connection with the slanting script.

The Vertical Style.

This is the only possible style of writing if the child is to sit in a proper position. It has the following characteristics:—

(*a*) Vertical down strokes.
(*b*) Short loops.
(*c*) Round letters.
(*d*) It is the only writing possible in a correct position.

In its favour may be urged many points, the chief of which are: (1) That it is more legible than the slanting style, and so does not strain the eyes so much. (2) It is more easily learned by children. When children begin to write they usually make vertical strokes, and have to be taught, with difficulty, to acquire a slant. (3) The writing point is at equal distances from the two eyes, so that eye strain is again relieved. (4) It can be used by the pupil sitting squarely in the desk, upright, and with the paper parallel with the edges of the top of the desk.

Holding the Pen.

The old-fashioned way of holding the pen is shown in Fig. 134. If it is held in this manner it is impossible to write upon paper set squarely in front of the body, because the fingers altogether hide the tip of the pen. The result is that the improper conditions already alluded to are

assumed. Moreover this way of holding the pen is difficult for children to acquire, and is very fatiguing, partly owing to the fact that in this position the radius and the ulna are crossed.

For vertical writing a considerable amount of individual freedom may be allowed the children, but the usual position is with the hand resting on its ulnar side, *i.e.* on the little finger and the side of the hand, so that the palm of the hand can be seen, while the penholder lies nearly in

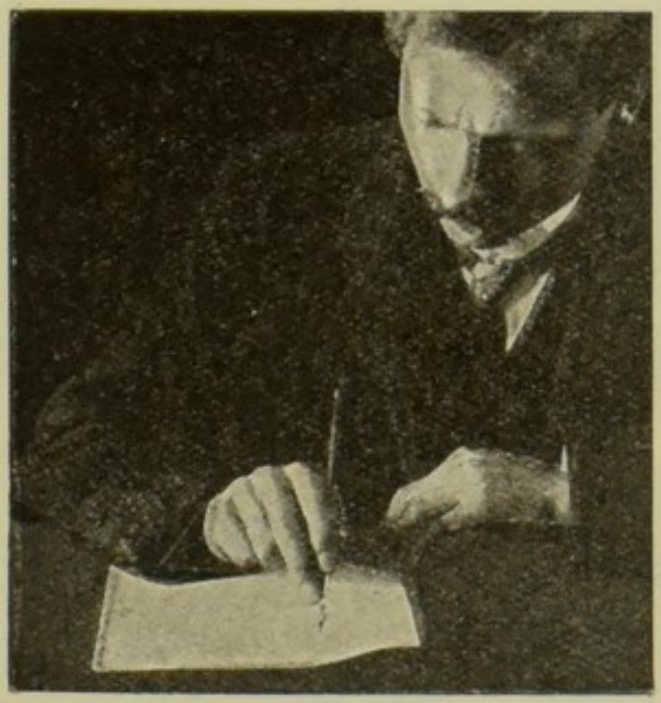


Fig. 134.

Old-fashioned Way of Holding Pen.

the depression between the index finger and the thumb, and points in a direction quite outside the right shoulder. When the hand is in this position the radius and ulna lie practically parallel, and no muscular effort is required to hold them so. The hand moves along on the outer side of the little finger, and the ulnar side of the hand.

The Left Hand.

In the ordinary slanting method of writing, with the pen held in the old-fashioned way, there is little for the left hand to do. The left hand and arm are left practically idle. As a result the left hand tends to be drawn towards the

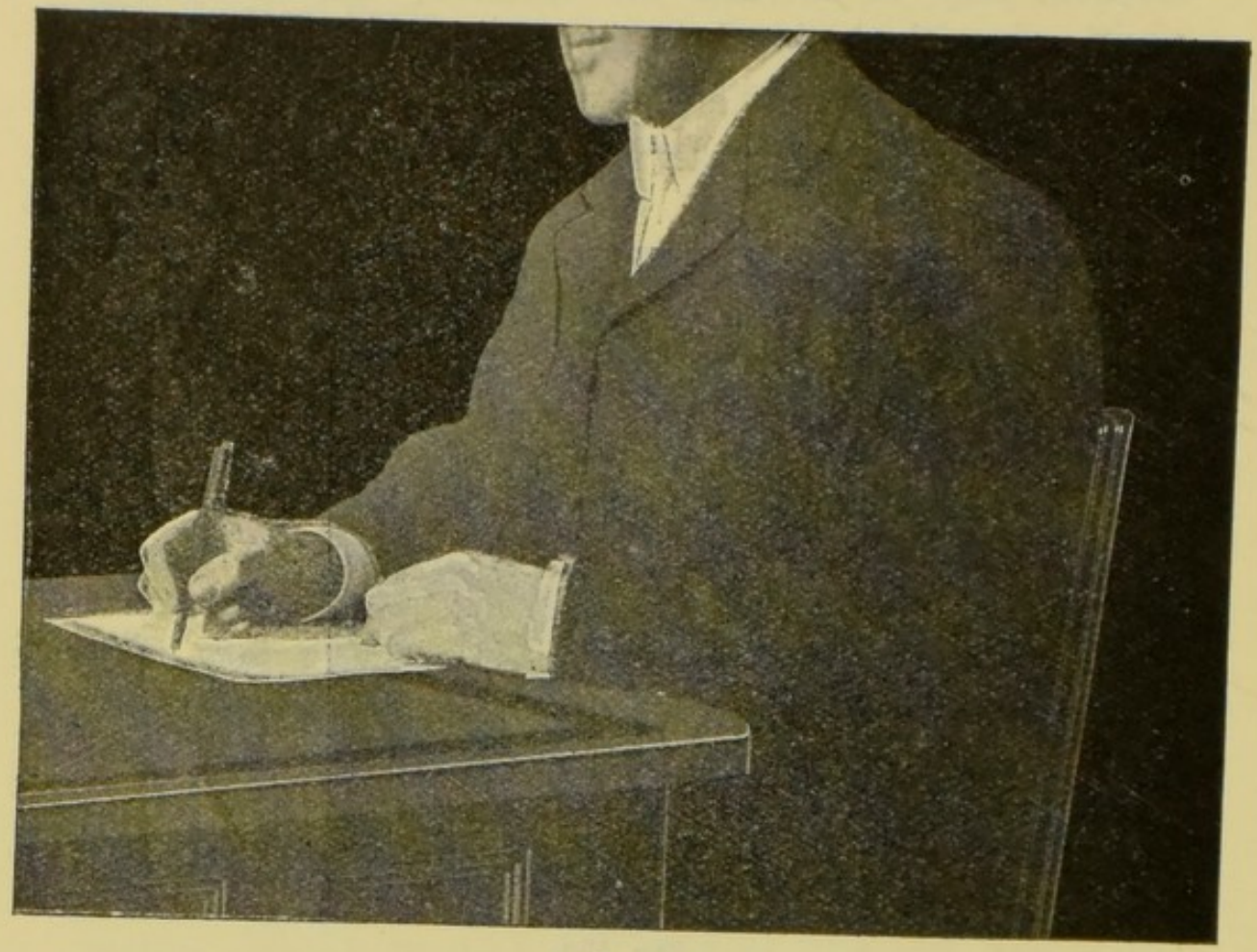


Fig. 135.

PROPER WAY OF HOLDING PEN.

Note position of hands and pose of shoulders.

side, the head is bent to the left, and a position of exaggerated lateral curvature of the spine is assumed. Exercises for the left hand often afford great relief to the child, especially while in the early stages of learning to write. Writing exercises with the left hand will often

cause a child to advance much more rapidly with its right-hand writing. While writing with the right hand the left should hold the paper on the desk. In order to give the left hand more active employment while learning to write it has been suggested that strips of paper 5 to 6 inches wide and 2 to 3 feet long should be used. The left hand is



Fig. 136.

Good Position in Zero Desk.

This position is tiring because there is no support for the back.

then constantly employed in moving the paper along so as to keep the writing directly in front.

The Position for Writing.

The paper should be placed directly in front of the child, with its edges parallel to the edges of the desk. It should

not exceed $5\frac{1}{2}$ inches in width. The pupil sits squarely in front; the forearms placed equally on the desk; and the elbows at equal distances (about a hand's-breadth) from the sides. The feet should rest fully on the floor, and the top of the desk be drawn to a minus distance of about 3 inches. The desk of course must be adapted to the height of the child, or it will be impossible for such a position to be easily assumed.

4. FOR STANDING.

The position for standing should be modified according to the length of time that the child is kept in that position. For short periods the best position is shown in Fig. 137, where the heels are placed slightly apart and opposite each other, the weight being equally divided between the two legs. The whole body is symmetrically placed. The weight should be thrown slightly on the balls of the feet, the hips drawn back, the lumbar curve of the vertebral column accentuated, the head held well back with the chin drawn in, and the chest thrown forward. Unfortunately such an ideal position cannot be maintained for long periods, because both legs are kept under the same tension and both get tired together. In order to obtain muscular relief and change, the child often adopts the injurious position shown in Fig. 138. For longer periods the best position is shown in Figs. 139 and 140. Here the trunk of the body is in the same position as in Fig. 137, but one foot is in advance of the other. The weight of the body is carried by the posterior leg, the knee of which is held rigid, while the muscles of the other leg are relaxed and at rest. The position is varied from time to time by placing the other foot in advance, and bringing the weight of the body upon the leg that has been rested. This position should not be exaggerated as shown in Fig. 141.

General Rules about Postures.

As a general rule girls are more liable to assume injurious postures than boys, and the results are also much more serious. Sitting with the knees crossed should not

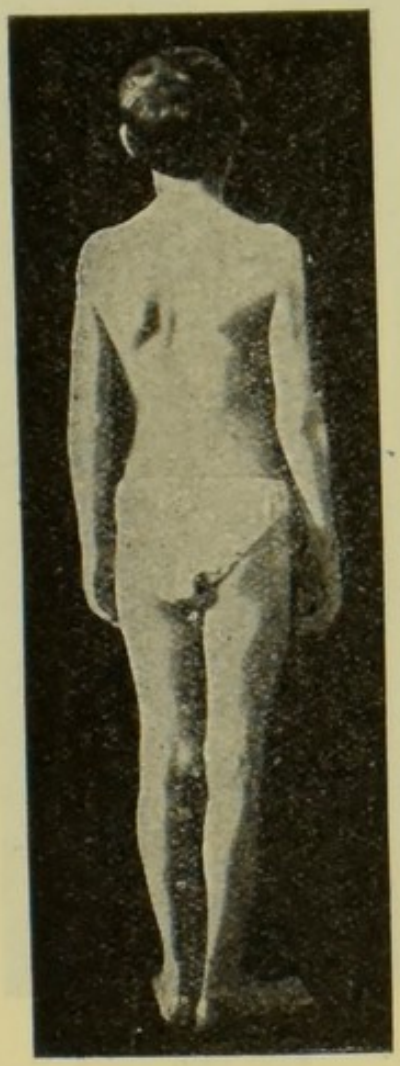


Fig. 137.
Position for Standing for Short Periods.

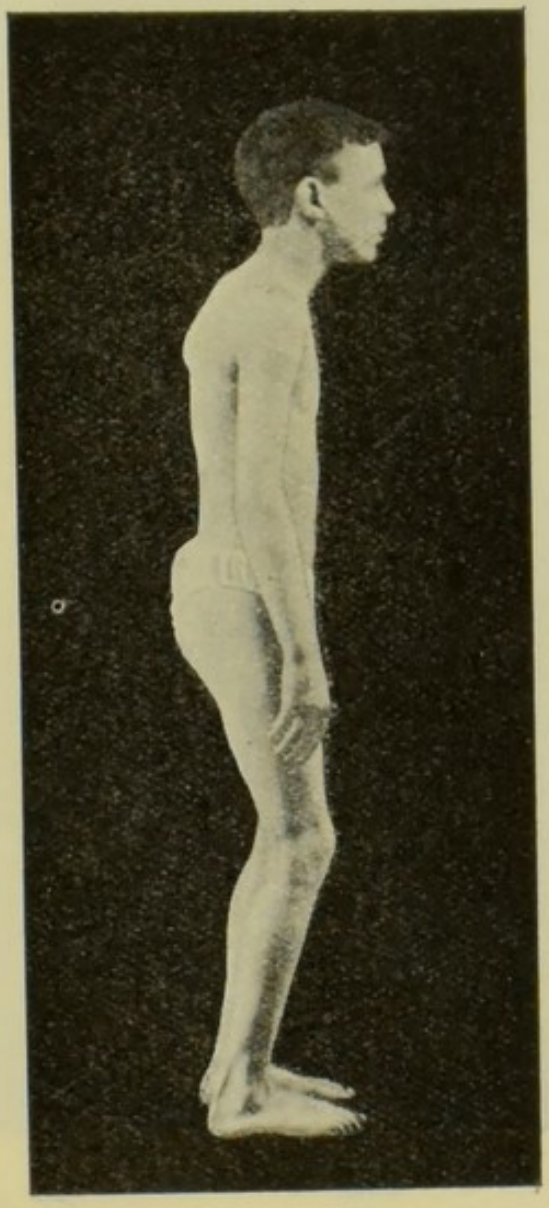


Fig. 138.
Common Position assumed by Children.

be allowed, because of possible distortion of the pelvis. The practice of carrying a load of books in a satchel propped upon one hip is also bad, because it tends to pull down

one shoulder, curve the spine, and injuriously strain the pelvis. A common injurious position at home is shown in Fig. 142.

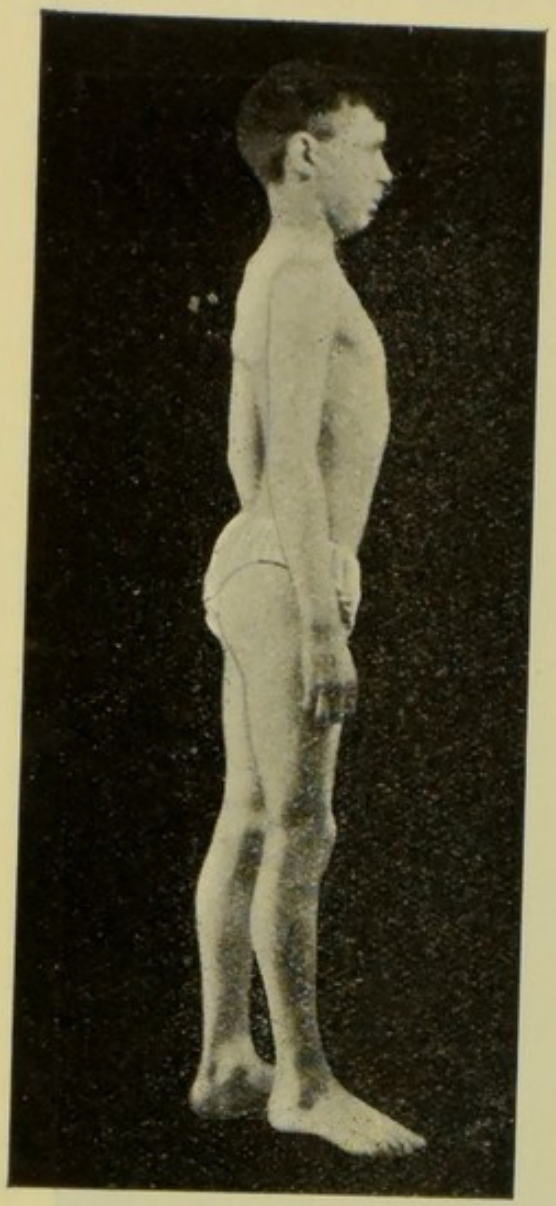


Fig. 139.

POSITION FOR LONGER STANDING. (Side View.)

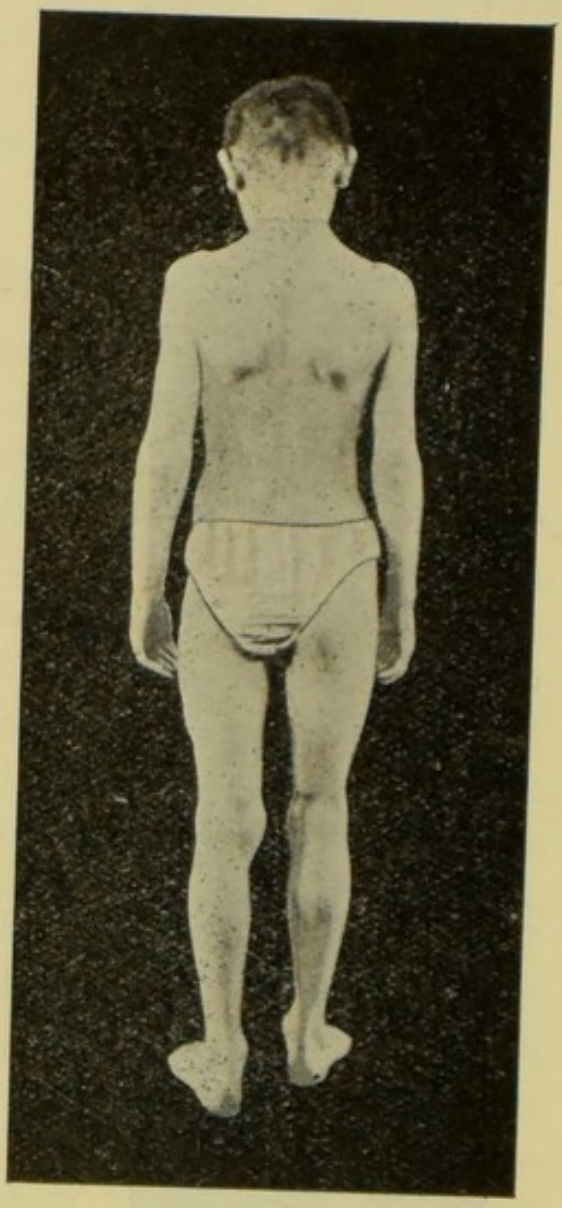


Fig. 140.

POSITION FOR LONGER STANDING. (Back View.)

It is usually necessary only to exercise vigilance over the postures assumed while the children are in the school or at home. When they are at play, and free to move when and how they like, there is very little likelihood of any injury

being produced in this way. The greater the amount of time available for games in the open air the better for the child. Drill, especially for young children, is not advisable,

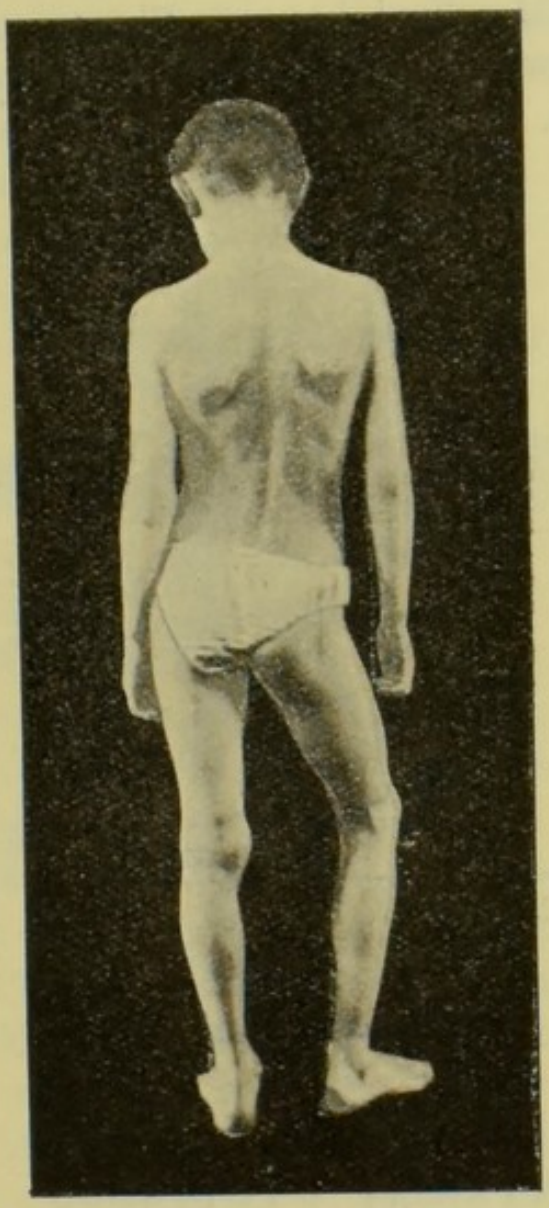


Fig. 141.

EXAGGERATED POSITION OFTEN ASSUMED BY CHILDREN, AND LATERALLY CURVING THE SPINE.

as it rapidly produces a condition of mental and physical exhaustion.

It should always be borne in mind that a child *must*

be injuriously affected if compelled to sit in a desk, however well constructed the desk may be, beyond a short period. Young children should not be kept sitting for longer periods than 20 minutes, and for not more than one third of the total school hours. Short periods of sitting should be followed by intervals of activity twice as long out of the seat. These periods of activity should not be

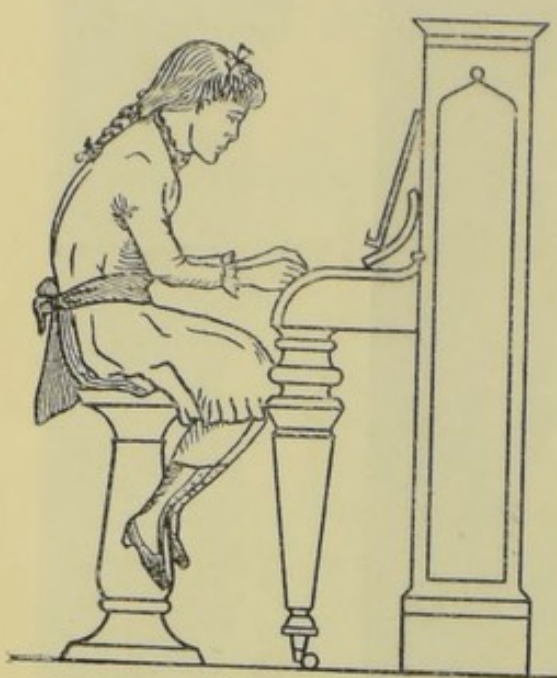


Fig. 142.

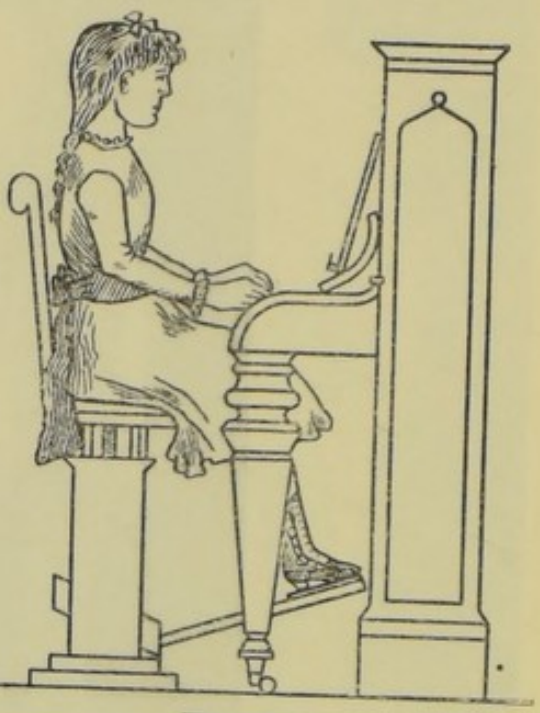


Fig. 143.

occupied by drill in any form, but certainly need not be devoted to play.

PHYSICAL EXERCISES.

The narrow view of the function of the schoolmaster is well exemplified in some schools, by the entire banishment of physical exercise from the rota of school-work. We send our children to school for the purpose of training them for the battle of life, which they will have to encounter when they reach to man's estate. It is by the

equal and continuous development of each and every part of the body that this battle will be fought with success, and if one part developes at the expense of another, or by its more rapid development puts a bar to the progress of the others, the subject of it is at disadvantage in his future struggles. Many a Cambridge wrangler and Oxford first-class man has found this out in after life. He is able to solve a problem in differential calculus, to make Latin verses, or to read a passage in any of the dead languages at sight, but he has not cultivated the talent of common-sense, or educated his muscles so that they can enable him to leap over some slight impediment in his path. He finds himself outstripped in the daily race by men whom he has been taught to despise, and who, in return, have a very small opinion of him and his mental power. The nerve force of thought in his brain has been developed at the expense of his motor power, and as the room for growth is limited, the latter is dwarfed and imperfect.

Life is "organisation in action," and the various activities of the body must be carried out with normal energy, and in a harmonious manner, if they are to be correct in their responses to any and every call that may be made upon them. Physical exercise is indispensable; and it is quite impossible for the functions of respiration and circulation to be carried on in a proper manner if the muscular system is not developed, or if the material which is necessary for the formation of the muscle is not used up in its proper order. If the muscles are not used equally with the brain tissue, some used-up matter is kept back, and will sooner or later act as an impediment to proper brain work, by getting in the way of the latter when it requires all the room which ought to be at its command. The assimilative and disarranging processes of the body are greatly influenced by the activity or inactivity of the

muscular system. Hence it follows that no school is properly constituted which does not provide an exercise ground for its pupils, and make the cultivation of muscular force a part of its daily routine. This is not the place to deal with the general effects of exercise, but it will not be out of order to call to mind the fact that, the natural heat of the body being 98·4, it follows that something must be produced in the blood which is the *débris* of the continuous fire that is always burning, and by means of which the natural heat of the body is kept up to its proper standard.

There is also another aspect of the case: muscular tissue wastes during long-continued rest. Any person may find this out for himself if he notes his muscular power before and after a few days of enforced confinement in bed; and there is no doubt also of the growth and increased strength of muscle by exercise. If any man changes his occupation, say from a clerk to a blacksmith, the comparison of power in the muscles of his arm at the end of a year will be found to efficiently prove this statement; but if the blacksmith gives up his anvil and takes to the pen, within a year the powerful deltoid muscles which he formerly possessed will be dwarfed and comparatively impotent. Let a man or a boy have sufficient intervals of rest between his times of labour, and whether that labour is brain work or muscle work it will tend to increase the power of the organ exercised, and the action of the one will by its own work clear the blood from the *débris* which has been produced by the work of the other.

The more powerful minds will be found among those men who do not neglect their muscular development; whilst the total neglect of mental work, which bodily labour sometimes compels the sons of toil to submit to, keeps them at a lower level in the scale of humanity than will be the case when both systems are allowed a chance by being

worked alternately, as they ought to be in every well-ordered school. We must bear in mind that by exercise the individual fibres of a muscle increase in size. The contraction of the muscle is one of the means by which an ample supply of blood is brought for the nourishment of the new tissue. If exercise is not forthcoming, the tissue dwindles and becomes fatty in its character, loses its proper elasticity, and does not leave room for new cells to take its place, for it is not removed in the way that a regularly-exercised muscle is. (Carpenter.)

There is no doubt whatever that in practically all the chief public schools the two extreme types are continually met. There are a number of lads who are encouraged to devote themselves to games in order to bring the school renown in the athletic world. Provided that the lad does sufficiently well there are often influences at work on his behalf, and instances are not uncommon of those who are by no means mentally distinguished being placed in positions that should be reserved for those who have at all events acquitted themselves creditably in mental contests. On the other hand the boys who show unusual brightness of intellect are encouraged to undertake excessive mental tasks, and are systematically "crammed" in order to advertise the school by winning some scholarship. A little more attention in both directions might be profitably given to the "average" boy.

The judicious combination of exercise, rest, and sleep plays a very important part in the health of the individual. Lack of exercise is soon followed by atrophy, or wasting away of the parts that are not used. A muscle that is not exercised, but lies idle, soon wastes away and becomes useless. This is particularly noticeable in the case of a broken or paralysed limb. The lack of use soon produces wasting and loss of power of the limb. The brain also,

when not exercised by study and reading, does not develop to its fullest possible extent. On the other hand, unless the exercise is combined with the proper amount of rest, the results are even more disastrous, as the body becomes overworked and exhausted.

Exercise is necessary at all periods of life, but especially so during childhood and early manhood or womanhood. It is the duty of all parents to see that their children enter into the school games, and spend a great deal of time in the open air. Practically all schools have now adopted physical exercises as part of their curriculum in recognition of the importance of these to the children. In the case of adults the exercise that should be indulged in must depend upon the nature of the daily work. Thus, if a man is doing bodily work all day, his muscles have had quite sufficient exercise, and mental exercise is what he needs for his spare time. On the other hand, those whose occupation is sedentary, such as clerks, students, etc., need physical exercise in their spare time, in order to bring their muscular, circulatory, and respiratory systems to the proper pitch of development.

For any beneficial result, the exercise taken must be systematic and regular, and not indulged in by fits and starts. By gradually and steadily increasing the work done by them, a set of muscles may be greatly increased in size, but there is a limit to this increase, and if the work be carried to excess the muscles will begin to waste away. Care should be taken to give every muscle of the body its necessary exercise. Many of our sports are faulty in leaving most of the muscles idle. The best real exercise for all the muscles is probably obtained by boxing, lawn tennis, and Rugby football.

Violent exercise should never be taken without proper training. By training, we do not mean the old-fashioned

idea of feeding a man on limited rations of half-raw meat, but simply an outdoor life, with plenty of good, nourishing food, and no lack of exercise for all the muscles. Violent exercise, without proper training of this kind, is likely to lead to most disastrous results, the commonest of which is heart disease resulting from overstrain.

Some of the physiological effects of exercise deserve special mention. We have already mentioned that the muscles are increased in size and are rendered capable of doing more work. By exercise they are also brought more under the control of the will. The first effect of exercise is, perhaps, the quickening of the heart beat and the rate of respiration. The heart beats more rapidly and more forcibly, causing an increased flow of blood through the blood vessels all over the body. If the exercise be sudden and violent, the heart may be incapable of meeting this sudden demand upon it, and the valves may be rendered incompetent, giving rise to heart disease. But by gradually increasing the exercise the heart is strengthened and the coats of the arteries are made stronger and healthier.

Respiration is also quickened by exercise. The amount of air taken in at each inspiration is increased, and larger quantities of water and carbon dioxide are given out in the expired air. Thus, a man at rest draws into his lungs each minute about 480 cubic inches of air, but if walking at the rate of three miles per hour he takes in 1550 cubic inches of air, and if he increases his rate to six miles per hour, the amount of air that he inspires is raised to 3250 cubic inches.

The skin acts freely while exercise is being taken. The blood vessels surrounding the sweat glands are distended with blood, and the secretion of sweat is increased. In this way an extra quantity of waste matter is removed from the body by the skin.

Other effects of exercise include the exhilaration and strengthening of the nervous system, the improvement of the appetite and digestion, and the stimulation of the kidneys and bowels, thereby aiding the elimination of waste matters from the body.

For the scholars in our schools there is little to choose between the various games. Cricket, football, rounders, rackets, tennis, fives, leapfrog, hopscotch, blindman's buff, skipping, swimming, and many others may be said to be almost equally good for children. Any game that organises children to perform free and natural movements in the open air or in well ventilated rooms should be encouraged. All that the child requires is to be taught a few games. Most healthy children may be safely left to themselves after that, so far as active supervision is concerned. A child who has had the proper amount of both mental and physical exercise during the day will sleep soundly at night, and will be completely refreshed after its proper night's rest.

One of the natural results of the increased circulation followed by increased secretion and evaporation which are caused by exercise is an increased desire for water. This should always be gratified, and children should be encouraged to drink freely, particularly after exercise. Ice-cold drinks should be avoided, but it is not dangerous to drink cold liquids while the body is heated provided it is taken in sips. A plentiful supply of water is needed by the body to dissolve the waste products and to convey them in the dissolved condition to the excretory organs.

The Recess.

In order that physical exercise may be possible there should be at least a fifteen minute recess in the middle of the morning and also of the afternoon school. This is

the absolute minimum, and twenty minutes is desirable in every school. These intervals should be fully occupied by simple games that can be commenced instantly by groups of the scholars, and it should be the duty of the teachers to organise some such system. Most of the children in our schools are taught no games properly, and the result is that the precious moments of the inadequate recess are wasted, except that the children are in the open air. Proper activity during these times will tend to counteract the tendency towards malformations which improper postures have commenced. The deeper breathing purifies the blood and removes some of the ill effects of insufficient ventilation, and in every way the recess should be regarded as the absolutely unalterable part of the school time-table.

The Games.

But it must not be thought that these intervals of recess give sufficient physical exercise for the children. The systematic organisation of school sports should include the summer evenings and the two half-holidays for secondary schools, and the evenings and Saturday mornings for primary schools. This organisation, if expected from any of the teaching staff, ought to be rewarded by proper payment. It is no exaggeration to claim that if any town or district devoted proper attention to this subject in its primary schools there would be an immediate improvement in the mental, moral, and physical condition of the children, and benefits would be conferred that would be lifelong. All teachers of experience are agreed upon this. In those schools which muster a team for cricket, football, jumping, or swimming competitions, the effect upon those children who are fortunate enough to get selected for such training is most marked. The

labour involved is not excessive. The energy of the British child is usually naturally exuberant, and simply requires directing along the right lines. A training in games and school contests tends to give perception and judgment, courage and skill, coolness and quick decision. The benefits of these in after life, particularly if they are not conferred by the sacrifice of proper mental training, are incalculable.

Dr. Dukes says: "No question in the training of the young is of more general importance than the mode of employing the *out-of-school* hours. Are the young as fully and wisely occupied in that time as during the hours of work? If not, moral discipline must be absent. Do the boys take regular and vigorous exercise? If not, no sound health can result. Is their freedom from work a period of cheerful recreation, and constant lively occupation; or is every hour a time of weariness and idle lounging? If the latter, then no guarantee for conduct exists, and the character and tone of the boys must deteriorate."

The essential idea should be that *all* must play. Among primary schools at present, even under the best conditions, there are a few scholars selected for the teams and all the attention is devoted to them. Also the necessary time and trouble are given quite voluntarily by usually one enthusiastic and good-natured member of the staff. The education authorities quite fail to recognise that physical education demands quite as much deliberate study, care, and method as mental training, and that it confers qualities which are *at least* as valuable in after life as those obtained by usual "education" as we know it at present.

It should be remembered that all violent forms of exercise should be discouraged among girls. I am con-

vinced that violent exercise at hockey or tennis is calculated to produce injury. The best and most uniform results are obtained by organising the simpler and less exhausting games among girls.

A **gymnasium** is not desirable for primary schools. It has many advantages for a secondary school, but it must not be allowed to take the place of games. In fact the use of the gymnasium should be mainly limited to the winter, after dark, and on wet days. Like drill it is not recreation, but merely a change of work, and the exercise of the young must be recreation as well as exercise.

Before dismissing the subject of physical exercises and games it is necessary to point out that there should be a physical examination of all scholars on entrance to the school. This should be carried out as carefully and as thoroughly as though for life assurance. Unless this is done those children who are most in need of physical education may receive grievous injury by indiscriminate, unregulated, and unwise exercise.

BREATHING EXERCISES.

The well-known injunction, "Shut your mouth; keep your mouth shut," should be one of the golden rules of childhood. Respiration can only be carried out properly when the air enters through the nose. A vast number of children, however, habitually breathe through the mouth. Many of these are unable to use the nose because it is partly or wholly blocked by adenoid vegetations, attacks of catarrh, or some other cause. Such children are usually of low vitality, and they soon give up all attempt to breathe through the nose. Where there is a mechanical obstruction it is obvious that breathing exercises are of little or no use until the obstruction is removed. On the other hand there are a great many children, and probably a rapidly increasing number, who have simply acquired the bad habit of mouth breathing, and to this bad habit may probably be traced the increase in the numbers of adenoid children. Mouth breathing as a bad habit is often acquired by weakly children, and in such cases it is practically always followed by nasal obstruction.

Whether the mouth breathing be due to a mechanical obstruction or to a bad habit it has a great and far-reaching effect upon the health, development, activity, and usefulness of the child throughout life. Lack of use is always followed by arrest in development, and as the nasal passages are mainly for respiration it necessarily follows that those regions will not take part in the general growth of the child if they are no longer used. The respiratory system as a whole remains undeveloped owing to partial use only, and the whole body and life of the child is necessarily affected. "A debilitated child, with low vitality, impaired energy, and lax tissues, will, if nasal obstruction be added to the other defects by which it is handicapped,

find it too much trouble to breathe fully. It gives up running or playing games which would compel it to expand its chest; it muddles through life at a low level of respiratory exchange." (*British Medical Journal*, 1905.) Weakly children of this type in fact breathe almost wholly by the contraction of the diaphragm, and where these respiratory peculiarities are combined with softness of the bones, as in rickety children, the contraction of the diaphragm will usually cause a well-marked depression, running outwards and downwards on each side of the chest wall, and marking the attachments of the muscle to the ribs.

Breathing exercises will be found very useful to occupy an odd minute or two between lessons. Of course they are useless, or nearly so, if the air is impure, so that all windows should be widely open at the time. No child can breathe properly when in a stooping position. The position of the shoulder-blades is important; they should be forced downwards and towards each other. A good plan is to teach the children to sit and stand with the hands firmly held on the hips, the shoulders pulled back and held steady, and the shoulder-blades pulled downwards and onwards. The child should then be taught to take slow steady breaths through the nose, the mouth being firmly closed, raising the chest to accommodate the extra quantity of air, and keeping the shoulders fixed. The object should not necessarily be to increase the permanent growth of the chest, but to make as great as possible the *difference* between the fullest expansion and the greatest contraction. The most vital measurement is the difference between the full and the empty chest. The power of emptying the chest, as well as the capacity for increased expansion, will be found to improve wonderfully with a little practice. The above mode of breathing should be

practised several times daily, but not for long at a time. It will be found, in a large number of cases, to induce a habit of calm, deep, steady breathing, and a marked difference will be noticeable in the shape of the chest, as well as in the general bearing and health. Such exercises, in fact, if generally and thoroughly carried out in every school, and by all children, would do more than anything else to cause a rapid diminution in the number of cases of adenoids in children and consumption in young adults, and, in addition, practically wipe away such complaints as indigestion and anaemia.

The following exercises are recommended by a writer in the *British Medical Journal*, 1905 :—

"1. Extend the hands and stretch the arms forwards from the shoulders, leaving about a foot between the hands, which should be turned with the palms inwards and fingers stretched out straight. Slowly move the arms backwards as far as they will go (while deeply inspiring), and slowly bring them forwards until they are in the same position as at starting (while deeply expiring). Repeat this from three to six times.

"2. Hold the hands down with the palms against the legs. Raise them with palms inwards (inspiring), and when they are immediately above the head turn the palms outward and slowly bring them down to the sides (expiring). Repeat from three to six times.

"3. Hold the hands against the thorax, with the fingers pointing inwards and touching back to back. Then with a swift movement swing the arms out as far as they will go (while inspiring). Begin again (expiring), and repeat half-a-dozen times.

"4. Keep the arms down, the palms touching the sides, slowly turn the palms outwards as far as they will go (inspiring), and slowly bring them back to the sides

(expiring). This may be done six or eight times. This exercise, apparently so simple, expands the chest and presses together the shoulder-blades."

It would be difficult to improve upon this simple and valuable set of exercises.

It may be useful to reproduce here the syllabus of breathing exercises recommended by the Inter-departmental Committee on the Model Course of Physical Exercises as presented to Parliament:—

DEEP BREATHING EXERCISES.

These exercises are of great value, and should form part of the daily training of every scholar. It is of great importance that the correct method of nasal breathing should be taught from the beginning of school life.

1. *For Infants*, a simple imitative exercise is the most easily acquired.

The infants, standing or sitting, and watching the teacher, place the left hand over the pit of the stomach and breathe in as she does, noticing the hand rise during inhalation. The child then breathes out slowly, the hand at the same time sinking. On each occasion the teacher must watch the class carefully, and note that all the mouths are firmly closed, and that all breathing is through the nostrils only.

This exercise should be repeated about 6 times at least twice daily.

2. *For Older Pupils.*

The teacher, starting from the position of attention, should see that all the mouths are firmly shut; then on the command *Breathe—In* (slowly given) instruct the pupils to breathe in slowly and deeply through the nostrils only, until the chest is fully expanded; then on the command *Breathe—Out* (slowly given) to breathe out quietly and steadily; this exercise should be repeated about 10 times at least twice daily. When the exercise is repeated the commands *In*, *Out* only should be used.

Note.—Care must be taken that during inhalation the head and chest be not thrown too far back, nor the abdomen thrust forward.

When the exercise has been thoroughly acquired, it can be gradually combined with the slow arm movements, which bring into play the auxiliary muscles of respiration.

3. *Combined Breathing and Slow Arm Exercises.*

When a combined movement is used, the caution, *With Deep Breathing*, should always precede the command for the arm movements, *e.g.*—*With Deep Breathing, Arms Sideways—Raise.* The arm movements employed should follow the rhythm of normal respiration (inhalation, exhalation—pause; inhalation, exhalation—pause), etc., and the breathing act must not be made to follow any artificial or arbitrary rhythm like that of music. It is also impossible that all members of a class should do the movements in absolute unison, for no two persons breathe naturally exactly alike.

The most suitable arm movements to combine with the deep breathing exercises are:—

WITH DEEP BREATHING—ARMS SIDEWAYS RAISING.

With Deep Breathing, Arms Sideways—Raise (One). Raise the arms sideways in line with the shoulders, fingers extended, and palms downward, and at the same time breathe in slowly through the nostrils until the chest is fully expanded.

Lower (Two). Breathe out naturally, and at the same time lower the arms to the sides.

(*a*) This exercise may also be combined with *Heels Raising*, the commands being *With Deep Breathing, Arms Sideways Raising, Heels and Arms—Raise (One); Lower (Two).*

WITH DEEP BREATHING—ARMS SIDEWAYS AND UPWARD RAISING

(To be done as a continuous movement.)

With Deep Breathing, Arms Sideways and Upward—Raise (One). Raise the arms as above, keeping the arms straight and well back, turn the palms smartly upward, and immediately raise the arms until they are vertical above the shoulders, and at the same time breathe in slowly through the nostrils until the chest is fully expanded.

Lower (Two) { Breathe out naturally, and at the same time lower the arms sideways and downward.

(*a*) This exercise may also be combined with *Heels Raising*, the commands being *With Deep Breathing, Arms Sideways and Upward, Heels and Arms—Raise (One); Lower (Two).*

WITH DEEP BREATHING—ARMS CIRCLING.

With Deep Breathing, Arms Circling —Raise (One). { Raise the arms forward to the level of the shoulders, palms inward, elbows and fingers straight, arms parallel, continue the movement upwards till the arms are vertical, and, at the same time, breathe in slowly through the nostrils until the chest is fully expanded.

Lower (Two). { Breathe out naturally, and at the same time lower the arms sideways, first to the level of the shoulders, keeping palms upward and arms well back, then turning the palms downward and lower the arms to the sides.

(*a*) This exercise may also be combined with *Heels Raising*, the commands being *With Deep Breathing, Arms Circling, Heels and Arms—Raise (One); Lower (Two).*

N.B. Breathing Exercises should always be taken at the end of a physical training lesson, in order to prepare for rest, and also to aid in the elimination of the carbonic acid accumulated by the repeated contractions of the muscles during the lesson. They may also with advantage be taken in the course of Physical Training lessons or other school work.

In connection with these exercises the attention of the teacher is specially directed to the fact that the object of such exercises is the healthy functioning of the lungs, not mere increase of chest capacity. The vital measurement is not chest capacity simply, but difference between the full and the empty chest.

CHAPTER XIV.

THE DAY'S WORK.

FATIGUE.

THERE are two factors in fatigue, the muscular and the nervous. A muscle, as everyone knows, becomes fatigued after a longer or shorter period of activity. The cause of this fatigue is the production of poisonous waste materials in the muscle. These are produced, during the activity of the muscle, at a greater rate than they can be got rid of, and when they accumulate beyond a certain point the muscle becomes incapable of further useful work. By a period of rest the muscle can be restored to its original condition because the waste products are rapidly eliminated during repose. Probably in just the same way the brain becomes fatigued by prolonged mental work. Toxic bodies are produced in the brain during the period of activity, and when they accumulate beyond a certain point further useful mental work becomes an impossibility. In children the channels for the elimination of these waste materials are but poorly developed, so that mental fatigue comes on very rapidly.

The whole of the mental apparatus is most truly rested by sleep, but, unless the fatigue is so great as to amount to exhaustion, there are other means of removing the poisons that have been produced in the brain during a lesson of undue length. Within reasonable limits the muscular and

the nervous activities may be regarded as complementary, the parts of the brain that have been used chiefly during the lesson being best rested by the activity of the muscles, *i.e.* by physical exercise or play. The effect of the exercise in increasing the rapidity of respiration and circulation still further tends to hasten the removal of the toxic bodies from the brain.

It should be remembered that the child becomes mentally fatigued rather by the length of the separate lesson than by the length of the day's work. For proper beneficial and useful work the child's lessons must be short and must be separated by intervals of play.

Many observers, as a result of investigations carried out by them, have pointed out that the length of time during which the attention can be fixed on a lesson is very short in early childhood and gradually increases with age. The results of their observations were as follows:—

At 6	years	the	attention	can	be fixed for	15 minutes.
From 7 to 10	,,	,,	,,	,,	20	,,
,, 10 ,, 12	,,	,,	,,	,,	25	,,
,, 12 ,, 16	,,	,,	,,	,,	30	,,

These figures mean that if the attention of the child has been concentrated upon mental work for the above periods the limit of good work has been reached, and if the same lesson is continued it will tend to produce mental fatigue, and the children will gain no benefit from further instruction. The time of the teacher and the children is wasted by long lessons. At the end of one of the above proper periods of instruction there should be a minute devoted to simple physical movements or breathing exercises, and then a second lesson given of the same length, the subject being as great a mental change from the first as possible. After the second of these lessons

there should be a period of physical exercise in the form of play.

It does not appear to be fully appreciated that the time during which the child is attending school is even more vitally important to its physical well-being than to its mental development. Any hindrance to the process of physical development during these years can never be compensated. The seeds of tuberculosis and diseases of the nervous, digestive, and circulatory systems are sown in many instances during school life. No wonder that children "outgrow their strength" when the demands that school life makes upon the body leave no balance for its proper development. All experts are agreed that the best work is got from the scholars by short and varied lessons. No lesson should exceed half an hour's duration, and after two such lessons there should be fifteen minutes' play. In this way there would be far more real working time in the school day than there is at present, and the results would more than justify the change.

There is a great deal of evidence that the school work of scholars is always best after intervals of rest, and steadily deteriorates after a certain period of constant work has elapsed. Usually the best work of the week is done on Monday and Tuesday, and on Tuesday afternoon the work begins to deteriorate. If there is a Wednesday half-holiday there will be an improvement on Thursday morning, and so on. For this reason it is an advantage to have a half-day's holiday on Wednesday and Saturday, instead of the whole day on Saturday.

The best work of the day is done during the first two hours, and the afternoon's work is always inferior. At all events this is the experience of most people who are actually engaged in educational work, although a certain amount of evidence has been brought forward against

such a view. For this reason the afternoon is best occupied by those subjects which produce the least fatigue, such as history, literature, and languages. It cannot be too often repeated that gymnastics and drill produce so much physical and mental fatigue that the work done afterwards is almost useless. No mental work should be attempted for at least half an hour after a meal.

Fatigue comes on with increased rapidity if the surroundings are injurious. Bad ventilation, bad lighting, improper desks and injurious attitudes are common causes of rapid fatigue in schools. If, in addition, the child arrives at school suffering from want of sleep and insufficient food, it is wonderful how the teachers manage to get any real mental work done at all. If it is done, what a price does the child pay for its poor little stock of knowledge!

THE DAILY TIME-TABLE.

The arrangement of the time-table has been mentioned above in connection with the subject of fatigue. According as the subjects are arranged it may contribute towards the production of fatigue or help to obviate it. The daily programme should be so arranged as to engage successively different kinds of mental activity. The best work is done in the morning when the children are fresh, and so the most trying and fatiguing work should be taken then. During the first part of the day the children think better and quicker, their memory is better, and they more quickly recover when fatigued than at any other time. Arithmetic and mathematics are therefore justifiably attempted the first thing in the morning. The arrangement of the other subjects may be left to the judgment of the teacher, but

care should be taken to make each subject as widely different as possible from the one before. The less fatiguing subjects should be reserved for afternoon.

The minimum times set apart for games should be twenty minutes in the middle of the morning, and the same interval in the afternoon. Better results would probably be obtained by having an interval of play after each hour or hour and a half of work. For young children under 9 years of age the ordinary school day of about $5\frac{1}{2}$ hours is simply cruelty and does an infinite amount of mental and physical harm. It has been proved over and over again that the best educational results are obtained by much shorter hours of school work, and much longer periods of outdoor exercise than are usual in most schools. The importance of the fact justifies its continued repetition, because education authorities at present appear to have quite failed to grasp this simple but fundamental truth. The experiment conducted by Mr. Charles Paget, M.P., is well known. Not being satisfied with the progress of the boys in the school on his estate he divided the school into two similar sections. One section continued the ordinary school work in the usual school hours, but the other devoted half the usual time to school work and the remainder to outdoor work in a garden. Those boys who were employed half their school time in the garden were found to excel the others in every respect.

Similar evidence is given by Sir E. Chadwick, who found that the children in half-time schools were ahead of those who attended the whole day.

For older children, of course, longer hours of work are necessary, and will do no harm, but many children arrive at the age of twelve or thirteen suffering mentally and physically from the effects of injudicious methods of education during their earlier years.

Dr. Clement Dukes gives the following table of the hours of school work suitable for each year:—

Ages.						Hours of work.
From	5	to	6	years	.....	6 per week
„	6	„	7	„	.....	9 „ „
„	7	„	8	„	.....	12 „ „
„	8	„	9	„	.....	15 „ „
„	9	„	10	„	.....	18 „ „
„	10	„	11	„	.....	21 „ „
„	11	„	12	„	.....	25 „ „
„	12	„	13	„	.....	30 „ „
„	13	„	14	„	.....	35 „ „

The same writer very wisely advocates a reduction of these hours for boys between 13 and 16 years and girls about 12 and 13 years in those cases where growth is proceeding very rapidly.

Education of Girls.

The injury done to boys and girls during "preparation for examinations" is now beginning to be recognised, but the terrible risks in the case of girls is not yet appreciated. The "higher education of girls," consisting as it usually does of several years' cramming for examinations, often in subjects utterly uncongenial to the feminine mind, is an unmitigated evil, and often results in a complete breakdown. A few exceptional brains can manage to acquire the necessary examination tricks in a short time, and some of these cases appear to survive the ordeal unscathed, but for the more numerous class who find it necessary to grind away incessantly in order to get up to the examination standard the process is injurious and mind-warping. When, in addition to this direct mental injury, one remembers that these processes are at work usually just at

the time when the body is finishing its physical development, and when it is being decided whether the body shall be normal and strong or abnormal and weak, there is little cause for surprise that education is at last making its first feeble efforts to dissociate itself from forced work for examinations.

"I would urge," says Dr. Clement Dukes, "that the education of growing girls should not be acquired at the expense of motherhood: we do not want crammed heads, but strong well-made bodies, fitted for Nature's requirements. There is no sphere for the girl which can excel that which comprises the virtues of motherhood; and if teachers and parents were more alive to their duties, and would see that education consisted more in training the girl for the beneficent occupation of home-maker, what a vast amount of happiness and usefulness would be engendered! Mental powers too highly developed in women involve a physiological cost, which her feminine organisation will not sustain without injury more or less profound.

"It is more essential for a nation to produce vigorous offspring, than to educate girls to the highest standard. By the highest *physical* education girls can be rendered strong, comely, and well proportioned; while by the highest *mental* culture (without this physical basis) they *may* be transformed into mere 'blue stockings' or neurotics, or a combination of both."

Such vital problems as physical degeneration, the decreasing birth rate, and the increase in lunacy and in neurotic conditions do not appear to have yet been popularly associated with the modern education of girls. Yet it is a possible association of cause and effect, and one that is well worth consideration by those who have at heart the well-being of the race, and who are seeking an explanation of these serious developments.

With reference to over-pressure in mental work it is impossible to improve upon the words of Sir Crichton Browne:—"It has often occurred to me that if educationalists could peep through a little hole in the skull, and see the living, throbbing brain, and realise that it is a pulpy organ of about the consistence of calf's-foot jelly; and if they could look at the minutest shred of it under the microscope and admire one little galaxy out of the millions of starry cells that it contains, lying scattered amongst the strands and sources of its fibres 'like a swarm of fireflies tangled in a silver braid,'—if they could, as physiologists can, picture to themselves the functional activity of the brain—now, as at times of ease and abandonment, *shimmering* over its surface from point to point; now, as at periods of calm and connected thought, localised into a steady *glow* in certain regions; and now, again, as in moments of intense mental application, concentrated on one spot into a *spark* of surpassing brightness—if our educators could do all this, and if they could become practically acquainted with the brain, they would, I think, be more careful in the handling of it than they sometimes are, and be a little less ready to deny that there is any danger of exerting overpressure on this delicate structure."

The brilliant boys at school are rarely successes in after life. The early mental overstrain either produces sufficient physical injury to handicap them heavily afterwards, or else causes them to rapidly reach their limit of mental development.

SIGNS AND SYMPTOMS OF OVERWORK.

Overwork as a rule quickly produces easily recognised effects upon the young body and mind. Unfortunately such effects are only too commonly found in many of the

secondary schools and colleges. In such cases the skin acquires an unhealthy appearance, dark rings appear round the eyes, and the scholar either becomes unnaturally restless and excitable, or unduly lethargic and dull.

Growth.

The growth is often arrested under such circumstances. Any child who fails to increase its weight regularly should be regarded as ailing. In fact, no stronger proof of its ill-health could be forthcoming. Occasionally the explanation is that the amount of food is insufficient in quantity, but more often it is the fact that the child is failing to digest the food supplied. Constipation, with its accompanying foul breath and loss of appetite, is a common result of overwork. By carefully noting the height and weight of every scholar three times a year it is possible to obtain a considerable amount of information as to their general well-being. The following table shows the average heights and weights at different ages:—

	Boys.		Girls.	
Age.	Height.	Weight.	Height.	Weight.
5	41·2 ins.	40·5 lbs.	41·0 ins.	39·6 lbs.
6	43·9 „	44·8 „	43·0 „	42·8 „
7	45·9 „	49 4 „	45·0 „	47·0 „
8	47·4 „	54·4 „	47·0 „	52·1 „
9	49·7 „	59·8 „	49·0 „	56·3 „
10	51·7 „	66·4 „	51·2 „	62·2 „
11	53·5 „	71·1 „	53·3 „	68·5 „
12	54·9 „	76·8 „	55·8 „	77·3 „
13	57·1 „	83·7 „	57·9 „	87·8 „
14	59·6 „	93·5 „	59·9 „	97·6 „
15	62·3 „	104·9 „	61·0 „	105·4 „
16	64·7 „	120·0 „	61·7 „	112·4 „

The above figures are averages of a large number of statistics. It should be remembered that there are variations in weight according to social conditions and surroundings. The following table shows such variations between 11 and 12 years of age:—

Class.	Age.	Average Height.
Public School ...	11 to 12 ...	54·98
Agriculture	„ ...	53·01
Factory	„ ...	51·56
Industrial School ...	„ ...	50·02

The above table shows that roughly there is a growth of about two inches per year. Also that between 11 and 13 years in boys, and 9 and 10 in girls, there is a curious retardation in growth. At these ages the children do not appear to be doing so well as at other ages. In boys at 16 and girls at 13 growth is going on at its maximum rate, and at these ages it is well if the mental and physical activities are brought to a minimum.

Chest Development.

A systematic record of chest measurements is even more valuable. If a child's chest shows no increase in size in six months it should be medically examined. Probably no physical factor is under such control as the chest measurement. Every child's chest can be developed to a fair standard by proper breathing and physical exercises. Overwork usually causes shallow breathing and consequently an ill-developed chest.

Other Effects.

Among other effects of overwork may be mentioned the dull, lifeless appearance, the inelastic gait, the flabby and

wasted muscles, and the various nervous conditions. The nervous evidences are very numerous, and include sleeplessness, bad dreams, somnambulism, headaches, starting and talking in sleep, hysteria, St. Vitus' dance, irritability, twitchings of muscles, and many other ill effects. Mental perversion is also common, and there is occasionally a total change in the moral nature of the child. Many of the above effects, unless quickly recognised and arrested, cause life-long misery and suffering.

EXAMINATIONS.

Much has been written on this subject. Most of the "experts on education," whose opinions are listened to with such reverence, have never had any real experience in teaching a large class of children. Periodical examinations are necessary and useful in order to test the progress of the scholar and the efficiency of the teacher. The examinations should be fairly conducted and the questions asked should be reasonable. The standard required also ought not to be excessive. Everyone who has had much experience in examinations has met that examiner whose idea of "examining" is to find out what the candidate does *not* know, instead of ascertaining how much he *does* know. Competitive examinations as at present conducted, whatever may be the necessity for them, are unmitigated evils both from an educational standpoint and also because of the enormous damage they do to the average candidate. One of the results of them is the evolution of the "examination expert," as he (or she) might be called. Such scholars early acquire the knack of absorbing knowledge from an examination point of view, and readily grasp the fact that the method of presenting the matter is of as much importance as the matter itself. These

candidates are rarely injured by the cramming process, and they succeed brilliantly in school examinations, but, curiously enough, they are rarely heard of afterwards. On the other hand the examinations often severely and permanently injure great numbers of scholars in secondary schools. The fault is not with the system of examination, but because there is no proper control over the methods of preparing candidates for them. Competition of all kinds is healthy and desirable, but when candidates are crammed and overworked by attempting to do twelve months' work in six, or less, a certain number of disasters is inevitable. At all events there should be an invariable rule, from which no exception should be allowed under any circumstances whatever, that no boy should take part in any competitive examination during his sixteenth and no girl during her thirteenth or fourteenth year.

HOME WORK.

If good work has been done during the school day there should be no need for work in the evening in the case of children under eleven or twelve years old. After that age a certain small amount of home work may be required, but it should be always restricted in amount and of a definite character, such as working a few mathematical examples the methods for which have been thoroughly learned at school, or committing to memory a short piece of prose or poetry. The work set should not present any difficulty to the scholars. Nothing should be set which will involve more than an hour's work at most, and it must not need much reading. To use the already overtired and overstrained eye, in indifferent artificial light, in still further struggles with the type of the average school book is to convert a possible into a probable disaster. Constructive manual work has not such great disadvantages as home work.

Everyone who has had educational experience realises that the work in the average school is not so continuous in character as it might be. There are slack times which must be made up for by periods of overwork, and unfortunately the usual time for setting large amounts of home work is just when there is extra pressure being exerted during school hours. If the work in school is done thoroughly throughout the year there should be no need for any work out of school hours.

HOLIDAYS AND HOLIDAY TASKS.

The present average elementary school holidays are fairly well arranged and of the right length. The holidays of secondary schools are undoubtedly too long and are the chief cause of the cramming that may go on during the term. Any holiday of a greater length than four weeks should be considered too long. The aim of educationalists for the future should be to increase the number of working days in secondary schools and thus make it possible to abolish home work and holiday tasks. The holidays should be *real*. If holiday tasks are set the holiday is merely make-believe, and if the holidays are so long that they cannot be spared entirely for real cessation of study they should be curtailed and the proper school work begun earlier. On the other hand there is no objection to sensible encouragement of the scholars to devote themselves to some pursuit or hobby during the holidays. Nothing can be said against encouragement being given to the scholars to make collections of moths or insects, wild flowers, etc., and fossils or minerals. Among boys with a liking for wood work or metal work the idea of returning to school with specimens of such work should be fostered. All these tasks will do good, and the children will return

to school all the better and fresher if they have failed to devote a moment of the holiday to ordinary school work.

Before leaving the subject of holidays it is important to mention the common form of holiday torture that is often inflicted upon children by well-meaning parents in the form of "musical education." Undoubtedly a great deal of harm is done to boys and girls by insisting upon set times of "practising" being observed when the child ought either to be resting the intellectual centres by means of sleep, or exercising its motor centres by physical activity.

CHAPTER XV.

ACCIDENTS AND EMERGENCIES.

WOUNDS.

Minor wounds, such as a simple abrasion of the skin caused by a child falling on gravel, should always be carefully cleaned with cold water and then bandaged. Do not bandage too tightly, and remember that the essential condition for the successful treatment of wounds is absolute cleanliness. In cases where the wound is at all severe it is best to send at once for medical aid.

In cases of small clean cuts the best treatment is to carefully adjust the edges, place over the cut a strip of clean linen soaked in clean water (or, better, in a solution of carbolic acid, one part of acid to forty of water), and bandage carefully.

The bleeding from small wounds often stops under the above treatment, but if it continues after the bandage has been applied, or if it is severe from the beginning, it will be necessary to adopt special means to check it.

Bleeding.

If any kind of blood vessel is injured bleeding will be produced, and the process varies according as to whether a capillary vessel, a vein, or an artery has been broken.

Capillary bleeding is the commonest and simplest form of haemorrhage. The blood slowly oozes from the raw

surface, and appears at many points. This bleeding is easily stopped by bathing the part with cold water, or by tying firmly over it a pad of lint soaked in cold water.

Bleeding from a vein is recognised by the fact that the blood is dark in colour, and wells up from the wound in a dark steady stream. The bleeding can be stopped by placing on the wound a pad of lint soaked in cold water, and kept in position by a bandage. The tightness of the

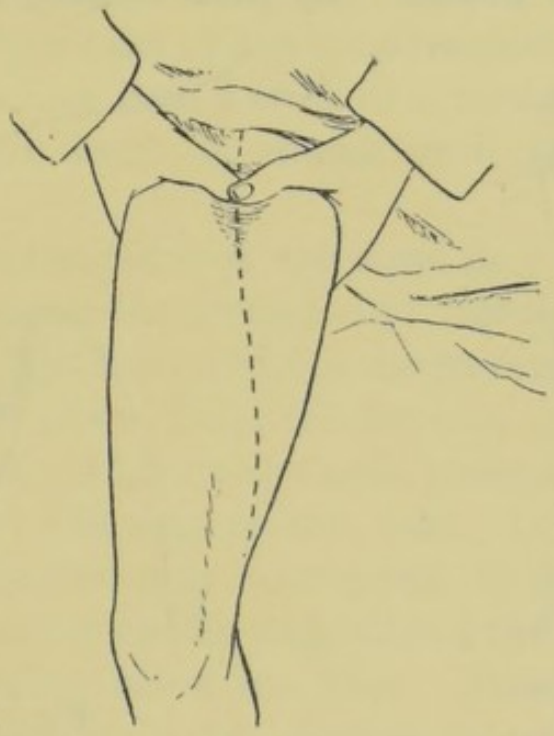


Fig. 144.

METHOD OF COMPRESSING ARTERY IN THIGH.

bandage should be gradually increased until the bleeding stops.

Arterial bleeding is the most serious form, and is the most difficult to stop. The blood is of a bright red colour, and is forced out in jets or spurts, if the artery is large, or in a continuous forcible stream from the smaller arteries. To stop the bleeding it is necessary to apply pressure over the wound itself. Press the thumb over the point in the

wound from which the blood is seen to be spurting. If the pressure is sufficient and is maintained, the bleeding can be held in check until medical assistance is available. In less severe cases the bleeding may be stopped by tying a pad of linen firmly over the wound.

Where the artery is at all large and the bleeding is occurring from a limb, the most satisfactory method is to apply pressure to the main artery at a place higher up the limb than the wound. By thus closing the artery at a

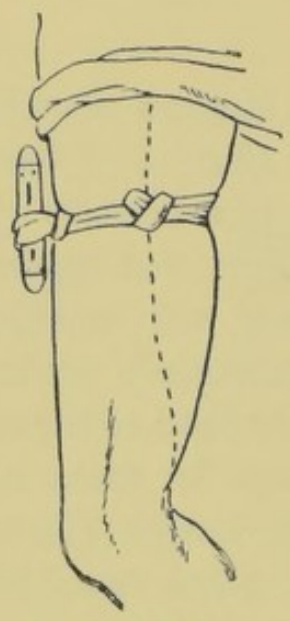


Fig. 145.

TOURNIQUET APPLIED TO THIGH.

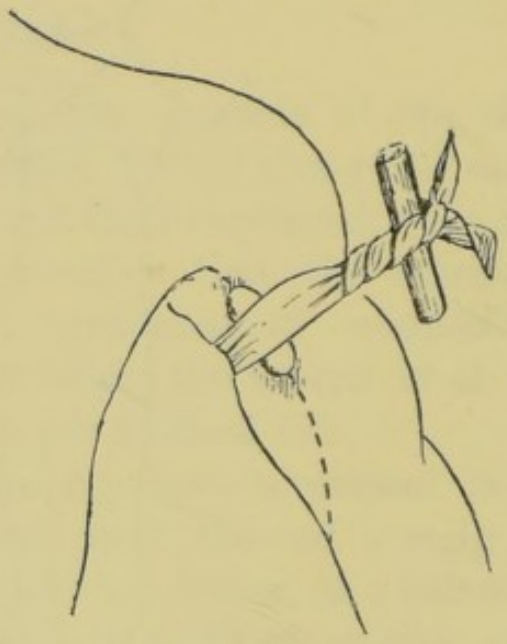


Fig. 146.

TOURNIQUET APPLIED TO ARM.

point between the heart and the wound, the bleeding will be arrested. This pressure is best exercised at a point in the course of the artery where it passes near to a bone. The artery can be easily identified by its pulsation, and it should be pressed against the bone by the two thumbs, one over the other. The points to be chosen for this pressure are easily learned by a few attendances at an ambulance class, but are difficult to describe in a few words.

Remember in cases of bleeding that sufficient pressure

brought to bear upon the spot from which the blood is running will in the great majority of cases be all that is necessary in order that the bleeding should cease. For keeping up continuous pressure it may be necessary to employ some form of tourniquet. A good tourniquet may be made by tying a knot in the middle of a handkerchief, placing this on the spot where it is desired to produce compression, and tying the handkerchief tightly round the limb. Instead of the knot a piece of wood, or a flat stone, may be tied on by means of the handkerchief. If this does not stop the bleeding pass a stick or a penknife under the handkerchief and twist it round until the pressure is sufficient.

Bleeding from the palm of the hand may be stopped by pressing a pad upon the wound and tightly binding the fingers over it. Similarly, if from the forearm, place a pad in the fold of the elbow, bend the forearm on the arm and tie it tightly bent. If from the arm, press a pad into the armpit and bind the arm to the side. In the same way bleeding from the foot may be stopped by direct pressure, while bending the leg upon a pad behind the knee will stop much of the bleeding below the knee. Bleeding from the face and head can usually be checked by pressure against the bony surface beneath.

Nose Bleeding.

Bleeding from the nose is sometimes difficult to stop. The child should sit in a chair, with the head thrown back and the arms raised. If this is not sufficient to stop the bleeding, the head, face, and neck should be freely douched with cold water. Do not let the patient bend down over a basin, and frequent blowing and wiping the nose should be prevented. Another treatment is to syringe out the nose with a strong solution of alum in iced water.

BITES AND STINGS.

Bites of animals often cause irregular jagged wounds that are long in healing. The immediate treatment of all bites is thorough and vigorous sucking of the wound and spitting out the saliva and blood. It is best to encourage free bleeding for a time. Then the wound should be again sucked and cleaned carefully with hot water, and then some strong Condy's fluid applied.

Stings by insects are often the cause of great pain and shock. If the sting has been left in the skin it must be pulled out. Then quickly rub on the spot some strong solution of washing soda, or sal volatile. The continued application of these substances is not desirable or necessary.

BRUISES.

The commonest accident in the playground is bruising. The bruise should be treated with cold applications such as a handkerchief applied and kept soaked with cold water. Bruised eyes if promptly treated in this way may be prevented from blackening. The alternative is the application of very hot water for about fifteen minutes.

FRACTURES.

When a bone is broken the greatest possible care should be taken to prevent any movement. Sometimes the force producing the fracture is so great that one of the broken ends of bone gets forced through the flesh and skin to the outside, forming an open wound as well as a fracture. This is called a compound fracture. When the skin is not broken it is called a simple fracture. Simple fractures are often converted into compound by mismanagement, and

the case is thereby rendered infinitely more serious, because the air can now get into the wound and may take with it some germs which may do serious injury and even cause death. A fracture is diagnosed by the loss of power of movement of the part involved, by the unnatural position, by local swelling and pain, or by the place of fracture being felt beneath the skin. Sometimes it is difficult to be quite sure whether a fracture has taken place or not, but the best rule is to treat every doubtful case as a fracture until medical help arrives.

When an individual has broken a bone, no movement whatever should be allowed until means have been taken to ensure immobility of the part. If the fracture is a compound one, the wound should be washed, if possible, with some clean water, or better, with a disinfecting lotion, such as a solution of carbolic acid (one in forty of water). Then place a pad of lint or a clean handkerchief over the wound, to prevent the entrance of more air.

In the case of a fractured skull very little can be done until the doctor arrives. The patient should be placed on a bed or couch with the head raised. Cloths soaked in cold water should be repeatedly applied to the head.



Fig. 147.

METHOD OF APPLYING BANDAGES TO BROKEN JAW.

A broken jaw is recognised by the patient being unable to speak, and also by feeling a depression at some point in the bone. If possible a bandage should be applied as shown in Fig. 147, after gently raising the jaw to its natural position. One handkerchief is fastened round the top of the head and below the jaw, and the other passes round the chin to the back of the neck.

A broken collarbone is a common result of a fall, especially among children. An irregularity will be detected by passing the fingers along the collarbone. Another sign is the inability of the patient to raise the arm above the shoulder. Place a pad, such as a rolled up handkerchief, in the armpit and, after placing the arm in a sling, tie it to the side by means of a broad bandage passed round the arm and chest, outside the sling.

Broken ribs are also of common occurrence. The patient complains of a sharp pain on drawing his breath, and a grating sensation at each breath may be detected by placing the hand over the spot. A broad bandage should be fastened tightly round the chest, and this is usually found to give great relief.

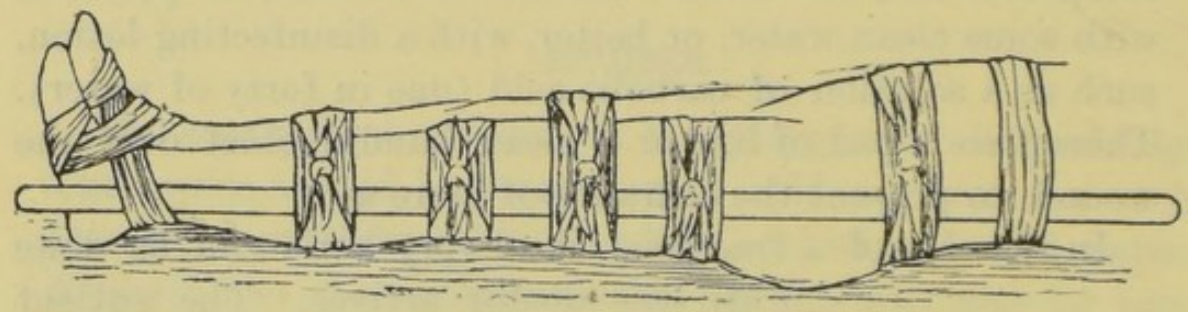


Fig. 148.

SPLINT APPLIED TO BROKEN THIGH.

In the case of a broken arm-bone temporary splints should be cut so as to reach from the armpit to the elbow. Roughly pad the splints by wrapping them round with handkerchiefs; and place one from the shoulder to the outside of the elbow, and the other from the armpit to the inside of the elbow. Bandage the splints firmly to the arm, and put the forearm in a sling.

Broken forearms are treated by fastening the arm to an angular splint. To make this, bind two pieces of wood at right angles to each other. Next, bend the arm to a right

angle at the elbow, and fasten it to the splint with handkerchiefs; then put the arm in a sling. Broken bones of the hand or finger are best treated by fastening the whole hand flat against a broad splint, and then putting the arm in a sling.

A broken thigh requires very careful treatment. First take hold of the foot with both hands, and pull steadily until the injured limb is the same length as the other. Then tie the feet together. Next obtain, if possible, a long splint—a broom-stick or an umbrella will do—and tie it as shown in Fig. 148. The splint should go from the armpit to the foot. If no splint can be obtained, tie the legs firmly together at several places.

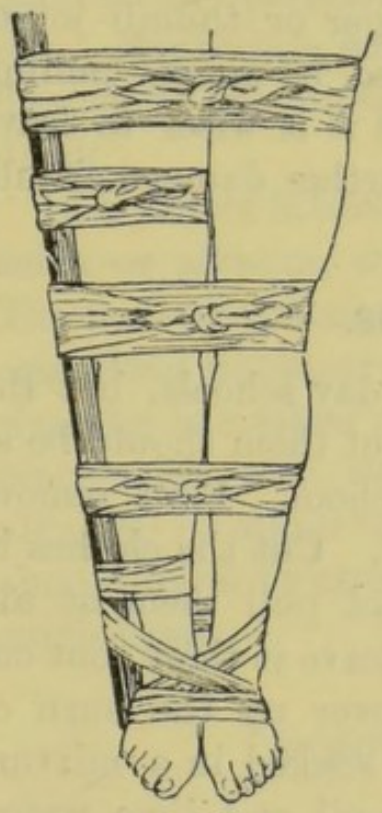


Fig. 149.

SPLINT APPLIED TO BROKEN LEG.

A broken leg is treated in a similar way. The splint should reach well up above the knee, and down below the foot. In all injuries to the knee, leg, foot, or ankle it is a good rule to tie the two legs together, so as to prevent any further injury being done by movement.

SPRAINS AND DISLOCATIONS.

When a joint is sprained there is usually a certain amount of damage done to the ligaments or membranes round the joint. The condition is usually very painful. The ankle joint is most often involved. A slight sprain is often relieved temporarily by a tight bandage round the joint. The treatment usually consists of cold applications,

such as cold water dressings, but as a general rule it is easier and more satisfactory to bathe the joint with water as hot as can be borne. If this is persevered with there is usually great relief obtained.

A joint is dislocated when the bones forming the joint have lost their usual relative position. This unnatural position causes pain and deformity, and as a rule the joint cannot be used. In many cases of finger or thumb joints the dislocation can be readily reduced by simply pulling the bones into place, but in most cases it is wiser to leave the operation to a medical man, lest further damage should be done.

BURNS AND SCALDS.

These are not common accidents at day schools, but the materials necessary for the treatment of them should be at hand in each department of every school. First remove any clothing covering the injured part. Cut the clothes in such a way that they drop off. Do not pull them at all, and if any clothing sticks to the skin leave it there, but cut off the loose parts all round. Then cover up the burn or scald with pieces of cotton or linen soaked in a mixture of linseed oil and lime water, or olive oil and lime water, or either of these oils alone. Another good dressing is a solution of carbonate of soda or washing soda in water or milk. Now cover the dressing with a thick layer of cotton wool or flannel. Keep the patient warm, and give some strong tea or coffee if there is any sign of faintness or depression.

Children should be instructed that if their clothing should catch fire the best thing for them to do is to lie on the floor and roll rapidly over and over. Few children, however, would retain sufficient presence of mind under such alarming circumstances, and the duty of a bystander

is to wrap round the burning child a rug, carpet, blanket, or coat, and then, laying it on the floor, roll it about rapidly until the flames are extinguished.

A common accident with children is the scalding of the mouth and throat by drinking out of teapots or kettles. In these cases the scalded parts swell up quickly and the child may suffocate. A doctor should be summoned at once, as an operation may be necessary to save the child's life. Meanwhile wrap up the child in a blanket, apply hot flannels to the outside of the throat, and give a little oil to drink.

In a school laboratory the skin is often burned by strong acids or alkalies, such as sulphuric acid or caustic soda. The best treatment is to immediately plunge the part into cold clean water, or hold it under the tap. When thorough washing has taken place it may be beneficial to wash the place with very weak acid (in the case of burning by alkalies) or alkali (for burns by acids), but such treatment should never be attempted until thorough washing has been carried out.

REMOVAL OF FOREIGN BODIES.

Substances, technically known as foreign bodies, may, as a result of some accident or mishap, have gained entrance to various parts of the body, such as the larynx, the stomach, the nose, eyes, ears, skin, etc.

Throat.

If a solid, such as a lump of food, a coin, a piece of bone, or even an orange pip, is sticking in the throat, or is drawn into the pharynx, it may cause most alarming symptoms: the face suddenly becomes purple, the eyes protrude, inarticulate sounds are made, and unconsciousness rapidly

comes on. Pass the forefinger into the mouth, reach down the throat as far as possible, and try to hook out the obstruction. Even if you cannot reach the obstruction your efforts may cause vomiting, which will do good. Sometimes a sudden slap on the back is effectual. If the exciting cause is some small object such as a coin or orange pip the old way of holding the child up by the heels, head downwards, and giving the back a smart smack is often successful.

Stomach.

When a child has swallowed some solid object, such as a plum-stone, a pin, needle, or nail, the next few meals should be given as dry as possible, and plenty of bread and vegetables should be eaten. Do not give aperient medicines.

Eye.

Small objects in the eye give rise to a great deal of pain and irritation, and should be attended to at once. The pain can usually be located and that part of the eye examined by partly everting the upper or lower lid by holding the eyelashes with the thumb and finger. When the object is seen it can be easily removed by means of the moistened corner of a handkerchief. If the object is seen to be sticking in the cornea do not attempt to remove it, but wait for the doctor.

Nose.

Occasionally children push up the nose small objects, such as beads, and fail to recover them. By making the child sneeze the object is often dislodged, but if this is not successful it will be best to await the arrival of the doctor.

Ear.

If some small object has become lodged in the ear it is best to refrain from taking any steps to remove it. Such matters are best left to a doctor. As a general rule the teacher will find it best, as a matter of common caution, to refrain from applying active remedies except in the simplest possible cases. The parent of an injured child is often inclined to blame some innocent and well-meaning individual who has attempted to help.

Skin.

Foreign bodies such as thorns, splints, or needles are commonly lodged in the skin. If their removal is obvious and simple there is no reason why it should not be attempted, but it is important to remember here also that unsuccessful attempts of this kind are apt to render the ultimate removal of the object a much more serious matter.

VOMITING.

A child may vomit owing to the most trivial cause, but on the other hand it may be the first indication of a most dangerous condition. It is commonly the first noticeable happening in the preliminary stage of scarlet fever, diphtheria, and other infectious conditions, as well as such severe illnesses as pneumonia and brain fever, or such dangerous conditions as obstruction of the bowels or rupture. On account of the possibility of it being an indication of some serious condition vomiting should not be regarded lightly. To relieve the feeling of nausea an excellent remedy is good effervescing soda-water.

FAINTING.

In overcrowded and ill ventilated school-rooms fainting is by no means uncommon. It is usually caused by

temporary feebleness of the heart's action, and is accompanied by paleness of face and some perspiration. Give the child fresh air and put the head as low as possible, either by laying full length on the floor or by bending the head and body forwards until the head is below the knees. Apply smelling salts to the nostrils, or sprinkle the face with cold water. When recovering it is beneficial to give some cold water to sip, but do not try to make the child drink during unconsciousness. Children should be taught that a most effectual remedy when feeling faint is to stoop down as if tying one's shoe-laces. This is usually quite sufficient to cause the feeling of faintness to pass away.

EPILEPSY.

An epileptic fit is a common cause of insensibility. In the severer type of disease the sufferer first screams, and falls down unconscious and rigid. Then the hands are clenched, the legs and arms are jerked to and fro, the face becomes purple, and foam often comes from the mouth. A common accident at this stage is the biting of the tongue if it happens to get between the teeth. The convulsive movements then gradually subside and finally cease, and the patient usually falls into a deep sleep. During the fit the eyes are usually turned sideways and they are quite insensitive to light and touch.

When a fit of this kind occurs the only thing to be done is to prevent the patient injuring himself. Loosen all the clothes about the neck, put something soft under the head, and if possible put a piece of wood or cork between the teeth to prevent the tongue being bitten. Do not try to restrain all movements, or give stimulants, or throw cold water on the face. Allow the patient to go to sleep as soon as possible.

Such fits usually recur at longer or shorter intervals, either regularly or irregularly. Children suffering frequently from severe fits should not be allowed to attend ordinary schools.

Much milder forms of epileptic attacks are common. Some are quite free from convulsive movements and are represented merely by loss of consciousness for a few seconds. The face becomes pallid, and there is usually perspiration during the attack. When consciousness returns the child may be liable to sudden eccentric behaviour or even acts of violence.

HYSTERIA.

As a rule attacks of hysteria are attended with laughing or crying, but occasionally there may be all the signs of an epileptic fit. There is, however, no real insensibility, and the condition may be distinguished by the patient resisting an attempt to raise the upper eyelid; also, when the eyelid is raised, the pupil will not be visible. The best treatment is either to leave the patient entirely alone or to dash a glass of cold water over the face.

POISONING.

In an ordinary school the possibility of poisoning is not very great, but if such an emergency should arise it is important to bear in mind the following rules:—

1. If the patient appears sleepy, keep him awake.
2. If there are stains about the mouth, with signs of blistering and destruction of the mucous membrane, do not give an emetic, but give raw eggs, milk, and then oils (linseed oil, olive oil, salad oil). Afterwards strong tea or coffee.

3. When there are no stains about the mouth give an emetic (large quantities of warm salt and water, or mustard and water, followed by tickling of the back of the throat by pushing the forefinger down as far as possible). Then give raw eggs, milk, and oils. Afterwards strong tea or coffee may be given. Do not give oils if there is a possibility of the poison being phosphorus.

DROWNING AND SUFFOCATION.

These are not common accidents of school life, but are possible ones. Instruction in the proper course to take in such emergencies should form a part of the teaching in all schools.

Although there may appear to be no sign of life in the body, it is the duty of those who are first on the spot to make every possible effort to restore animation.

Send for medical assistance, and in drowning cases try to get some hot blankets if any house is near, but do not leave the spot yourself. At once proceed to loosen all clothing about the neck and chest, and clear out the mouth if there is any froth or dirt. Draw forwards the tongue, and fasten it out by means of an elastic band, or ribbon, or strip of linen, which must be passed over the tongue and tied under the chin.

Then turn the body over on one side, resting the head on the forearm. Then turn it on the back, and rub the chest vigorously, exciting the nostrils, when possible, with snuff or smelling salts.

If no attempt at breathing is made by the individual himself, lose no more time, but apply artificial respiration at once.

ARTIFICIAL RESPIRATION (Silvester's method).

(1) Put the patient on his back, with a pillow beneath the shoulders. Pull out the tongue, as directed above, and keep the mouth open all the while.

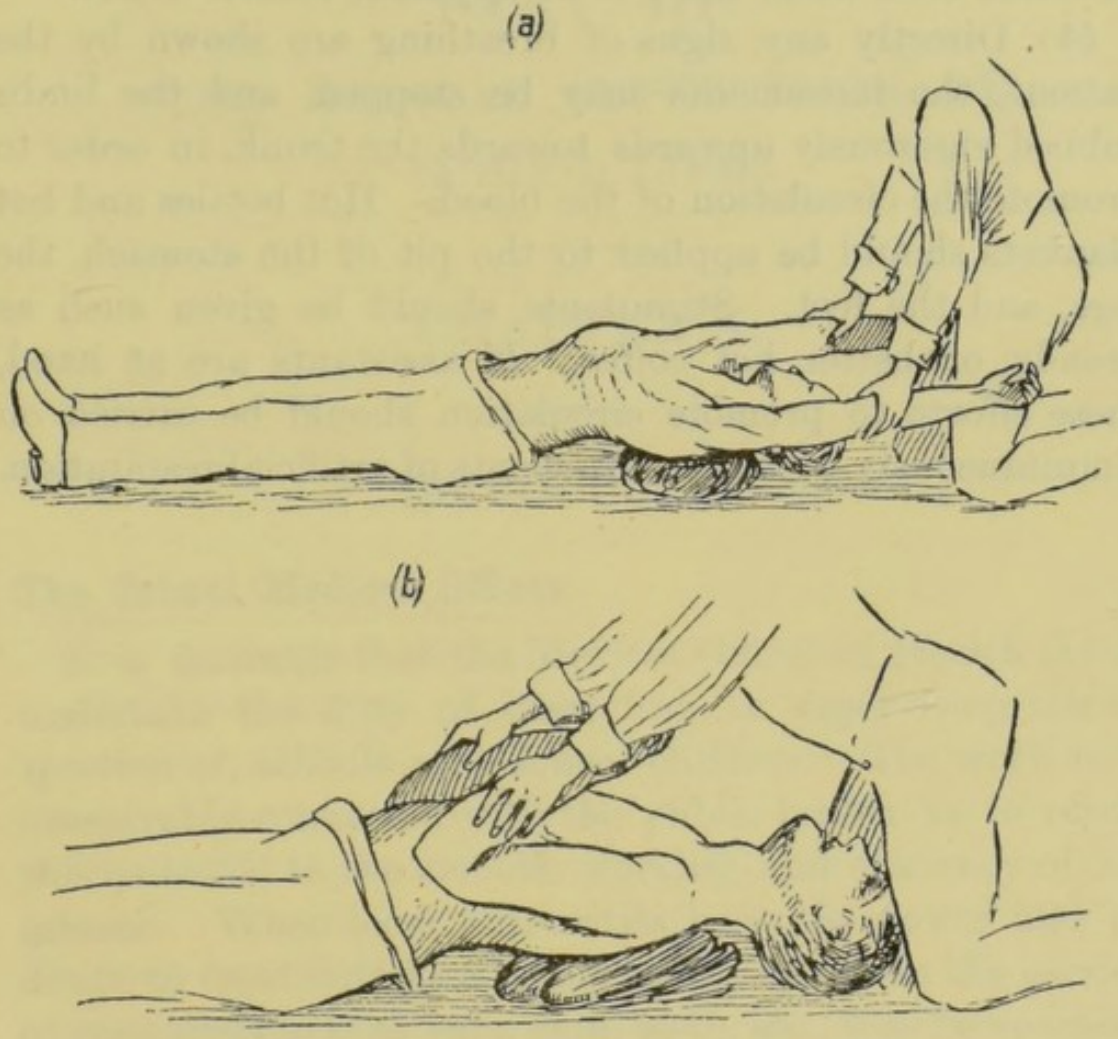


Fig. 150.

ARTIFICIAL RESPIRATION.

(*a*) Method of producing Inspiration. (*b*) Method of producing Expiration.

(2) To produce artificial inspiration, kneel at the patient's head, and grasp the arms just below the elbows. Then pull the arms slowly and steadily above the head. This raises the ribs and expands the chest, causing air to enter the lungs.

(3) In two or three seconds, produce artificial expiration, by bending the arms back again, and pressing them very forcibly against the chest. This forces the air out of the lungs. This double movement should be repeated about fifteen times a minute, and should be kept up for at least an hour, even when there is no apparent return to life.

(4) Directly any signs of breathing are shown by the patient, the movements may be stopped, and the limbs rubbed vigorously upwards towards the trunk, in order to promote the circulation of the blood. Hot bottles and hot blankets should be applied to the pit of the stomach, the legs, and the feet. Stimulants should be given such as brandy, or better hot coffee. If assistants are at hand, these efforts to promote circulation should be carried on simultaneously with the movements of artificial respiration.

PART III.

THE MEDICAL SUPERVISION OF SCHOOL LIFE.

CHAPTER I.

INTRODUCTION.

The School Medical Officer.

It is desirable that the Medical Officer of Health should undertake the duty of inspecting, or supervising the inspection of, schools and school children. The work is so inseparably connected with the public health as to render this essential to the smooth working and efficiency of any scheme. When local authorities have the power and the desire to treat defective bodily conditions, then the services of specialists in eyes, ears, skin, teeth, etc., *may* be necessary for a few special cases, but the school buildings, the health of the school children, and the inspection of the children should be in charge of the Medical Officer of Health.

MEDICAL INSPECTION AND SUPERVISION.

It is generally recognised that the organisation and direction of the medical inspection of schools should be assigned to the Medical Officer of Health, and the appointment of Dr. Newman as Chief Medical Adviser to

the Board of Education seems to show that the Board intends to take this view. The following considerations may be urged in favour of such a course:—

(1) The Medical Officer of Health represents the preventive functions of the Sanitary Authority and the work of medical inspection is largely preventive.

(2) He controls the sanitation of the child's environment,—drainage, water, overcrowding, food, ventilation, housing, plans of buildings and the like.

(3) He has access to the school for the purpose of examining the children for infection, and he has control of all the apparatus for managing infectious diseases.

(4) He necessarily has a hygienic interest in the child before it begins to go to school, during its stay at school, and after its school days are over. The child cannot be divided up into abstractions,—the home-child,—the school-child,—the street-child,—the factory child,—the work-child and so on. It is the same child right through its hygienic relationships and, as the school is the largest depôt of children for the time being, the Medical Officer of Health should have the administrative advantage that direct personal examination can give to the preventive functions of the Sanitary Authority.

(5) The Medical Officer of Health knows that the physical condition of the child is an index to the sanitary condition of the home, and he wishes to have this new line of entry into the home in order to improve the child's and the parents' environment.

Medical inspection should not mean merely dealing with epidemic and isolated cases, but should be a system whereby education will mean the development of body as well as mind. At present we neglect curable conditions in childhood and treat them later on in asylums and hospitals.

In Leipzig the children are systematically examined

about three months after admission to school. The preliminary examination is made by teachers under medical superintendence. Then the detailed examination a little later by the doctor. Most of the parents attend this. The doctor delivers a short preliminary lecture on personal hygiene, then in the presence of mother and teacher each child is examined. A separate card is filled up for each child, and this passes with it through the school. If defects are found the parents are directed to seek treatment.

Of course in very large districts and towns the whole of the work cannot be personally done by the Medical Officer of Health, and part of it may be delegated to an Assistant Medical Officer. The aim of those directing education should be to arrange that every child should be medically examined soon after it comes to school, and this examination should be checked every year. Parents are compelled to send children to school, and so during the school age they may be said to be in charge of the State. But ordinary school conditions are undoubtedly useless or injurious to certain children, and it is the duty of the State either to weed out these children and to treat them separately, or to endeavour to bring them to the normal condition and educate them with the others. Moreover it is likely that with skilled medical supervision the methods of modern education may be modified so as to produce less physical harm and more mental good than is achieved at present. In connection with such work there is also a vast field of possible research with regard to the development and mental conditions of childhood. Such an examination as is recommended should include information under the following heads:—Name, date of birth, height, weight, chest measurement, personal appearance, general development of body, cleanliness, condition of teeth, eyes and eyesight, ears and hearing, nose

and throat, deformities, diseases, etc. In cases of mental deficiency the head measurements should also be recorded.

Height and Weight.

The importance of this information has already been discussed and a table of standards is given on page 206.

Chest Measurements.

This is perhaps the best and most reliable indicator of physical capacity. It should invariably be recorded and carefully checked year by year. The results give a great deal of information as to the condition and development of the child. A well developed chest usually means sound lungs and heart, upon which the well-being of the body entirely depends.

Personal Appearance.

Under this head should be recorded the complexion, the appearance as to healthiness, carriage and general balance, and brightness and alertness.

General Development.

The general conditions of development and nutrition.

Cleanliness.

The condition of the body, the head, and the clothing should be carefully recorded, as affording, in the case of young children, an index of the character of the parent, and in older children a clue to the personal disposition of the child as well. Dirt always denotes ignorance and incapacity of the parent.

Condition of Teeth.

The importance of attention to the teeth has been explained elsewhere. Under this head the cleanliness,

attention received at home in the form of daily brushing, the shape, regularity, number missing, number decayed, and the number of permanent teeth visible above the gums should be noted. The shape and development of the palate may well be added here. (See Table at end of book).

Eyes and Eyesight.

Disease or deformity of eyes or eyelids, as well as the colour and the acuteness of vision should be recorded. From a school point of view it is sufficient if the child can manage to read ordinary type at the normal distance, and to see easily writing on blackboards or diagrams. It is occasionally pointed out that this may be done if one eye is normal, or by extra accommodation if the defect is slight, and a child may be suffering from an optical defect without having its school efficiency impaired. Later in life, however, after leaving school, such a defect may become very troublesome, and may prove to be a severe handicap. Consequently extremists advocate that conditions of short sight, long sight, and astigmatism should be accurately recorded. On the other hand it may be urged that if the routine examination is to include retinoscopic tests it will postpone, by its tedium and delay, the general adoption of urgently necessary medical inspection. If this is so, then the average child should be submitted to the general test of eyesight as already described and the more minute examination reserved for the cases weeded out by the general test, and also for cases where intellectual progress is unsatisfactory, and for special cases such as children suffering from persistent headaches, etc. In fact, the above plan represents all that is really necessary, and if generally adopted would prove of the greatest possible service.

Ears and Hearing.

The record here should show any deformity or disease of the ears, as well as the result of the test of hearing already described. If the general test shows hearing deficiency, then the ears should be tested separately. Avoid special minute examinations except where the general examination shows that the child has some defect and is therefore not capable of taking full advantage of the ordinary school instruction.

Nose and Throat.

It has already been pointed out that the condition of the nose and throat is an important index of the child's health. The condition of the tonsils, the cervical glands, the pharynx, as well as the habit of breathing should be recorded. The sense of smell may also be tested.

Deformities.

Congenital and acquired deformities should be separately noted. The congenital deformities include harelip, cleft palate, club foot, peculiarities of ears, indented nose, etc., all of which may be of great service in investigating the case of a mentally deficient child.

CHAPTER II.

THE ORGANISATION OF MEDICAL INSPECTION.

The Education (Administrative Provisions) Act came into operation on January 1, 1908. Section 13 is as follows:—

13. (1) The powers and duties of a Local Education Authority under Part III. of the Education Act, 1902, shall include:—

(*b*) The *duty* to provide for the medical inspection of children immediately before, or at the time of, or as soon as possible after, their admission to a public Elementary School, and on such other occasions as the Board of Education direct, and *the power* to make such arrangements as may be sanctioned by the Board of Education for attending to the health and physical condition of the children educated in public Elementary Schools.

This section of the Act was subsequently interpreted by the issue of a Memorandum by the Board of Education. The more important points dealt with in this statesmanlike Memorandum are:—

I. That the aim of the new Act is not merely to produce a record such as is obtained by systematic medical inspection, but to bring about a general physical improvement

of the race. It is extremely likely that by proper attention to the health of the children the numbers of the criminal and pauper classes will be considerably diminished.

II. As a result of the introduction of medical skill into the methods of education it appears very likely that the methods at present in existence will have to be considerably modified in order that they may be adapted to the physical needs of the children. It is beginning to be realised that a healthy and vigorous frame is, from a national standpoint, a matter of supreme importance.

III. *Organisation.*—The whole of the work is to be organised under the direct supervision of the Medical Officer of Health, and the Memorandum contains definite instructions that the existing machinery of medical and sanitary administration must be used to the utmost extent, and that the whole of the work should be carried out in intimate conjunction with the Public Health Authorities.

IV. *Grants.*—It is repeatedly emphasised that the work actually suggested in the Memorandum must be regarded as a minimum interpretation of the Act. The effectiveness of the working will be taken into consideration in determining the grant for the schools. In this connection it is to be noticed that beyond such minimum requirements certain important developments are mentioned, and in all probability the amount of the grant will depend upon the extent to which such developments are carried. For instance, special arrangements for attending to the health and physical condition of the children are expected to be submitted to the Board from time to time, and other special work is alluded to. It is very desirable that special earmarked grants will be made for the work of medical inspection and its inevitable sequelæ.

V. *The Teachers.*—The possibility of assistance by the teachers is alluded to, and the necessity of their cordial sympathy and help is specially mentioned. I have already dealt with this matter to some extent, and suggest that in the ordinary schools a special assistant teacher be selected in each department. It should be arranged for all teachers to receive some definite instruction on the subject, but so far as possible the teacher should be selected on account of some special knowledge of hygiene.

VI. *The Parents.*—It is evidently regarded as very important that the parents and the homes must be affected by the Act, and that a sense of duty and responsibility must be stimulated, also efforts must be made to obtain the attendance of one or both parents at the first medical inspection of the child.

VII. *The Medical Examination.*—The actual examination consists in recording certain facts regarding the previous history of the child and other facts relating to its present condition. Particular attention has to be given to the special senses, sight and hearing, and teeth. The inspection must be conducted in school hours and on school premises, and the facts entered in a register kept at the school. It will be necessary to keep records at the Health Department in the form of a sheet-filing system.

VIII. *The Routine Work.*—Four inspections of each child are suggested, the first on admission to school, the second three years after, the third after another three years' interval, and the fourth on leaving school. The ordinary year's work will be :—

(1) The examination of the children on entry, *i.e.* age 5 or 6 years.

(2) The examination of children ready for the second inspection, *i.e.* age 7 or 8 years.

(3) The examination of children ready for the third inspection, *i.e.* age 10 years.

(4) The examination of children leaving the school, *i.e.* soon after the thirteenth year.

IX. *Developments.* Further developments of the Act are outlined in the Memorandum, viz.: the establishment of school surgeries and clinics, the treatment of diseased and defective children, the provision of school baths, the provision of meals, and other matters.

X. A special recommendation with regard to the type of school books is of the greatest possible importance, and no school books should be purchased without the type having been approved by the Medical Officer.

It is difficult to imagine how the above work can be organised successfully in any other way than by co-ordinating it with the existing machinery of the Health Department of the Medical Officer of Health. To attempt to divide the work into two parts, school and general district work, with separate organisations, would be to directly and definitely invite endless friction and reduplication of labour. Everything concerning the health of the district should be organised entirely at the Health Department of the town or the county, and for smooth and efficient working it is imperative for the Medical Officer of Health to have sole charge and responsibility. Any attempt to separate the work would necessitate the employment of an inferior type of official, and considerably increase the total cost.

SYSTEM OF RECORDS.

(*a*) At Schools.

It is necessary first to decide upon the system that is to be adopted. In order to display all the examinations of any child in a manner that will be of value, a separate card

must be used for each child. A convenient size is ten inches by six inches. An objection to the card system is that it may become altogether disarranged without the defect being easily discovered. Also supervision is difficult, and any attempt to check the work involves considerable time and labour. On the other hand, the employment of a register appears to present insuperable difficulties.

The school cards are kept in a special box at the schools, and index cards should be supplied, so that they may be arranged in ages, boys and girls separately. In classifying into age groups the year of birth is the guide, *e.g.* during the year 1911 all children born in 1906 would be called five-year-olds and would be arranged alphabetically behind the index card marked "5 years." At the end of each year all cards would move up into the higher group.

The cards of children requiring parental or medical attention, as well as those that should be examined again at the next visit, are distinguished by a clip, so that they may be easily picked out from among the rest.

When the Medical Officer makes a routine inspection the necessary age groups (five-year-olds and thirteen-year-olds) are picked out and are at once in readiness for use. When a special visit is made in order to determine the progress of the children requiring attention the "clipped" cards are picked out and the required children can be presented to him without difficulty. If a child has received suitable attention the clip is removed from the card, but if further attention or treatment is desirable the clip is left on and the child continues to be a "special." The card used by the author is shown on pages 392, 393.

(*b*) At the Health Department.

If the above cards formed the only records it would be found impossible to prepare reports or to summarise the

HAMPSHIRE SCHOOL CARD.

NAME..... SCHOOL..... AD. NO. .....

ADDRESS..... BORN..... VACC. MKS. .....

DATE EXAMINED									
AGE									
HEIGHT									
WEIGHT									
CHEST MEASUREMENT	Inspiration ...								
	Expiration ...								
NUTRITION									
CLEANLINESS	Body								
	Head								
CLOTHING	Quantity								
	Repair								
	Cleanliness... ...								
	Boots								
SIGHT									
TEETH	Total								
	Decayed								
STANDARD									
ATTENDANCE									
CAUSE OF IRREGULARITY									
PARENTS' OCCUPATION	F. ...								
	M. ...								
HOUSE	Bedrooms								
	Living Rooms								
PERSONS IN HOUSE	Over 14								
	Under 14								

HISTORY.
(Insert age of child at time of illness.

MEASLES	
WHOOPING COUGH ...	
CHICKEN POX	
DIPHTHERIA	
SCARLET FEVER (Scarlatina)	
MUMPS	
SMALL POX	
RHEUMATISM	
TUBERCULOSIS	
FITS	
OTHER ILLNESSES ...	

SPECIAL FEATURES.

							Date.	IV.—Observations by Medical Officer.	Notices Issued.
Date of Examination									
Parents Present									
Deformity									
Paralysis									
Rickets									
Tubercle	Glandular ...								
	Pulmonary ...								
	Osseous								
Skin Disease									
Heart Disease									
Lung Disease									
Anaemia									
Epilepsy									
Chorea									
Nose and Throat	Articulation ...								
	Breathing ...								
	Snoring								
	Tonsils								
	Adenoids								
	Glands								
Ears	Hearing								
	Discharge								
Eyes	Squint								
	Lids								
	Conjunct								
Vision	Near								
	Distant								
Mental Capacity									

results obtained, especially as to averages of heights and weights, percentage of defective, etc. Summary sheets must therefore be used. The summary sheet used by the author is shown on pages 394, 395. The chief headings, arranged vertically upon the child's card, are placed horizontally on the summary sheet, so that the entries made upon the card at any particular examination can be copied upon the summary sheet opposite the child's name. There is room for twenty-five names upon a sheet, so that a full sheet would represent the maximum amount of work that can be done in half a day. The filling up of these sheets is described later on. Boys and girls should be entered upon different sheets, and separate sheets should be used for different ages.

These sheets, therefore, not only form records of work in the order in which it is done, but also provide a safeguard against loss or displacement of the separate cards at the school.

In those districts where the actual inspection has to be carried out by assistants to the Medical Officer of Health, these summary sheets regularly despatched to the Central Office are also of great value in comparing work done and in securing uniformity. Notes and queries can be made on the sheets, thereby saving a considerable amount of formal correspondence between the assistants and the Central Office.

ROUTINE INSPECTION.

1. Work by Teachers.

Every child in each school has its card. Different colours are used for the two sexes. In the case of the card reproduced on pages 392, 393, it will be seen that the schedule of medical inspection as outlined by the Board of Education has been followed largely, but that the matter has

been rearranged in order to secure certain obvious advantages. Additions have also been made which experience in such work has shown to be advisable, and others that are made necessary by the Board's memoranda. No additional cards are used for special cases. The cards for such children are denoted by a small clip, which remains fixed as long as the child requires attention. When the necessary parental or medical attention has been given, the clip is removed, and the card filed among those of children born in the same year.

The front of the card contains nine columns, one for each year of school life (five to thirteen years old), and these items are filled in for each child every year. Unless some such continuous record is made, it is difficult to imagine any real value to be attached to these observations. The regular performance of this work has, moreover, a very considerable educational value for both teachers and scholars. This is a point that is now beginning to be appreciated by large numbers of the teachers.

The teacher fills in each year items 1—16 on the card of every child in the school. All the items are checked by the medical inspector at the time of his visit, and, where necessary, items 10, 15, and 16 are filled in by him, if the teacher has had difficulty with them.

An excellent introduction to the work is afforded by a course of lectures to teachers by the Medical Officer, and the opportunity can be taken to explain simple methods of eye and ear testing such as can well be undertaken by teachers.

The cards are then supplied to the various departments in sufficient quantities, and boxes to hold 400 cards can be obtained at about 3s. 6d. each. The box should be kept under lock and key in a cupboard or desk. A circular

SUMMARY SHEET.

GIRLS ONLY (born in). NAME (Surname first).	Vac. Mks.	Date.	Age.	Height.	Weight.	Nutrition.	Cleanliness.		Clothing.				Sight.	Teeth.		House.		Persons in House.		Medical History.	Parent Attended.	Deformity.	Paralysis.	Rickets.	Tubercle.
							Body.	Head.	Quan.	Rep.	Clean.	Boots.		Total.	Decayed.	Bedrooms.	Living Rooms.	Over 14.	Under 14.						
1																									
2																									
3																									
4																									
5																									
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19																									
20																									
TOTALS																									

	Skin Disease.	Heart Disease.	Lung Disease.	Anaemia.	Epilepsy.	Chorea.	Nose and Throat.						Ears.		Eyes.			Vision.		Mental Capacity.	I. Directions to Teacher by S.M.O. II. Notices Issued.	IV. Observations by Medical Officer.
							Articulation.	Breathing.	Snoring.	Tonsils.	Adenoids.	Glands.	Hearing.	Discharge.	Squint.	Lids.	Conjunct.	Near.	Distant.			
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
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15																						
16																						
17																						
18																						
19																						
20																						
Totals																						

letter of directions is then sent to each head teacher. The following is an example :—

Medical Inspection of School Children.

DEAR SIR OR MADAM,

It is desirable that a school card should be prepared for every child in the school. The cards for children who reach the ages of five and thirteen years will be required first.

The buff cards are for boys and the azure cards for girls.

At the top of the card all the information can be filled up with the exception of the number of vaccination marks.

On the admission of any child, its previous history, with regard to the group of infectious diseases, should be carefully ascertained and noted ; the diseases that have been suffered from being denoted by a date placed against them. Also on admission the occupation of the father and the information concerning the house and the number of occupants in the house should be ascertained.

The filling up of the height (without boots), weight (in ordinary indoor clothes, but without shoes), and chest measurements should then be undertaken, chest measurements being taken under the outer garment, and the two figures should represent the minimum and maximum measurements.

The cleanliness of body and head should be recorded by writing the figure 1 if the child is clean, 2 if the child is not clean, and 3 if very dirty. If vermin are present write V against the figure used. Thus 2V means that the child is not clean and that vermin are present.

Similarly clothing (quantity and cleanliness) is denoted in three degrees, 1 meaning satisfactory, 2 not satisfactory, and 3 very bad.

The sight should be rapidly tested in the way that has been already described, and the children thereby classified in the three groups, the normal, the slightly defective, and the obviously defective, denoted by A, B, and C respectively.

The total number of teeth and the number among these that are decayed should be recorded.

Finally, the hearing is roughly tested in the way that has been described.

Faithfully yours,
R. A. LYSTER, *Medical Officer.*

For the ordinary year's work the teachers should get filled up as rapidly as possible the cards of those children who are due for medical examination. Afterwards the other children can be dealt with.

The figures 1, 2, and 3 are used and represent the three degrees of comparison. Thus "cleanliness 1" means that the child is apparently and usually very clean, while "clothing (quantity) 3" infers that the child is usually insufficiently clad. Item 9 (sight) is filled in by the teacher by dividing the scholars into three grades of vision, viz. $^6/_6$, between $^6/_6$ and $^6/_{12}$, and worse than $^6/_{12}$, and for this purpose special sight-testing cards should be supplied for their use. Children whose sight is not normal are further tested by the Medical Inspector, who records the condition carefully against item 15 on the back of the card.

As a means of education, both for teachers and scholars, the filling in of the item as to chest measurement is particularly valuable. The figures obtained are of no particular value for statistical purposes, but their educational value cannot be overestimated. The mere fact that the measurements of the chest, during full inspiration and expiration, are made, serves to impress upon those concerned their great importance, and the interest thus excited cannot fail to produce good results. Many teachers add, on the taking of such measurements, a simple lesson upon "breathing." In fact, it is evident that most of the items can be made of considerable educational value by intelligent teachers. The record of chest measurements at several schools reveals the interesting fact that these measurements in the case of choir boys were considerably greater than the average.

The information required concerning the house and occupants, as is clearly shown by the Board's Circulars 576, 582, and 596, is indispensable, at all events for future

work, and represents the minimum amount that must be obtained eventually if the scheme is to be developed upon the lines indicated by the Board of Education. These three questions represent the essential preliminary steps towards putting into effect the Board of Education's clear and oft-repeated instructions that all actions taken towards amelioration should be on the broad basis of public health.

It should be understood that this information is expected to be obtained only so far as it can be elicited from the children themselves by personal private questioning. In the case of infants, the spaces may be left blank until reliable information is obtainable. Its value is, however, not limited to a mere fulfilment of the requirements of the Board of Education, as it has an obvious local application. For example, the children in a certain school may be found on medical examination to possess a low average standard of health. If facts concerning outside conditions were not available, this low standard of health might be attributed to defects in the school itself, whereas the real reason may be the fact that the majority of the children live in insanitary and overcrowded homes. In individual cases the information would be of considerable value in helping the medical inspector to form a correct opinion as to the actual reason for any given case of ill-health.

The information as to previous illnesses is obtained at the time of entry to the school. Concerning older children, the parents should be requested to furnish it on special forms attached to the notice about the inspection. The facts under this heading will also gradually accumulate during the child's school life by the teacher filling in the child's age at the time that any of the recorded illnesses occur.

It is difficult to imagine any successful scheme of medical inspection in which the teachers are not expected to play a

very prominent part. In Hampshire, from the beginning of the work, this fact has been frankly recognised, and the teachers have been allotted an important part in the scheme. They have performed their part in a manner that has reflected the greatest credit upon them personally, and also upon their profession. I have always maintained that for all ordinary purposes an intelligent teacher is far more useful to the work of medical inspection than a nurse could possibly be, and the teachers here have amply justified such a contention.

It is obvious that if the cards were filled up entirely by strangers visiting the school, the disturbance of the school routine would be considerably greater, and the time occupied by the work would be increased. Particularly would this be the case when infants are being examined. Moreover, any information obtained only at the time of a special inspection, after due notice to parents, would be of little value in connection with items 7 and 8 (cleanliness and clothing).

Every teacher who realises the responsibility of his or her position regularly inspects the children as regards their general cleanliness. Also many teachers in the county have for several years been in the habit of testing the sight, and measuring and weighing the children every year. The present scheme simply requires the teacher to make these observations a little more exactly, and to record them on official cards.

2. Arrangements for the Inspection.

The following steps are now taken :—

A letter is sent to the head teacher to the effect that the Medical Officer will attend at the school at a certain day and hour, and requesting that certain groups of children (see page 389) be selected for examination. The

head teacher then sends out, at least one clear day before the medical inspection, the following notice to the parents or guardians of the children selected for examination.

DEAR SIR OR MADAM,

Under the Act of 1907 it has been made compulsory upon Education Authorities to arrange for the medical inspection of school children. The medical examination of your child has been arranged for next, the of , at o'clock at the school.

If you wish to be present during the examination I am to request your attendance at the school at the above-mentioned time.

Yours faithfully,

HEAD TEACHER.

The teacher should also see that the cards of the selected children are filled up as far as possible in readiness for the inspection. The maximum number of children for examination during any morning or afternoon is 25, and where the school is sufficiently large to permit it, children of the same sex and approximately the same age should be selected for examination at any one time. In any case it must be remembered that separate summary sheets must be used for boys and girls, and that one sheet should contain the records of children of approximately the same age. The entries made on the card by the teacher are copied on the summary sheet in readiness for the visit of the Medical Officer.

When the Medical Officer attends the school the head teacher should have ready a table and three chairs in a class-room, or a screened part of the school. The chairs are occupied by the Medical Officer, the parent (if present), and an assistant teacher. The head teacher should arrange that each child is prepared with clothes over the chest already loosened or removed, and that as each examination is completed the next child on the list is ready.

The Medical Officer rapidly fills in the parts of the card

not already completed, and then hands the card to the assistant teacher, who copies his records upon the summary sheet. At the end of the morning or afternoon the summary sheet forms an exact record of the work done at any one sitting.

3. Apparatus at each School.

At each school there should be provided a weighing machine, a box for school cards, with index cards by means of which they are divided into age groups, height measures, tape for chest measurement, and sight-testing cards (special for teacher's use, and ordinary for medical inspector's use). A weighing machine is necessary not only for each school, but also for separate departments of the larger schools.

4. Selection of Special Cases by Teachers.

The teacher should be invited to present at the time of the visit of the Medical Officer any children concerning whom a medical opinion may be considered desirable, and all such cases presented should be examined. As illustrating the excellent judgment that is displayed by the average teacher, I may mention that out of 5,627 children thus presented by the teachers in Hampshire, 4,800 were found to be in need of attention. A few teachers, unfortunately, still appear to be afraid to deal properly with the dirty children in their school, and fail to realise that without their active co-operation any considerable improvement in the cleanliness of the children is likely to be a matter of difficulty and improbability. Many schools have been completely transformed as regards cleanliness of the children by the activity and help of the head teacher.

Another very important matter that is at present inadequately realised by the teachers is the advisability of

exercising a certain amount of supervision over the cleanliness and condition of the teeth of the children. This is so obviously an educational matter that it should not be necessary to have to point it out to them.

5. The Medical Officer's Work.

Properly and intelligently assisted, it will be found quite possible to examine at the rate of ten children per hour, but a great deal depends upon the kind of assistance given by the teachers. The Memorandum of the Board of Education has been misinterpreted by some into meaning that all children were to be examined in detail, and that positive or negative opinions were to be expressed upon every point. Such cannot be the intention, because under these conditions the scheme would be unworkable.

Obviously the intention is to arrange for every child to have the benefit of medical opinion as to whether its physical and mental condition is such as to enable it to take full advantage of the educational opportunities that are presented. Children whose ages, heights, and weights are in proportion, who appear normal upon casual inspection, and who have passed the simple tests of sight and hearing conducted by the teacher, should be rapidly passed on. The essential object of the routine medical examination is to weed out those children who are abnormal.

The question that inevitably arises is whether an exact diagnosis of all abnormal conditions is necessary or desirable. My personal opinion is that all that should be expected of the school medical inspector is the *classification* of the abnormal conditions into groups, without exact diagnosis, except in the more obvious and simple conditions. My chief reason is that, as a rule, the school medical officer cannot possibly treat the cases that he discovers. A vast amount of the "amelioration" referred to

in the Memorandum of the Board of Education (beyond general schemes for controlling ringworm, verminous conditions, etc.) will be brought about by merely pointing out to parents the fact that children require medical attention, but there certainly would be friction if the children are taken to the general practitioners with a ready-made diagnosis on a card. Also the children passed on to hospitals or dispensaries for treatment would meet with a doubtful reception in such circumstances.

It will be far better to regard the Medical Officer of Health and the School Medical Officer chiefly as the means whereby the normal can be separated from the abnormal, the abnormal roughly sorted and classified, and also whereby improvements can be brought about in many general conditions concerning the scholars and school-life. For instance, at present, in many districts it appears to be sheer waste of time for a medical inspector to ascertain exactly the amount of deficiency of vision in a given case of defective sight. Very rough testing will determine whether the child can see sufficiently well for ordinary school purposes or not. If special attention is considered to be necessary, the sight undoubtedly will be exactly tested by the ophthalmic surgeon under whose care, either privately or at hospitals or dispensaries, the vast majority of such cases will come.

The school doctor will be far more profitably employing his valuable time in following the advice of the Memorandum and removing "unsatisfactory conditions of school-life which are a common cause of fatigue and of injured eyesight," and in bringing about such educational modifications as will avoid the necessity of spectacles and "diminish the prevalence of the bad habit of working the eyes near distance, or ensure the adoption of suitable type of letterpress for the readers' eyes."

At the medical inspection it is convenient to hand the cards, as they are filled up, to an assistant (a teacher usually), who copies the records upon a prepared summary sheet as already described. These summary sheets should be used separately for boys and girls and for different ages (in years). Such sheets enable the Medical Officer to keep the statistical records continuously up to date, instead of leaving an accumulated mass of material until the end of the year.

THE RESULTS OF INSPECTION.

As a result of the medical inspection of school children, it is possible to divide children as follows:—

(1) Normal healthy children.
(2) Children needing parental attention (dirt, vermin, clothes, lack of food or sleep).
(3) Children needing medical or surgical attention (eyes, ears, adenoids, skin diseases, anaemia).
(4) Children needing both parental and medical attention.
(5) Children suffering from physical defects, such as heart disease, serious myopia, or deafness, and therefore unlikely to benefit from ordinary school routine and surroundings, although of normal intelligence. Such children should be collected together and educated, as far as possible, in open-air schools.
(6) Crippled children.
(7) Epileptic children.
(8) Backward children.
(9) Feeble-minded children.
(10) Imbecile and idiot children.
(11) Blind children.
(12) Deaf children.

Exclusion of Children.

The exclusion of children by the Medical Inspector is, of course, a matter of frequent occurrence. The forms of exclusion are made out in triplicate by the Inspector, one copy being retained by the teacher, and two being forwarded to the central office. One of these forms is sent to the Director of Education, and the other one is filed. The form is as follows :—

Hampshire County Council.

Public Health Department (Medical Inspection Branch).

Exclusion of Scholars by School Medical Officer.

Name of School.....

.....Dept.

I have this day advised that the undermentioned Scholars be excluded from School on the grounds stated :—

Name.	Suggested Period of Exclusion.	Ground for Exclusion.

.....

School Medical Officer.

Date.....

CHAPTER III.

FOLLOWING-UP AND TREATMENT.

WORK OF AMELIORATION.

The work of amelioration must be attempted at first as a matter for experiment. Different districts require different methods, not only because their needs are not the same, but also because agencies are available in some that are not in others. After definitely ascertaining the needs of the district in these directions, and after carefully experimenting with different methods, it will be desirable that Local Education Authorities should ultimately formulate and submit to the Board schemes for the amelioration of the evils revealed by the medical inspection.

NOTICES TO PARENTS.

As a preliminary step in cases requiring medical or parental attention, and brought to light in one of the many ways referred to above, a notice should be sent to the parent. Notices concerning verminous heads have already been referred to earlier in the book, and similar notices may be sent concerning other cases requiring attention from the parents. Where medical attention is required a notice should be sent to the parent stating that the child is in need of medical attention, and requesting that the same may be obtained without delay. It is *not* advisable that a

definite diagnosis should be part of this notice. By following up such cases it will be possible to determine which of them are prevented by poverty from obtaining treatment. With the present poor law and its administration, the treatment of such cases presents almost insuperable difficulties, but it is, perhaps, not too much to hope that the day of the "guardians of the poor" is over, and that Boards of Guardians will soon cease to exist. It is impossible to understand why their existence has been tolerated for so long, in the face of so many revelations of incapacity and corruption on the part of both guardians and officials.

The old problem of poor law administration is constantly brought before all school medical officers. In their ordinary work they frequently meet genuine cases of need, and in still more instances they have such cases reported to them. Unfortunately, however, they can usually do nothing officially. Both friendly suggestions and simple reports appear to cause irritation and resentment on the part of relieving officers and all officials connected with the poor law administration. One would imagine, from common-sense principles, that there should be the closest intimacy between the public health organisation and the poor law work; in fact it is obvious to those people who have given time and attention to the subject that public health and poor law work should be practically one public department. But at present it is impossible to imagine any two departments more isolated from each other, and the public good must continue to suffer until they are brought together.

The machine-like methods adopted in poor law administration are resulting in the overcrowding of workhouses, and have increased rather than diminished pauperism. It not only, in many cases, robs the poor of the little self-

respect, courage, and independence that the stress of circumstances has left to them, but it also makes permanent paupers of many who, with a little outside assistance, would soon be able to hold up their heads before the world. Wise and humane discrimination is the essential part of successful charitable effort, and the public charity which treats all cases alike is as unwise as the private generosity which gives to all cases, whether deserving or not. The present poor law methods appear to have fostered a grovelling and shifty spirit among the poor, because it is found that such characteristics are the surest passports to assistance, while the few who have preserved their original and sturdy independence, and who constitute the very best type of the poor, regard the whole system with very obvious horror.

My reason for introducing this subject is that it is inseparably connected with the public health. Poverty and disease work on each other in a vicious cycle. Among the poor there is a vast amount of infectious illness continually present. Many such cases remain unreported, untreated, and practically unknown. They serve, however, as a continual and ever-present focus for the spread of such diseases among the general public. There is thus constituted a most grave public danger.

The only possible way to remove such a danger is to devise improved and more easily available means for treating these cases. Treatment and prevention are inseparably associated in practically all diseases. The one is essentially the complement of the other. By adequately providing for the early recognition and the proper treatment of all disease, an almost incredible improvement in the public health would rapidly result. The mere existence of disease, altogether apart from any consideration as to whether it is accomplished by destitution or not, should be sufficient

to ensure proper medical treatment, if the public are to be relieved of the ever-present dread of the sudden and rapid spread of infection.

For ordinary cases requiring relief everyone agrees that the closest investigation should always be made in order to separate the deserving case from the parasitic type that is unfortunately so common. But no such investigation should be required in cases of disease. In such instances it is not the individual but the public good that should be considered, and it is of urgent public importance that all such cases should be treated without one moment's delay. Only by such methods will a successful attempt be made to check the continual spread of disease.

Further Notices.

At a subsequent visit to the school, the Medical Inspector first sees all cases who have received such notices, and records their present condition, and whether medical treatment has been obtained for those who were in need of it. Further notices are issued if still necessary. In this way it is possible to keep up constant pressure upon the parents in order to cause them either to improve matters themselves, if the case is one needing parental attention only, or to seek medical attention through the usual channels.

By following out the above plan a good deal of improvement can be brought about, but it is desirable that some more continuous information as to the progress of the case should be forthcoming. Forms may be supplied to head teachers containing a list of the children concerning whom notices have been issued, and they are requested to write against each name the steps that have been taken towards improvement. Cases requiring parental attention (cleanliness, clothing, etc.) are reported as improved or unchanged or worse. Children needing medical attention are reported

to have received the same or not. These report forms pass frequently between the teachers and the Medical Officer, and give most valuable information as to the progress of the cases. In this way it is possible to send more frequent notices to parents, and the speed with which improvement is brought about in consequence is very greatly accelerated.

Children requiring Medical Attention.

The parents of Children found to need medical attention receive the following notice:—

Important Notice to the Parents or Guardians of

The above-named Scholar has been examined during an Inspection of the School, and found to be in such a condition as to need immediate medical attention.

You are recommended to give the matter your attention, and to obtain medical advice regarding it at once.

If the parents attend personally, the notice is handed to them, and its importance is explained. In their absence the notice is placed in an envelope and handed to the child to give to its parents. In some cases, the notice is sent by post. The condition requiring attention is described in general terms only, at the foot of the notice.

If defective vision is found, a special notice, similarly worded, which reads as follows, is given:—

Important Notice to the Parents or Guardians of

The above-named Scholar has been examined during an Inspection of the School, and found to need immediate medical attention on account of defective vision.

You are recommended to give the matter your attention, and to obtain medical advice regarding it at once.

For defective teeth a special notice also is given, which is similarly worded in front, and has the following additional advice on the back:—

Decay of the teeth is the forerunner and the cause of many serious conditions, especially in children. Decayed teeth interfere

with the nutrition of the child, and so prevent proper physical and mental development. Also they cause poisons to be formed in the mouth which may inflame and enlarge the glands in the neck, and thereby pave the way for tuberculosis or consumption.

It is also extremely probable that the unhealthy mouth and throat which is always associated with decayed teeth causes a child to be very susceptible to infectious diseases.

Children with Defective Vision.

Children suffering from defective vision receive notices on which the parents are urged to obtain the necessary treatment. Subsequent notices are sent if no treatment has been obtained, and every pressure should be brought to bear upon such parents to obtain the necessary treatment through the ordinary channels. If the parents are reported to be unable to obtain treatment on account of poverty, the cases may be brought before the notice of the Correspondent of the Managers and other local individuals who may be likely to help.

As the result of these efforts, a considerable proportion of the children are usually examined properly, and obtain spectacles where necessary. Some are able to get the prescription, but have no money for obtaining glasses. To meet such cases, many Education Authorities have entered into a contract for the supply of spectacles at special rates. The prices are as follows for spectacles with nickel steel curled frames :—

	s.	d.
With Spherical Lenses ...	2	2
With Cylinder Lenses ...	2	10
With Sphero-Cylinder Lenses ...	3	1

The advantages of this contract are available for the parents of any of the children attending the elementary schools if they can produce a proper prescription obtained either by means of their own efforts through the usual

channels or from the Medical Inspector as a result of the examinations at centres.

Information concerning the contract and the method of procedure should be sent to all head teachers and correspondents of managers. In many cases the head teachers are particularly active in securing prescriptions for the affected children, and assisting to raise the necessary funds for the purchase of the spectacles.

These efforts leave a certain proportion of cases without prescriptions, and in order to deal with these, the following scheme may be arranged. The Medical Officers attend at the schools at certain centres, varied from time to time, on Saturday mornings in order to examine special eye cases, and to issue prescriptions for spectacles if they are found to be necessary. To the parents of children who need such examination, and live sufficiently near to the centre to attend, the following notice is sent:—

To the Parents or Guardians of

Previous notices have been sent you with regard to your child's eyesight, which has been found to be defective. The condition of the eyes is likely to become worse by neglect, and it is most important for the eyes to be thoroughly examined at once by a Doctor, in order to ascertain whether spectacles are necessary, and, if so, the kind required. Neglect of the matter may injure the child for life.

Spectacles purchased without a proper medical prescription are likely to do more harm than good, and parents are specially warned about the danger of purchasing spectacles from chemists or opticians without previously obtaining a prescription from a doctor.

The Medical Inspector will be prepared to examine the eyes of your child on day, the day of ,
at
at o'clock. ,

No charge will be made for the examination. If spectacles are found to be necessary, a prescription for these will be given. The cost of the spectacles will not exceed three shillings and one penny.

Please sign and return this form to the Head Teacher at once. It

is important for me to know whether you intend to bring the child as requested, and whether you are prepared to pay for the spectacles at the time of the examination.

(Parent's Reply.)

I intend to bring or send my child as requested, and wish for a thorough examination of the eyes to be made. I shall be prepared to pay for the spectacles at the time (if they are needed).

Signed

At the same time the teacher is sent a notice as follows:—

The Medical Inspector will attend at
on day, the day of
at o'clock, to examine the eyes of children. A notice, in the terms given on the other side hereof, has been sent to the parents or guardians of each of the children whose names are given below. I shall be glad if you will return to me, not later than the ,
all forms received back from parents. If no reply is received from the parents of any child by that date, please inform me of the fact.

On the back of this letter is a copy of the notice that has been sent to the parents. From the replies received from teachers it is possible to map out a satisfactory morning's work at each centre.

Parents unable to pay for the glasses at the time of the examination receive the following notice:—

To the Parents or Guardians of

The sight of your child has been carefully examined by the Medical Inspector, and glasses are found to be necessary. The prescription for the spectacles has been recorded, and they may be obtained on payment of

The money should be sent to me, together with this notice, and the glasses will then be forwarded.

If you are unable to pay for the glasses, application should be made at once to the Relieving Officer for your district.

Important.—You are reminded again that the sight is liable to get worse, and the child injured and handicapped for life, if the matter is neglected. Spectacles should be obtained without delay.

Ringworm.

The disease is one which is most difficult to cure even when intelligent and persistent treatment is applied. As a general rule, however, the treatment undertaken consists of the application of various quack remedies supplied by chemists, and the case goes on month after month without any signs of improvement. The trouble is usually spread by a child returning to school almost but not quite cured, and in this connection it must be remembered that for the purpose of determining the existence of the disease microscopical examination of the hairs is absolutely essential. The disease is not only spread by direct contact between infected and healthy children, but also by insufficient cloak-room accommodation.

In order to stamp out the disease, the following steps would be necessary:—(1) The careful and immediate exclusion of all infected children. Teachers are doing this, but are doing it irregularly. Definite instructions should be given to teachers to exclude all cases of ringworm, and to notify these, together with any suspicious cases, to the Medical Officer. They might at the same time give the child a copy of instructions to the parents as to the steps that should be taken.

(2) No children once affected by ringworm should be re-admitted to school without a medical certificate as to freedom from infection. If the plan is to be successful, it would be necessary to insist upon hairs from the infected part of the scalp being sent to the laboratory of the Medical Officer for microscopical examination. Such an examination might be undertaken free of charge. It would be necessary, however, to arrange some scheme for the payment of the medical certificates that would be required under this plan. An alternative plan would be

to arrange for all excluded children to be examined by a member of the medical staff before being re-admitted.

(3) Excluded children would have to be very carefully followed up either by Attendance Officers or by Health Visitors or by the help of Local Committees. Otherwise they would be away from school indefinitely without adequate treatment being obtained.

(4) The above plan would probably work satisfactorily, but it would entail rather long absences from school, particularly in some cases. The period of treatment could be very considerably shortened by introducing treatment by X-rays. By means of such treatment the necessary period is cut down to a minimum. It should be possible to arrange for a portable form of such apparatus to move from centre to centre until the whole area was clear. In towns, of course, one centre would be sufficient.

Children requiring Parental Attention.

The parents of children who are found to be neglected as regards their cleanliness, clothing, boots, etc., receive the following notice:—

Important Notice to the Parents or Guardians of

The above-named Scholar has been examined during an Inspection of the School, and found to be in such a condition as to need your immediate attention.

You are recommended to give the matter your attention at once.

At the foot of this notice an indication is given as to the matter that particularly needs attention from the parent.

Children found with verminous heads receive one of two notices which are somewhat differently worded in order to meet the needs of the slightly affected and the more badly verminous cases respectively. For the less severe cases the notice which reads as follows is sent:—

Private Notice.

The careful and regular examination of the heads of all Children at School has been found necessary in order to ensure more satisfactory conditions.

Your attention is drawn to the fact that there are nits on the hair of.....

On the other side you will find directions for satisfactorily dealing with the matter.

For the more severe cases the following notice is sent:—

Private Notice.

The careful and regular examination of the heads of all Children at School has been found necessary in order to ensure more satisfactory conditions.

Your attention is drawn to the condition of.....
..... head.

By attending to the directions given on the other side, the head can be made quite clear within a week. If the condition is not perfectly satisfactory by that time the child will have to be kept separated from the others in school until it is remedied.

On the back of both these notices are printed the following clear instructions:—

Treatment of Heads of Children.

Even clean children are liable to become infected with vermin, and it is therefore necessary to carefully examine the hair every week or oftener.

In every case where nits are present on the hair it is advisable to crop it short all over, as a great deal of time and trouble is saved thereby.

The treatment to be applied is as follows:—

First Night.—Wash the head thoroughly with soft soap and hot water and dry it with a dry warm towel. Then rub in sufficient Paraffin Oil over the head so as to leave the whole of the Hair and Skin completely wet with oil. The oil is left on until the next night.

Caution.—Do not use Paraffin near a fire or a naked light.

Second Night.—After combing the Hair with a fine-tooth comb, the head is thoroughly washed again with soft soap and hot water, then dried, and the Paraffin applied as before.

Third Night.—The head is again combed, washed, dried, and the oil applied as before.

In most cases, if the above directions are carried out thoroughly, there will be no nits to be found after the third day. The worst head can certainly be cured within a week. The head should be thoroughly searched for nits, and if any are found the treatment must be carried out again each night until the head is perfectly clear.

The presence of crusts or scabs on the head makes the above treatment more urgently necessary. The scabs should be carefully removed when they are softened by the washing. Iron the collars of all the clothes with a hot iron.

After the head is quite clear it is advisable to follow out the above treatment once a week to ensure perfect cleanliness.

Many of these notices are sent by post direct to the parents, particularly in the case of the larger schools. If at a subsequent examination an improvement is found, but the child is not yet quite clear, a further notice is sent:—

Private Notice.

The careful and regular examination of the heads of all Children at School has been found to be necessary in order to ensure more satisfactory conditions.

The condition of

has improved since the date of the previous notice, but it is not yet clear of nits.

On the other side you will find directions for satisfactorily dealing with the matter.

If, on the other hand, the child continues to be in a badly verminous condition after frequent notices, a final notice is sent:—

Second Warning.

To the Parents or Guardians of

As the Private Notice sent you with regard to this Child's Head has been disregarded, the Child has now been separated from other

Children in school as unfit to be in the ordinary class. You are again requested to remedy the unsatisfactory condition within the next week. If you fail to do so the Child will be excluded from school, and you will be liable to prosecution and fine for not sending it in a fit state to school.

A good method of treatment is given on the other side of this card.

For parents in whom it is possible to awaken a sense of responsibility, these notices are quite sufficient, and the child is sent to school clean. Among a considerable percentage, however, they have no effect. In such cases the child either continues to attend school in its original verminous condition, or, if it has been excluded, returns after a few days' absence without any improvement.

The latter constitute the worst type of child and parent, viz. the child of the defiantly and persistently dirty mother. These families are in many instances for years a continual source of trouble to the teacher and to the clean families, and all efforts to bring about improvement or to awaken any sense of responsibility in the parents are in vain. Previous to the day of the medical inspection at the school, these parents (in accordance with the instructions of the Board of Education) receive notice of the visit of the Medical Inspector. In nearly every case they either keep the child (or children) at home during that day, or bring about a temporary improvement sufficient to pass muster, but soon to return to their previous condition. It should be borne in mind that so long as there are a few persistently verminous children in a school, it is impossible to prevent the other children being continually infected.

It is obvious, therefore, that the scheme of medical inspection outlined by the Board of Education would by itself prove entirely a failure so far as any permanent improvement of the verminous conditions in the schools is

concerned. Even very frequent medical inspections would, as shown above, fail to bring about the desired results, because the bad cases would be merely kept at home on that day. Moreover, frequent medical inspections are not practicable in a county area, and would, in addition, seriously interfere with the school routine.

Shortly after the commencement of the work of medical inspection, it became apparent that additional and more regular information concerning the condition of the verminous children was indispensable, in order that the sense of responsibility of the neglectful parents might be aroused or definite pressure brought to bear upon them to cause them to bring about improvement. It was found, however, that the difficulties in the way were apparently insuperable. Even if one of the medical staff was able to pay a few surprise visits to schools, his legal position in making a thorough examination of any children was extremely doubtful and unpleasant. The teachers, in a great majority of cases, were perfectly willing to assist in any scheme for bringing about an improvement in the cleanliness of the children, but they, in their turn, were uncertain of their legal position, and it was not considered fair to ask their help while such was the condition of affairs. All these difficulties were removed by Section 122 of the Children Act, 1908, which came into operation on April 1st, 1909.

Section 122, Children Act.

This Section can be made of some use in connection with the work of medical inspection, as it gives a definite and direct power to the School Medical Officer or any person acting under his authority to examine at any time the person and clothing of any child attending school. If the person or clothing of any such child is found

to be infected with vermin or in a foul or filthy condition, notice can be sent to the parent requiring him to cleanse properly the person and clothing of the child within twenty-four hours. If this notice is not complied with, the person and clothing of the child may be cleansed by any person acting under the authority of the School Medical Officer. Many Education Authorities are arranging to carry out this cleansing process upon some part of the school premises in those districts where public baths are not available.

A somewhat unsatisfactory point about this Section is that no punishment is provided for the careless parent until the child has been cleansed by the Education Authority as described above and has been allowed to get into a dirty condition again. Many Authorities will therefore probably decide to continue to deal with such cases as they are doing at present.

This Section also definitely establishes the legal position of the Medical Officer when examining these children on the occasion of surprise visits to schools. Also, with the approval of the Committee, there can be given to those head teachers who have expressed their desire to help an authority to examine, thereby making their legal position perfectly clear. In county areas it is hardly practicable at present to use Section 122 of the Children Act any further than the acquirement by it of the right to examine children in the public elementary schools, with a view to ascertaining their cleanliness. In fact, any further action under this Section is impossible in most county areas. The authority to examine under the Section merely establishes the legal position of the teachers, and enables them to report upon the subsequent condition of children who at the time of the medical inspection have been found to be verminous, and also those habitually verminous children who have evaded

the inspection, and who could continue to evade it for an indefinite period.

When, at the time of the medical inspection, a child is found to show evidence of vermin, a notice is given. Very bad cases are excluded for a specified period. After a reasonable interval usually about a fortnight, a list of these children is sent to the teacher, with a request that the children may be examined and their present condition reported. Parents whose children show no improvement are then sent a stronger notice, and the teacher again reports upon their condition after another interval. The parents of children who are still unsatisfactory receive another of these notices, and this process is repeated, when necessary, several times. In this way it is possible to awaken some sense of responsibility in most of the parents and most of the children are reported "clean" after a few weeks.

There still remain untreated and unimproved the children of persistently and defiantly dirty parents who can only recognise and appreciate compulsion. To these are issued the final notice. If, after the expiration of another week, its condition is not improved, the teacher is instructed to exclude the child from school, and the case is reported for prosecution under the attendance bye-laws. The powers conferred by Section 122 of the Children Act have changed the vague and indefinite possibilities of this work as included in the general scheme of medical inspection into the definite and precise action outlined above. Without these powers the difficulties in a county area would have been almost insuperable, and the time of the Medical Inspector would have been taken up year after year in sending useless and disregarded notices to the same parents.

Section 12, Children Act.

Section 12 of the Children Act, 1908, gives certain power of action against wilfully neglectful parents. Failure to provide medical aid, or, if being unable to provide medical aid, failure to take steps to procure the same under the Acts relating to the relief of the poor, is specially mentioned as one kind of neglect. When all ordinary means by notices and by local persuasion have failed, this Section should provide a very valuable means of compelling careless and neglectful parents to assume their proper responsibility to their children. There is no doubt that quite a large number of parents are deliberately neglecting their children, and only some such treatment will bring them to reason.

District Sub-Committees.

The formation of special sub-committees for dealing with cases discovered by the inspection is greatly to be desired. Persons should be chosen who, besides being educationists, are interested in health questions, or who occupy positions which enable them to influence philanthropic or charitable agencies for the amelioration of conditions of defective eyesight, teeth, or hearing, and for treatment in general. Deficient food and clothing are also matters that will certainly occupy the attention of such a committee.

A great amount of good could be done by properly organising existing local energies and charities, and by directing the attention of local philanthropic persons towards these special cases. Probably a great deal of philanthropic effort is being wasted at the present time by being directed towards undeserving and unsuitable cases or in aid of unnecessary treatment.

If the Managers of each school could be induced to take an active interest in this work, there should be no difficulty

in the formation of a small local Committee from among them. The work of such a Committee would be to undertake to report upon the list of special cases that have been discovered at the school, and to ascertain by visits the circumstance of each case. The Committee would also be able to direct local charities and philanthropic efforts towards these cases. Tact and sympathetic handling would, of course, be essential for success, and the work should therefore only be attempted by those who are keenly interested in the physical improvement of the children.

The detection and tabulation of defects among the children in the country have now proceeded for sufficient time for the accumulation of a mass of material that requires to be dealt with in some such way as has been outlined above. Such detection and tabulation, although an essential part of the scheme, should be regarded merely as its introduction.

Many of the conditions requiring immediate medical attention (defects of vision, defective teeth, skin diseases, enlarged tonsils, adenoids, etc.) are regarded by a great number of the parents with indifference and unconcern. One of the effects of the work of a local Committee would be the education of these parents, so that they might appreciate the gravity of such conditions, and be helped to understand the fact that the future life of the child will be very largely influenced by the amount of attention it obtains during childhood.

Some practical results are obtained without difficulty, but there usually remain a large number of cases that can only be dealt with by some local organised effort. If this can be brought about, the definite practical results of the scheme of medical inspection will be obvious to everyone, and criticisms that may occasionally be fairly directed towards the scheme will then be groundless.

Organisation of the Work of Attendance Officers.

A considerable amount of help could be given by the proper organisation of the work of attendance officers. At present these officials have to visit the homes of absentee children, and it is not unreasonable therefore to suggest that they might visit the homes of special cases, particularly excluded children, in order to ascertain what treatment, if any, is being employed. Regular reports concerning such cases would be of the greatest possible help, and would enable proper pressure to be brought to bear upon neglectful parents in order that they might secure the necessary treatment. Also attendance officers should be required to report dirty, overcrowded, or insanitary houses that come to their notice. In fact there appears good reason to expect that in the near future the attendance officers will form an important part of the staff of the school medical officer.

The above is intended merely as a suggestive outline of work to be performed. It is undoubtedly capable of almost indefinite improvement and extension; but, judging from the gratifying thanks received by the writer from medical officers to whom he has explained the methods used by him, it may prove to be useful in some cases.

CHAPTER IV.

GENERAL AMELIORATION.

In connection with the subject of amelioration it must be remembered that prevention plays at least as important a part as actual treatment, and that both prevention and treatment should be regarded as public health work.

PREVENTION.

(1) **Before School Age.** A large proportion of the defects, diseases, and unsatisfactory conditions are undoubtedly present before the child reaches school. They are largely due to the carelessness and ignorance of parents, deficient or improper food, and, to a limited extent, to insanitary home conditions. The prevention of these is obviously a very broad subject, but it may be advisable to suggest here that a great improvement would take place in the next generation if the education of the older girls at the schools were altogether revised and made to bear more particularly upon their future life. Most of these girls have no chance of any proper home education, and their education at school does not help them in any way to become better wives and mothers.

By means of a complete system of co-operation between the Medical Officers of Health and School Medical Officers it is possible to get defective home conditions dealt with as

soon as they are discovered. At the medical inspection of children many are discovered whose condition leads one to suspect that the home conditions may be unsatisfactory, and concerning such cases the advice and help of the Medical Officer of Health are sought at once, and are always available. The visits of the Medical Officer of Health or the Sanitary Inspector to these houses often leads to the discovery of younger children, below school age, in a neglected, dirty, and diseased condition. It has been possible to deal with many such cases, and to bring about a considerable improvement.

Another very important matter is the obvious lack of proper medical assistance to poor people. The Poor Law medical service is available only for those who are destitute and are willing to receive the brand of pauperism. Between these people and those who have the means to provide proper medical attention there are vast numbers who are just able to afford the bare necessaries for existence, and who cannot possibly provide medical attention for themselves or for their children. The result is that minor defects and maladies are neglected or are treated by chemists or quacks, with the result that by the time school age is reached a considerable proportion of the children are injured and handicapped for life. The only remedy for this is the entire reorganisation of the Poor Law medical service, and the provision of a proper medical service available for all people who are unable to provide the same.

(2) **At School Age.** Similar remarks apply to the needs of children of school age. The additional means of preventing the production or aggravation of defects during school age are mainly improvements in school conditions. Defective vision, curved spines, nervous conditions, and the spread of infectious maladies may be fairly attributed to defective lighting, improper desks, over-pressure, and

lack of proper space and ventilation respectively in the schools. A considerable amount of prevention is possible by improving the lighting, warming, cleanliness, equipment, and sanitation of the schools. More active measures would include an alteration in the school curriculum in conformity with modern views, and the introduction of adequate exercises and games as part of the school time tables. It is, for example, astonishing to find still that sewing is taught children under seven years of age in spite of the vast amount of discussion that has taken place and warning that has been given in connection with the subject.

TREATMENT.

The possible methods of treatment may be divided into (1) use of existing agencies and (2) direct treatment by an Education or Sanitary Authority. The Board of Education suggest consideration of existing agencies as far as possible in any scheme of treatment. The existing agencies for the provision of medical and surgical treatment are the local doctors and dentists, hospitals and dispensaries, medical clubs, and the Poor Law medical service.

Local Doctors and Dentists. The ordinary notices that are sent to the parents undoubtedly cause a proportion of these to pay a visit to the local doctor. Many of them go, although they are not in a position to pay, and there is no doubt that in several cases treatment is obtained without the doctor having any prospect of pay for his services. On the other hand, it must be remembered that for the treatment of many of our cases the local medical men make no provision. Few of them undertake the detailed examination of eyes or the operative treatment for tonsils and adenoids, because they have found in the past that the remuneration that they are able to get is totally inadequate for such extensive provision and skilled work. I have no

doubt that many of them would be very glad to undertake the work, and would do it well, if they could be sure of adequate pay. Dentists are practically unknown in the small villages unless a large village or town is near. A good deal of work for them could be found in most districts as the results of inspection, and I have no doubt that the supply would very quickly equal the demand if there were any provision for remuneration.

Hospitals. The hospitals have dealt with a very large number of cases that have been discovered by the inspection of the schools, but they are very naturally protesting against the increase of work, and are pointing out that such public work ought not to be provided for by an extension of the gratuitous work of the medical staff. Several of them have also very forcibly expressed the opinion that it is not their legitimate duty to enter into business arrangements with a public authority. It will be, therefore, necessary in the near future to organise our schemes without reference to hospitals. The medical men attached to such hospitals have in the past given their services freely because other philanthropic people have been providing the necessary funds for the upkeep of the various institutions. As soon as public money is devoted to their maintenance, such an arrangement must be altogether upset, and the establishment ceases to be purely philanthropic.

Poor Law. The Poor Law medical service is, or should be, available for certain cases. The attention of Guardians is often drawn to special cases, and in some instances treatment has been obtained. The provision of spectacles for poor children has been made by some Guardians. Some Boards of Guardians have made a special arrangement for the operative treatment of cases of tonsils and adenoids, and are paying a special fee to their medical officers for such cases.

Assistance to Parents. Under the Education (Administrative Provisions) Act, 1907, Education Authorities apparently have power to present to the Board schemes dealing with medical treatment. Such a scheme might involve monetary assistance to parents for such purposes as the provision of spectacles, surgical boots, or grants towards special medical or surgical treatment. Of course, the exercise of a great deal of care would be necessary in dealing with these grants, and the work might be simplified if help from local Committees such as I have suggested were forthcoming. Local Committees could be required to satisfy the County Authorities that every effort had been made to deal with the case by other means and that all efforts had failed. The need of such funds is very obvious to those who are actually engaged in the work. Some districts are well provided for either by local charitable funds or philanthropic persons, while in others there are no such advantages, and appeal to the Poor Law Authority is met with a curt refusal.

DIRECT TREATMENT.

(I.) Treatment of Verminous Children.

Section 122 of the Children Act, 1908, gives power to an Education Authority to remove any child to suitable premises, and there properly clean the person and clothing of such child after giving twenty-four hours' notice to the parent. In most county areas facilities for dealing with children under this Section will be extremely limited, and in order that the matter may be attended to satisfactorily, it would be necessary to provide at new schools some form of bath, and also apparatus for sterilising clothing.

(II.) Provision of Health Visitors.

I have already pointed out that in my opinion there is no necessity for or advantage from the visits of nurses to schools, and the smooth working of the scheme of medical inspection in Hampshire and other areas proves conclusively that at all events they are not indispensable. They can, however, be undoubtedly of help in following up and in visiting the homes of the special children discovered at the medical inspection. If this is to be their duty, they should be called Health Visitors, and they should be part of the staff of the Health Committee. Their work would be entirely a health matter, and could not be claimed to have any real relationship to education.

The duties of these nurses would be :—

(1) To visit cases of (*a*) uncleanliness, neglect, verminous conditions of head, body, or clothing, with a view to giving advice and assistance to parents, and to report progress ; (*b*) cases of ringworm, scabies, and impetigo, in order to ascertain the nature of the treatment provided.

(2) To visit the homes of all children the examination of whom leads the Medical Inspector to suspect that the home conditions are bad or that the parents are neglectful.

(3) To report to the local Medical Officer of Health all cases of infectious disease, insanitary houses, overcrowding, etc., that are met with in the course of these visits.

(4) The services of the nurses would be available to treat, under the direction of the local doctor, cases of discharging ears, inflamed eyes, etc.

(III.) Provision of Medical Treatment.

I have already pointed out that a very large number of people are quite unable to afford proper medical attention and treatment, and yet are unable or unwilling to obtain such treatment through the Poor Law. The methods I

have outlined above would undoubtedly ameliorate the condition of these people, but probably the only complete and really satisfactory solution of the difficulty would be by the provision of some public medical service quite independent of guardians, available for those whose means are obviously incapable of providing the same.

Attempt to make some such provision is now being made by some Authorities by the establishment of school clinics, which provide the treatment for persons of school age. The defects usually attended to at the school clinic are defective vision, ear discharges, ringworm, sores of all kinds, *e.g.* sore heads, impetigo, scabies, sore eyes and eyelids. This would leave untouched cases requiring operations for tonsils and adenoids and attention to teeth, which cases are at present causing us considerable difficulty. On the other hand, it is obvious that the school clinic once established would be able to extend its work to the treatment of those conditions. The chief advantage of the school clinic is that it ensures the treatment of such diseases among those children who at the present time are neglected. Cases of ringworm, sore heads, sore eyes, running ears, etc., which at present remain untreated and unimproved for months at a time, can be dealt with and cleared up promptly.

Of course, vigilance could be exercised in order to prevent persons able to pay for medical treatment from obtaining treatment at the school clinic. If any such were found to have obtained treatment, it would be possible for the Education Authority to recover the cost of such treatment summarily as a civil debt from the parent under the Local Education Authorities Medical Treatment Act, 1909. The recovery of this from some cases would probably act as a sufficient deterrent in others.

Another method of providing direct medical attention

for those children who are found to be needing it, but whose parents are quite unable to provide the same, would be by means of some form of "voucher" system. After careful and thorough investigation of the circumstances of the parents, and after all efforts to obtain assistance through local philanthropic funds or persons had failed, an excellent plan would be to hand to the parents a voucher which could be presented to any local man, who would thereby be assured of definite payment for his services, and who would therefore promptly proceed with the necessary treatment.

In order to organise successfully any such scheme, it would be necessary to come to some arrangement with the local divisions of the British Medical Association as to the fixed terms that would be accepted. I recommend this suggestion to the very careful consideration of the Education Committee. The number of cases to be treated by this method would not be unreasonably great, while it would be extremely valuable to have such a possibility in reserve when all efforts to obtain treatment had failed.

(IV.) Provision for Specially Defective Children.

(*a*) *Blind and Deaf Children.* Provision may be made for blind and deaf children under the powers contained in the Elementary Education (Blind and Deaf Children) Act, 1893.

Blind Children. There are 25 residential schools and 15 day schools for blind children in England and Wales, accommodating about 1,500 children.

The chief cause of blindness among children is neglected or improperly treated ophthalmia soon after birth. It is no exaggeration to say that nearly one-half of the blind children are thus handicapped by sheer ignorance and carelessness. Another important cause is neglected or

improperly treated ulceration or inflammation of the cornea, resulting in opacity. Similarly, disease of the retina or optic nerve, if not promptly and efficiently treated, is likely to end in blindness. The prevention of this condition therefore resolves itself into adequate and prompt medical treatment.

It is being gradually realised that a day school is unsuitable for the training of blind children, and that the residential school is the only satisfactory provision to make up for such cases. Children not really blind, but incapable of seeing sufficiently well to be taught in ordinary schools, should be collected and taught in special classes where such a course is practicable.

Deaf Children. For these children there are 20 residential schools and 28 day schools in England and Wales, accommodating about 3,100 children. In about one-half of the cases the defect is congenital, and in the other half it is caused, early in life, by such diseases as scarlet fever, measles, and meningitis. The congenital defects could be reduced by preventing such persons marrying, and the others by providing efficient and early medical treatment for such cases.

For educational purposes, residential schools possess many advantages over the day schools.

In most schools children will be discovered who are not quite deaf, but whose hearing is not sufficiently acute to make it possible to educate them with normal children. For such children special classes should be formed at convenient centres.

(*b*) *Physically Defective Children.*—More than half of the "crippled" children have been attacked by tuberculosis of spine, hip, knee, and other bones and joints. The provision for the education of such children is necessarily inadequate on account of the obvious difficulties in the

way. In large centres it is possible to collect many of them daily and convey them to a special school, taking them home in the afternoon. The kind of school most suitable is the type known as the Open-air Recovery School.

By providing efficient and adequate medical treatment it would be possible to diminish these cases by more than one half.

(*c*) *Feeble-minded Children.*—The Royal Commission on the Care and Control of the Feeble-minded reported in 1908. They recommended among other things that there be one Central Authority for the general protection and supervision of mentally defective persons, and for the regulation of the provision made for their accommodation, maintenance, care, treatment, and control. This means that such children would be relieved from the authority of the Board of Education and the Education Department.

The Minority Report of the Royal Commission on the Poor Law declare that the continued detention in the general mixed workhouses of no fewer than 60,000 mentally defective persons herded indiscriminately with the sane amounts to a public scandal. The Majority Report also is in favour of the speedy enforcement of the proposals of the earlier Commission. If their proposals were carried out, a Committee of the County Council would be appointed who would have charge of all such cases, including those who are insane. The actual recommendations of the Commission are as follows:—

With regard to education, the Commissioners recommend that the portions of the defective and Epileptic Children Act which relate to mentally defective children should be repealed, and that it should be made a statutory duty of the above-mentioned County Committee for the Care of the Mentally Defective to provide manual, industrial, and other training for mentally defective children of all grades. The local Education Authority would be required to notify to this Committee any children thought to be mentally defective, who

would then be examined by the Medical Officer and reported on by him to the Committee, and, if necessary, kept under observation in special schools in order to ascertain whether they should be returned to the normal schools, kept in special schools, or sent to boarding institutions. The Committee would be empowered to take over all the special schools or classes from the Education Authority, or to contract with that Authority to train children; such schools would then be taken out of the hands of the Board of Education, and would be under the supervision and inspection of the Board of Control. The Committee would also have power to compel parents to send their mentally defective children to any school or institution which the Committee considered best suited to their needs, whether a day school or a residential institution.

Evidently there is an urgent necessity for giving legislative effect at any rate to the most important recommendations of the Commission. As a result of want of control over both male and female feeble-minded persons, the evil is tending steadily to grow. What is imperative is power to take possession of the feeble-minded, and to prevent them from becoming, by reason of their irresponsibility, the transmittors of the evil, or perpetrators of crime.

The principle adopted by the Commission was that those "who cannot take part in the struggle of life owing to mental defects, whether they are described as lunatics or as persons of unsound mind, idiots, feeble-minded, or otherwise, should be afforded by the State special protection as may be suited to their needs." At the present time, the weak, feeble, and criminal types are increasing at the expense of the strong, hard-working, and the capable. Postponement of the problem will only result in increasing this difficulty and its expense. Almost one half of the mentally defective have inherited the taint directly from their parents, and it has been admitted that nearly 70,000 mentally defective persons in this country are in need of segregation, not only in their own interest, but also in that of the more normal of the community.

At the present time there is very little obvious advantage in undertaking costly experiments in the education, real or imaginary, of mentally defective children. As soon as they leave the education centres to which they have been drafted, the great majority of them return, little improved, and eventually hand on their curse to their unfortunate children, as well as, in a considerable number of cases, helping to swell the number of criminals that have to be dealt with. It is quite true that a very small proportion of the more promising of these cases do, with special education, become almost normal, and actually return to the ordinary school for the completion of their education.

Even with this advantage, however, it is impossible conscientiously to advise the expenditure of large sums of public money upon the education and training of these unfortunate children until definite legal power has been given to a properly appointed body to supervise them and control them during the whole of their lives if necessary. My own personal experience in dealing with such cases is that considerably more than half of such money, under the present system, is entirely wasted, owing to the fact that these children escape all control just at the age when they are most likely to become dangerous and still more expensive to the community.

It is only necessary to examine criminal statistics to realise how many of the feeble-minded commit various offences against the law. At the present time the prisons contain hundreds of persons belonging to the feeble-minded class, who ought to have been segregated from their youth, in order to prevent them from committing crime, and so that their curse may die with them.

There appears to be a larger number of mental derelicts in rural districts than in large towns. Also rural districts

vary very considerably among themselves, the more isolated villages usually being the worst affected, probably owing to continuous intermarriage. The larger proportion of dull and defective children in country districts is probably due to the fact that the towns take continual toll of those members of the population who are better equipped mentally, and are more reliant and active than the average.

(*d*) *Word-blind and Word-deaf Children.* These children must be carefully distinguished from those who are altogether incapable of ordinary education. They have already been referred to as children unable to interpret either the written or the spoken word, while, for all other purposes, sight or hearing are perfect. Word-blindness is more common than word-deafness. The defect is due to some deficiency in the parts of the brain cortex which should store up the memories of word sounds and word images.

(*e*) *Defective and Epileptic Children.* Authorities have power under the Elementary Education (Defective and Epileptic Children) Act, 1899, to make arrangements for the education of mentally and physically defective and also of epileptic children. Unfortunately the Board of Education have decided that the Local Education Authority have no power to treat individual cases without taking the preliminary step of adopting the Act for their whole area.

(V.) Provision of Meals.

The provision of meals under the Education (Provision of Meals) Act should undoubtedly be regarded as an important ameliorative measure. This work is discussed elsewhere in this volume.

(VI.) Provision of Open Air Schools.

Another important ameliorative factor is the "Open Air School" which has been established by many Local Education Authorities. In these schools the children are taught as much as possible in the open air, and have one or two meals at the school. Proper intervals for rest are arranged. The "school" need only consist of a roofed building open in front and behind, with end walls, if a house or cottage is available for the preparation of food. All children admitted to such schools have to be specially certified by the School Medical Officer as being in need of some definite treatment of this kind. It is possible to permit the attendance of children at these schools who could not be permitted to attend an ordinary school, and astonishingly good results can be obtained with underfed, neglected children, and those who have a tendency to consumption.

Obviously the "open air school" is more essential for, and more easily organised in, large towns than county areas. Nevertheless it should be by no means impossible, nor necessarily very expensive, to arrange for one or two of such schools to be started, on a small and simple scale, in county areas. They could be tried first in those districts where there have been already found a number of children likely to benefit thereby.

(VII.) School Baths.

An important ameliorative influence will be introduced by the provision of school baths.

(VIII.) Other Ameliorative Work.

Important items in the work of the medical officer must include:—

(*a*) The exclusion of affected children, supervision and examination of "contacts," and disinfection of schoolrooms, in order to check the spread of infectious disease.

(*b*) The oversight of the sanitation of the school buildings.

(*c*) The organisation of a systematic supervision of the personal and home life of the child.

(*d*) The stimulation of public interest locally towards the important problem of defective nutrition in children.

CHAPTER V.

COMMON AILMENTS AND CONDITIONS.

ANAEMIA.

A LARGE proportion of town children (boys and girls) are suffering from a deficient vitality that appears to be caused mainly by a diminution of the number of red corpuscles in the blood. Such a condition constitutes one of the forms of anaemia. It is brought about by badly ventilated rooms, by improper food, by insufficient sleep and exercise in the open air. The crimson colour of the lips diminishes in intensity and in the worse forms becomes pallid; the child becomes languid, drowsy, and disinclined for exertion, and is quickly fatigued; headaches and fainting attacks become common; the appetite diminishes and becomes morbid, indigestible messes being preferred to solid food, and occasionally a fondness for slate pencil, chalk, or coal is developed. Such children should receive medical attention, and all the teacher can do is to see that the rooms are well ventilated and that the child is excused part of the lessons and encouraged to take exercise in the open air.

BONE CONDITIONS

1. Curved Spine.

The association of this condition with the badly constructed desks has already been discussed. A lateral curvature is not at all uncommon among children of over twelve

years. All kinds of work or any desks that conduce to improper attitudes of standing or sitting are active causes of the deformity. Other causes include the habitual use of a high pillow in bed, so that the spine is bent when the child is lying asleep on its side, and the carrying of a heavy satchel. By keeping a vigilant eye on the children's attitudes a teacher can do much to prevent such deformities developing, and by careful physical exercises may help to remedy the defect when produced. More serious curvatures are those caused by rickets and by tuberculous disease of the bones. In the latter case the curve is usually more acute than in the former. There is also a tendency to special stiffness of the spine, particularly in the affected region.

2. Flat Foot.

This is another condition commonly caused by rickets. It is nearly always an acquired condition and is often found in weakly children about twelve years old. The muscles of the foot and the ligaments that support the bony arch of the instep become weakened by rickets or rheumatism, or by general conditions, such as acute fevers, with the result that the arch flattens down. The condition can be greatly improved, in many cases, by skipping exercises on the toes, and by exercises causing the body to be raised on tip-toe several times in succession. It should always receive attention, as it develops into a most painful condition and will be much more difficult to cure later on.

3. Affected Joints.

The commonest joint disease in schools is tuberculosis. The tuberculous joint exists in many varieties, and only a medical man can decide whether a joint is tuberculous or

not. The hip and the knee are often affected. If a child is seen to be getting into a habit of standing with the weight of the body mainly on one leg, and rests one foot on the other, the medical officer's attention should be called to the fact. Limping, dragging, or rigidity of joints show that the disease is getting well advanced. There may be pain in the hip or knee.

The condition should receive immediate attention, and the child should be excluded from school altogether.

4. Rickets.

Rickets is a disease of very common occurrence in schools in poor districts. It particularly affects the children who suffer from the effects of bad feeding, incorrect feeding, and bad housing conditions. Special common causes include feeding upon condensed milk during infancy, deficiency of fresh milk, deficiency of fats, excess of starchy food, lack of fresh air, etc. The effects are probably caused by certain poisonous materials that are formed in the stomach or intestines by bacterial action. The rickety child is usually distinguished by certain signs that are the effects of the disease upon the body. These are the square head; the beaded ribs; the narrow and constricted chest; curved spine and bent legs; enlarged wrists, ankles, or knees; knock-knee or flat-foot; brittleness of bones, predisposing to fracture; general enfeeblement and pallor, and delayed development; and a marked liability to catch cold and acquire various diseases, particularly lung diseases.

The most important matter is to correct the general home conditions, and this is usually impossible. In school the child should receive extra consideration, should not be over-worked, and should be excused much standing. Careful physical exercises and plenty of play in the open air will do much to improve matters.

CHILLS AND COLDS.

Children improperly clothed, and especially those who are shut up in overheated and badly ventilated rooms, are liable to chills and colds. These may develop in their turn into severe illness. Severe "cold in the head" appears to be a highly infectious disorder, and any child with obvious symptoms of such should be sent home.

CHOREA OR ST. VITUS' DANCE.

Chorea is a severe nervous disorder which is common among school children over seven years old. It is probably caused by some special form of bacterial life and is usually associated with rheumatism. Sometimes it follows the acute fevers—scarlet fever, measles, whooping cough—and occasionally is said to follow a fright or shock. Badly decayed teeth are common among children suffering from chorea.

In mild cases the child may simply appear to be clumsy and awkward, but in the more marked and severe forms there are very obvious signs which vary according to the part of the body involved. The muscular twitchings may be limited to the face, or one limb, or one side of the body, or they may be general. If the face is affected the child appears to be continually "making faces," on account of the curious jerkings and twitchings of the muscles of the lips, nose, eyes, and cheeks. The speech is often affected. When asked to put out his tongue such a child usually jerks it out and in again and snaps together the teeth. All the movements of this disease are increased in intensity by excitement or by the knowledge that anyone is watching.

When the arms or legs are affected there is usually a

constantly repeated, purposeless movement caused by the contraction of the same muscles over and over again. The child is never at rest. Mentally the child is in the same condition, being unable to concentrate his attention, besides being morbid, excitable, irritable, and quarrelsome.

The condition often lasts about ten or twelve weeks, and the child is unfit to attend school during the whole of the period. School work will only tend to intensify the ill effects, and no child should be allowed to return to school while the slightest trace of the signs is noticeable.

DIARRHOEA.

Diarrhoea among children commonly assumes an epidemic character during the later summer months. The disease is more prevalent during a hot dry summer than in cold and wet ones. Usually a marked connection can be traced between the temperature of the soil and the number of cases of the disease. It is practically limited to bottle-fed children, those fed entirely at the breast nearly always escaping. There seems to be no doubt that the disease is caused by pollution of the food by dirt and dust. Flies probably play a very important part in the spread of the disease.

Children suffering from diarrhoea should be sent home from school, and the parents should be advised to seek medical attention for them.

EYE DISEASES.

The matters connected with defects of vision have already been discussed. It now remains to mention some common conditions in the region of the eye.

1. "Red Eyes."

The commonest condition is the one in which the edges of the eyelids are inflamed and red. It usually indicates that the child is out of health and needs attention. Dirty and neglected children, particularly if of a tubercular tendency, are most liable. On the other hand it may be due to a defect of vision.

In the worse type of case the glutinous secretion from the inflamed edge sticks together the eyelashes in clumps. Scabs are formed, and the eyelashes are often removed with them.

The parents should be reminded that great care and cleanliness are necessary, and that the child requires medical attention.

2. Stye.

Styes are common amongst weakly, poorly fed, and neglected children, and they may occur as the result of defects of vision. They are caused by the obstruction of the ducts of small glands that open on the edge of the eyelid. The obstruction causes the gland to become inflamed and the stye results. It appears as a round, reddened swelling on the edge of the lid, and gives rise to a great deal of pain and inconvenience. In cases where they appear in crops the vision should be carefully tested.

3. Twitching.

The usual cause of twitching of the eyelids is some error of vision or, less frequently, some local condition of the eyelids.

4. Inflamed Eyeball.

Children suffering from a redness of the "white of the eye" or conjunctiva, together with "watering" and fear of the light, should be rigidly excluded from school. Many such conditions are of an infectious character and would spread through the school, while those conditions which give rise to the above signs, but are not infectious, render it desirable that the child should not be troubled with school work.

HEADACHES.

All teachers are familiar with children who are continually complaining of headache. In every case it should be regarded as a symptom caused by some disorder—possibly a very serious one.

(1) The commonest cause of all is probably eye strain. It has already been pointed out that children with defective vision often suffer from headache caused by the strain of the eyes. When the defect is remedied and the trying conditions are removed the headache disappears as if by magic.

(2) Another common cause of headache is an unhealthy condition of the throat and nose. Nasal catarrh and adenoids are particularly liable to cause headaches, and the child who frequently has a cold in the head is a continual sufferer in this way.

(3) Unhealthy conditions of the alimentary tract prove a fertile cause of headaches in children. Bad teeth and indigestion, singly or together, and constipation are commonly associated with headaches.

(4) General conditions, such as anaemia, rheumatism, debility, and malnutrition, in many cases are found to exist

in children who are continually complaining of headache when they have done some small amount of mental work.

(5) Highly nervous children, and particularly children about the critical age of fourteen, frequently suffer from headaches.

(6) A bad headache, especially in the case of a child not usually complaining, may indicate an approaching attack of some serious acute disorder, such as measles, scarlet fever, diphtheria, or pneumonia.

(7) Although the above lengthy list provides ample possibilities for explaining a headache in a child, yet the first thing that should occur to a teacher when members of the class are complaining is the possibility of the cause being the badly ventilated and overheated condition of the room. It is important for a teacher to bear in mind the fact that the room may have become excessively foul so gradually that the senses have failed to notice any special pollution. With this exception it should be definitely understood that healthy children never suffer from headache, and that they are always an indication that something is wrong.

HEART DISEASE.

A child may be suspected to be suffering from heart disease in the following instances:—

(1) Puny under-developed children with expanded finger ends (clubbing), and pale or livid skin.

(2) Dull children, with an obvious lack of energy and vitality associated with some lack of bodily development.

(3) Children who are rapidly exhausted by physical exercise, and become breathless after any unusual exertion.

(4) Attacks of faintness and fainting are often indications of heart disease.

(5) A bad circulation, evidenced by cold hands and feet, chilblains, etc., may indicate heart disease.

It is usual to recognise three kinds of affections of the heart, viz. :—

I. Congenital Affections.

Some children are born with the heart defective. If the defect is serious the child dies quickly, sometimes a few minutes after birth. The less serious cases may reach school age, but the children are always deficient in vitality, and the greatest possible laxity should be allowed. They rarely reach adult life.

II. Organic or Acquired Heart Disease.

Many of these cases are caused by rheumatism, although any history of a typical attack of rheumatic fever is rare. More usually it is possible to find the rheumatic association by a history of "growing pains," vague pains in the joints and limbs, attacks of tonsilitis and sore throat, or attacks of chorea (St. Vitus' dance). Other cases are caused by previous attacks of scarlet fever, measles, diphtheria, or other infectious disorders. In all cases the valves of the heart are injured in such a way as to prevent the heart working properly.

III. Functional Disorders.

This is the term applied to those cases where the heart appears to be sound and properly developed, but where the beat of the heart is too rapid, or too slow, or irregular, or where the child suffers from palpitation. Common causes of such conditions are anaemia and disturbances of the alimentary tract.

Children suffering from heart disease should receive extra indulgence wherever possible. Physical exercises

should be very carefully graduated according to their capacity, and there should be no possibility of strain allowed. If the child is properly looked after at home and at school it is always possible that the heart may develop in such a way as to minimise the defect from which it suffers. This is called compensation.

INDIGESTION.

Faulty and improper digestion is common among school children. Among the better class children it is often due to excessive feeding or to rich and indigestible food. Among poor children the digestive system shares the general debility of the body, and the unhealthy condition is often intensified by improper food. Children should receive nothing but plain wholesome food, and any deviation from this rule usually inflicts its own penalty. Bad teeth will always upset digestion, not only by interfering with the proper mastication of the food, but also by the swallowing of poisonous matter from the decayed parts. Indigestion is the frequent cause of anaemia, headaches, constipation and diarrhoea, as well as many other common conditions of ill-health among children.

SKIN DISEASES.

The majority of skin diseases from which school children are likely to suffer are infectious, and the general rule of excluding such children from school should be adopted. In most cases the condition is the result of uncleanliness and overcrowding.

1. The commonest condition is the presence of sores and crusts on the scalp, especially of girls. Upon closer examination the presence of vermin is almost invariably detected. The worse forms, with great masses of crusts

and enlarged glands or even abscesses at the back of the neck, are disgusting to look at, and to the inexperienced eye appear to be dreadful cases to deal with. The observer will be astonished to notice how wonderfully these cases clear up directly the vermin have been entirely eliminated by the processes already described. The infection is caused and the acute condition is continually maintained by the scratching of the scalp by the child. This goes on continually while vermin are present, and poisoning of the skin is inevitable. Beyond the elimination of the vermin the only necessary treatment is the softening of the crusts by poulticing or bathing in hot water, and their removal. This condition should not be called eczema.

2. Impetigo.

This disease usually affects the skin at the angles of the mouth and on the chin. Small blisters appear in the middle of red patches. These afterwards become yellow, dry up, and form yellow crusts. It is extremely contagious and affected children must be excluded from school. It usually occurs among dirty and neglected children, and rapidly spreads from one member of the family to another If neglected it may spread through a whole school.

3. Eczema.

All skin diseases among children are popularly known as eczema. The real disease is quite common, especially in children about five years old, and the appearance varies from a simple scaliness to an angry-looking wet red patch that afterwards forms crusts. Although there is no reason to regard it as very contagious, yet it is advisable to exclude all affected children.

4. Ringworm.

This term includes a group of skin diseases produced by a kind of fungus. Occasionally schools are visited by an epidemic of ringworm, and teachers should be alive to the fact that a single case neglected may cause nearly all the other scholars to become infected. The disease is caused by a fungus, or vegetable parasite, which attacks the roots of the hairs, and the typical signs of the disease may be found on the scalp or scattered over the body.

The beginning is usually a small red scaly spot which gradually spreads evenly so as to produce circular patches. The hairs in the affected area become brittle and break off, leaving the patches bare. By the coalescence of two or more of the circular patches the affected areas may become irregular in shape. If neglected the condition may persist for years, and may result in permanent loss of hair over the affected area, but spontaneous cure often takes place after a long time.

In order to verify the diagnosis, and particularly in order to ascertain whether a cure has been effected, it is necessary for the medical officer to make a microscopical examination of hairs from the affected area.

The affected children should be removed from school. It is extremely contagious and spreads easily by means of hats, gloves, towels, hair brushes. The slightest particle of scale from the infected area is sufficient to infect another child or another part of the same child. If any child showing the slightest sign of the disease is at once dismissed and reported, there should be no difficulty in keeping the schools free from this infection. Unfortunately many teachers neglect to take this precaution, and as a result the disease is often spreading actively through schools.

5. Favus.

This is the name given to a more serious affection of the scalp. It is due to another vegetable parasite which attacks the roots of the hairs. The cure is extremely difficult.

Pale yellow cup-shaped patches form on the scalp, and afterwards fuse with each other to form greyish crusts. The hairs become brittle, and bald patches are formed as in ringworm. A characteristic and unmistakable mouse-like smell is emitted from the crusts. In every case immediate and total exclusion from school is urgently necessary.

6. Itch or Scabies.

The itch insect usually attacks the skin between the fingers, where the skin is thin. It is very minute, and the female burrows into the skin, unnoticed at first, but afterwards causing itching and redness. Under the skin she lays her eggs, which hatch in about fourteen days. The young ones then burrow afresh on their own account, and so the disease spreads. The intense itching causes vigorous scratching, and this results in considerable inflammation of the skin, with the formation of fairly typical crusts.

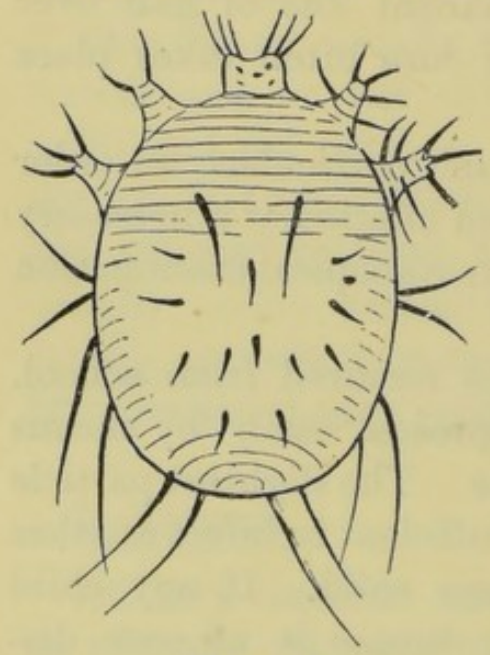


Fig. 151.
THE ITCH INSECT.

The itch is very contagious, the slightest contact being sufficient to cause infection. It is also conveyed by infected garments and bedclothes, all of which require disinfection

before the disease can be stamped out. Infected children should be rigidly excluded from school.

THROAT CONDITIONS.

1. Adenoids.

Adenoids are soft growths attached to the mucous membrane of the nasopharynx or the cavity at the back of the nose. They are unfortunately very common among all classes of children. Heredity plays some part as a predisposing cause, but the actual cause is unknown. Enlarged tonsils are often associated with this condition. They may commence to grow after an attack of measles or whooping cough, and a probable predisposing cause is mouth breathing, which is acquired by many children merely as a bad habit. At the age of fourteen they tend to disappear spontaneously, but in many cases they have been the cause of irreparable mischief by that time. Their effects are numerous and are best discussed separately.

(*a*) **Depression and discomfort.** A child suffering from adenoids is continually feeling depressed and uncomfortable.

(*b*) **Mouth breathing.** Owing to the obstruction of the nasopharynx the child finds it difficult or impossible to breathe through the nose. The mouth is therefore always open, and this gives a dull and stupid appearance to the face, which gradually acquires a mask-like look that is incapable of expressing either joy or sorrow.

(*c*) **Dulness and stupidity.** Not only does the face look stupid and dull, but the mental condition quickly follows suit, and the child becomes backward and incapable of doing much mental work. Examples are common where such children have been regarded as mentally defective, but it is important to remember that their mental apparatus is quite normal in every respect except that the brain

is clouded, as it were, by their complaint. The writer well remembers two extreme cases that were presented to him by their teachers as badly defective mentally. These children had each been at school about two years, and had not yet succeeded in learning the alphabet. Fortunately it was possible to get these cases properly treated, and on their return to school they rapidly became normal children and made good progress. It is very probable that large numbers of adenoid children are at the present time being "educated" at special centres for mentally defective children. Of course this is the result of inadequate medical supervision, and not only wastes public money, but also fails to educate at all a child who is capable of being educated in the ordinary way.

(*d*) **Fatigue.** Directly any mental work is attempted the child gets a headache and suffers from mental fatigue. This is due to the difficulty that there is in getting away the waste products from the brain. Such children are constantly complaining of headache.

(*e*) **Dead Speech.** Owing to the absence of resonance the speech acquires a characteristic dead quality, and there is difficulty with the letters *m* and *n*, *b* and *d* being substituted. Thus the child says "by" instead of "my," and "do" instead of "no."

(*f*) **Deafness.** In many cases the opening of the eustachian tube into the pharynx becomes blocked and deafness results.

(*g*) **Chest deformities.** The obstruction that prevents free and easy respiration causes extra strong action of the diaphragm in the effort to fill the chest. In young children this may result in serious deformity. The sternum is pushed out and often bent, while the lower and lateral parts of the chest are retracted, producing the condition known as "pigeon chest." If adenoids are present in a

rickety child, a common combination, these effects are very pronounced. A long narrow chest is produced and the child is predisposed to consumption.

If the obstruction begins at about the age of ten the forced respiratory efforts produce a barrel-shaped condition of the chest.

(*h*) **"Veiled look."** The eyes of adenoid children often have a characteristic appearance that has been called the "veiled look." This is caused by the lower lid covering more of the eye than it normally does. The explanation is that connecting the muscle of the lower lid with the ring of muscle surrounding the mouth there are small muscular bands which, when the mouth is kept closed, hold the lower eyelid down. If the mouth is perpetually open this tension is relaxed, and the lower lid creeps a little way up the eyeball.

The lot of the adenoid child is not a happy one. He is looked upon as stupid and dull; is often punished for not doing mental work that he is quite incapable of performing; and is disliked, ridiculed, and avoided by the other children. If he survives till the age of fourteen he loses the adenoids, but they have so crippled his development that he usually falls an early and easy prey to consumption a few years later.

Treatment.—Directly the condition is recognised the parents should be urged to seek medical aid. By the removal of these growths many of the children rapidly become normal in every way, and the author can recall several instances of adenoid children, previously regarded as being mentally defective, rapidly becoming bright and alert and active after the removal of the growths. The earlier that they are removed the better will be the result, because their presence hampers and hinders the proper development of the child. It is only by systematic physical

examination of the scholars that the detection of early cases can be hoped for.

Probably much can be done to prevent the growth of adenoids by proper breathing exercises several times a day with the mouth closed. Children should be most definitely instructed to keep the mouth closed. By these means the membrane of the nose and pharynx is kept in a healthy condition.

It is very probable that mouth breathing, as a bad habit, is an important cause of adenoids by making the mucous membrane of those regions unhealthy. Systematic breathing exercises with the mouth closed, several times a day, in the open air or with widely open windows, would serve to keep the membrane healthy and check the tendency towards adenoids. Probably large numbers of adenoid children die of consumption during early adult life, and so by preventing the growth of adenoids, and by their prompt removal when they do occur, the great number of deaths from consumption may possibly be decreased. Teachers should remember that if they can persuade the parents of such children to obtain treatment for them they will not only be doing a public service, but will also help in wholly changing the lives of these miserable little unfortunates.

2. Enlarged Tonsils.

Enlarged tonsils are often associated with adenoids, and in some cases are the direct result of mouth breathing. The condition can be easily recognised by inspection of the throat. In some schools an astonishingly large percentage of the children (as many as 30 or 40 per cent.) show enlargement of the tonsils, and it is often an indication that the housing conditions of the locality are inferior. If the

enlargement is considerable similar results to those produced by adenoids may be brought about. Mouth breathing and deafness are particularly common accompaniments. Also such children are particularly liable to throat affections, diphtheria, ulcerated throat, quinsy, etc., and also rheumatic fever. Teachers should suggest to the parents that such children require medical attention.

3. Sore Throats.

A child suffering from sore throat should always be at once placed in a desk to itself, because the condition is probably infectious. It is most important to remember that such cases may be suffering from diphtheria, and may set up a severe epidemic in the school. The fact that the child is liable to sore throat is not any reason why the above rule should not be observed. During epidemics of diphtheria and scarlet fever all children suffering from sore throat should be sent home and should be reported to the medical officers. Teachers should also realise the importance of the fact that children who do not suffer from any soreness of the throat may have the germs of diphtheria or an infectious disease in the throat, and may be spreading the disease among the scholars. A valuable indication of any mischief in the region of the throat is the presence of hard glands in the region of the angle of the jaw. During times of epidemic teachers are strongly recommended to make this examination, and to submit all children possessing such hard glands to the medical officer at once. During a throat epidemic at Handsworth, the writer found the help of the teachers in this direction most valuable, and a large number of infected children were discovered in this way. By excluding these children the epidemic was effectually and speedily stamped out.

CHAPTER VI.

EPIDEMIC DISEASES.

The epidemic diseases affecting schools include diphtheria, scarlet fever, measles, German measles, whooping cough, mumps, chicken pox, and small-pox, all of which have certain characteristics in common, viz.—

(1) They are all communicable from one person to another.

(2) Each disease has a definite duration.

(3) When infection has taken place no symptoms are produced at first. The interval of time, between the actual infection and the appearance of the first sign or symptom of the disease is called the period of incubation. When the incubation period has elapsed the typical symptoms of the disease appear, and last for a certain time, during which death may occur. If the active period of the disease is survived recovery usually takes place.

(4) A remarkable characteristic is that an attack of one of these diseases is rarely followed by a subsequent attack of the same disease in the same individual. In other words, an attack confers immunity from that disease. The chief exception to the above rule is diphtheria.

(5) In many cases the disease has been conclusively shown to be caused by some special form of bacterial life, and the same explanation is inferred in the case of the others on account of their common characteristics. From the obvious analogy that exists between the ordinary process of fermentation (*i.e.* a stage of quiescence or incubation followed by a period of activity and then by exhaustion of the process) and the course of these diseases the term zymotic has been applied to them.

SPREAD OF INFECTION.

1. By Air. The germs of whooping cough, scarlet fever, measles, small-pox, chicken pox, mumps, diphtheria, influenza, and tubercle seem to be capable of being carried by the air. In most of them, however, the possible distance is only a small one, and it is likely that only in the case of tubercle, small-pox, and influenza can the infection be carried any considerable distance.

2. By Water and Food. Typhoid fever and cholera are notoriously water-borne diseases. Infected milk may spread tubercle, scarlet fever, diphtheria, or measles.

3. By Clothes. Scarlet fever and small-pox germs have a special proclivity of lying dormant for long periods in clothes and furniture of the sick room. Infected books and toys similarly help in the spread.

4. By Living Creatures. Flies are probably active carriers of diphtheria and typhoid fever, and in towns probably play a conspicuous part in the spread of these diseases. Fleas may similarly carry infection. Cats undoubtedly suffer from and spread diphtheria.

PREVENTION OF INFECTION.

The spread of infectious diseases is prevented by carefully and thoroughly carrying out instructions and by the adoption of different precautions such as are grouped together as follows :—

1. Isolation. The sick should be at once separated from the healthy.

2. Quarantine. Those who have been exposed to infection should be isolated separately and kept under observation until the period of incubation of the disease in question has expired.

3. Disinfection. The disease germs that may be present in the room, on walls, floors, desks, etc., or on pencils, books, or clothes, must be destroyed.

4. Immunity. In the case of small-pox the disease can be checked in its spread and could eventually be stamped out by efficient vaccination, which confers immunity from the disease.

5. Notification. When a case of infectious disease occurs it must be notified at once to the local medical officer of health.

6. Exclusion. All children from an infected house must be excluded from school until the medical officer certifies that they can resume attendance.

SPECIAL WORK.

1. By Attendance Officers.

In the ordinary course of their work the attendance officers receive from parents various excuses as to their

children's absence from school. If any suspicious or infectious or contagious disease or condition is given as the reason to the attendance officer, he at once forwards such cases to the medical officer on the following form:

NOTIFICATION OF INFECTIOUS DISEASES.

_____ School. _____ Department.

To the Medical Officer of Health.

SIR,

At the foot hereof I forward you a list of cases of Infectious and Contagious Diseases which have been reported to me.

Yours faithfully,

_____

Attendance Officer.

NAME.	RESIDENCE.	DOCTOR ATTENDING.	DISEASE.

These notifications by attendance officers are most valuable, and intelligent officers are of the greatest possible help. Cases of measles, chicken-pox, mumps, sore throat, ringworm, skin diseases, verminous heads (usually reported as "eczema of scalp"), and many other conditions, are brought at once to the notice of the medical officer of health. The medical officer examines these reports, and either arranges for the inspection of the children at home or sends a notice asking for the child to be brought to see him. Cases visited are recorded on special cards, of which the following is a type:

MUMPS.

Name and Address — School

Notification received — House visited — Last at School

Commencement of illness — Doctor — Age

Present condition. — Excluded until

Other School Children.				Babies.		
Name.	Age.	Had Mumps?	Excluded until.	Name	Age.	Had Mumps?

Parents infd. — School infd. — A.O. infd.

Inspector.

If a doctor is in attendance, the time of return of the child is left for him to decide as a general rule.

Similar cards are used for measles, whooping-cough, chicken-pox, while those cases for which there are no special cards are recorded upon a general card as below:

NOTIFIED CASES.

Name. Age.

School Notified by on

On the other hand, some children may be considered to be fit to come and see the medical officer, and to these cases a notice is sent requesting the parent to bring or send the child.

As the result of the information thus gained, it is possible in many cases to decide definitely when the child will probably be fit to return to school. Accordingly, the following notice is sent to the parents:

URBAN DISTRICT OF HANDSWORTH.

HEALTH DEPARTMENT.

Owing to the existence of in your house it will be necessary to keep the following children from school until the dates against their names:—

The following children may continue to attend school as usual:—

Medical Officer of Health.

Similar information is sent to the Education Office on the following form:

URBAN DISTRICT OF HANDSWORTH.

HEALTH DEPARTMENT.

_____ School. _____

Owing to the existence of infectious disease in their homes the undermentioned children have been excluded from school until the dates shown against their respective names:—

NAME.	ADDRESS.	EXCLUDED UNTIL.

The undermentioned children may continue to attend school as usual:—

NAME.	ADDRESS.

Medical Officer of Health.

Also, the head teachers are similarly notified as to children who are excluded, or those who are allowed to return to school.

Of course many cases are discovered that need medical attention, but are not receiving it. These and similar cases are dealt with under "Amelioration."

It is astonishing to observe the effect of work such as is described above. The parents quickly appreciate the fact that increased attention is being given officially to infectious and contagious diseases and conditions, and increased vigilance and carefulness on their part is soon noticeable.

2. By the Teachers.

Unfortunately it is quite common for children to arrive at school in such a condition as to justify the teacher sending them home because they obviously may be a source of danger to the other children. Stamped post-cards, addressed to the medical officer of health, are supplied to the head teachers. These contain the following notice:

_____ Schools. _____ Department.

The undermentioned children have been sent home to-day for the reasons indicated against their respective names:—

NAME.	ADDRESS.	REASON FOR EXCLUSION.

_____ Date _____ Head Teacher.

The reasons given include sore throats, swollen glands, skin eruptions, verminous conditions, rashes, discharging ears, etc.

These cases are treated in precisely the same fashion as those notified by the attendance officers.

On the other hand, there are a number of children whom the head teacher does not feel altogether justified in sending home, but who are apparently abnormal in some way. For notifying these cases similar post-cards are supplied, stating that "the following cases appear to require medical examination without delay." These cases are seen at the school as quickly as possible. A keen and observant teacher can be of far greater real use in detecting suspicious cases than a school nurse, because such a teacher is seeing the children every day, and knows their normal appearance. In both the above ways a large number of children are discovered who are in urgent need of medical attention.

3. By School Nurses or Health Visitors.

The school nurse should also be a health visitor. They are useful in visiting notified cases at home, and reporting to the medical officer. At the home they are able to follow up the printed recommendation that medical attention is necessary by personally urging the parents to call in a doctor. Their help in personally assisting the parents to treat properly ringworm and verminous conditions is also valuable.

4. By the Medical Officer.

From the above outline it is obvious that the medical officer will be kept constantly in touch with the happenings in the district, and will have brought to his notice a very

large proportion of the infectious and contagious diseases and conditions that are among the children. Attendance officers, teachers, and school nurses will be constantly presenting special cases for examination.

SMALL-POX.

Owing to the effect of vaccination this disease is uncommon in schools. During epidemics, however, outbreaks may occur, and when this happens it usually serves as a most striking object-lesson upon the effects of vaccination. The circumstances of the outbreak of small-pox among school children at Ossett, near Wakefield, illustrate this. The following figures are taken from the report of Dr. Kaye, the County Medical Officer for the West Riding of Yorkshire. In the mixed department of this school were 169 scholars. On October 27, 1904, a child in one of the classes was found to be suffering from small-pox and was promptly removed to the hospital. In this class there were 27 scholars, 19 of whom had been vaccinated and 8 were unvaccinated. Every one of these 8 unvaccinated children took the disease, while the 19 vaccinated children all escaped. Similarly in two other classes every unvaccinated child contracted small-pox. Altogether there were 42 cases of small-pox among the scholars and only five of these had been vaccinated, and these five were in one class of older scholars in whom the effects of vaccination during infancy were wearing off. Throughout the whole school not a single re-vaccinated person took the disease.

There is abundant scientific and statistical evidence to prove that efficient vaccination, as shown by the production of four good scars, during infancy confers absolute immunity for at least ten years. Also if revaccination is properly

performed at the age of twelve to fourteen years it will undoubtedly confer immunity for the remainder of life. In countries where revaccination is compulsory the disease is practically unknown.

The incubation period of small-pox is twelve days, during which period there are practically no symptoms. Then pain in the back, headache, vomiting, fever, and shivering show the commencement of the attack. In mild cases, such as occur in inefficiently vaccinated children, the eruption is the first sign. This begins on the third day of the illness. It is first noticed on the forehead, neck, face, and wrists. Afterwards it spreads over the trunk and limbs.

The rash appears first as red spots, slightly raised, and afterwards becoming more prominent. They are hard and "shotty." On the third day of their appearance the centre of each becomes clear and transparent, and they now look like blisters full of clear fluid. In two more days the middle becomes depressed and the clear appearance changes to dull yellow. After the eighth day the spots begin to dry and form scabs. A case should be regarded as infectious until all the scabs have quite disappeared.

During an epidemic of small-pox a teacher should send home any child with suspicious spots on the face or wrists, and report the case to the medical officer. No child from an infected house can be allowed to attend school.

CHICKEN POX.

This is very common among children, and spreads rapidly through schools in epidemics. It has a variable incubation period of from twelve to nineteen days, during which time there are no symptoms. The rash appears first as red spots

on the chest, afterwards on the face and scalp, and then on the limbs. Fresh crops of the spots appear at intervals, and as each goes through the same development it follows that all stages of the process are noticeable on the same individual at the same time. In a few hours the red spots change into blisters, then they turn yellow, and in two or three days they burst, dry up, and form scabs. A child is free from infection when all traces of the scabs have disappeared. All children from infected houses must be excluded from school.

Any child showing a suspicious eruption should be sent home and reported to the medical officer.

SCARLET FEVER OR SCARLATINA.

The incubation period of scarlet fever is variable, being usually three or four days, and the disease is highly infectious from its commencement. In the earlier stages infection is spread mainly by the breath and the secretions of the nose, mouth, and throat, and later on a possible cause may be the scales of desquamated skin, that are particularly liable to adhere to clothing and to lie latent for an indefinite period. After the disease is apparently over a child may be sent to school with discharging ears or nose, or in very mild cases the disease may have been undetected and the child continue its attendance at school until this discharge commences. Such discharges are intensely infectious and will rapidly spread the disease. No child with discharging ears or nose should be allowed in school during a scarlet fever epidemic until the medical officer has made an examination.

A common event is the discharge of a child from the hospital apparently well, and with no discharge of ears or

nose. Such a child is then sent to school, and is sent out to play in the playground with the others during recess. Although the weather may be very cold the child usually goes out of the warm schoolroom into the cold air without any additional clothing, and with no hat. A cold is contracted, and a discharge from the nose or ears is set up. This proves to be infectious and an epidemic is caused. With greater care exercised to prevent such children from taking cold there is reason to believe that they would not prove to be infectious to others, but if they contract a cold the infectivity appears to burst out afresh.

The usual premonitory signs of an approaching attack of scarlet fever are pallor, shivering, vomiting, headache, and sore throat. If scarlet fever is at all prevalent in the district any child showing two of the above signs should be sent home and reported.

The attack itself nearly always begins with shivering and vomiting, with more or less severe sore throat. The face then becomes flushed, and the rash appears on the side of the neck and on the chest. Afterwards the rash spreads to the abdomen and the limbs, but, curiously enough, does not appear on the face, the palms of the hands, or the soles of the feet. The rash appears as small deep red dots on a red skin. It disappears about the seventh day.

The sore throat is often a prominent symptom, and the glands about the jaw are swollen and painful, causing difficulty in mastication and swallowing. The tongue becomes brightly red, with swollen papillae, giving it the appearance of a strawberry.

Desquamation or peeling begins in severe cases on the third or fourth day; in milder cases from the sixth to the ninth day; occasionally it is postponed until much later. The peeling usually commences where the rash first

appeared, *i.e.* on the sides of the neck and the chest. Then the trunk and the arms begin a few days after, then the palms of the hands, and finally the soles and the heels. From a school point of view a constant routine examination of the children's hands and fingers during an epidemic is most useful. Quite recently in the author's district an epidemic of scarlet fever was associated with a large public elementary school, and systematic examination of all the children in attendance was carried out. Three children were discovered in the peeling stage, and several others were sent home as suspicious cases. These afterwards developed the disease. By these means, combined with thorough disinfection of the rooms, etc., and the visitation of all suspicious cases of absence, the epidemic was suddenly and completely arrested. An examination of the registers showed that the children who were found to be peeling had stayed away from school, for one day only, about two weeks previously. This serves to illustrate the fact that mild cases escape ordinary observation and do not appear to be ill, but they continue the spread of the disease. In fact it is always more difficult to stamp out epidemics of a very mild character simply because some of the cases are not ill enough to be kept at home.

An ordinary case of scarlet fever is free from infection in about six weeks, but no child should be allowed to resume attendance while it shows any discharge of ears or nose. Of course all children from infected houses must be excluded from school.

MEASLES.

This disease causes a very high death rate among children, but it is not necessarily so fatal as it appears, most of the deaths being due to bronchitis or pneumonia, which so often complicate or follow an attack of measles and are

frequently caused by neglect and exposure to cold. The incubation period is usually about twelve days.

The increase in the prevalence of measles during recent years is attributable to the crowdi g together of children in schools, the relative increase in town populations, and the impossibility of definitely recognising the disease before it becomes infective.

During an epidemic of measles the following precautions should be taken :—

1. Susceptible children from infected houses should be excluded from school altogether until the most recent case is certified as being free from infection.
2. Scholars who appear to be suffering from the slightest cold should be sent home.
3. All absentees should be visited by the attendance officers, and all suspicious cases visited by the medical officer. This is a most necessary and important step in order to properly enforce rule (1).
4. In severe epidemics it may be desirable to close infants' schools if the adoption of the above measures does not stop the spread. It is unnecessary to close the other departments.
5. During the closure the infants' school should be thoroughly disinfected. It is often advisable to disinfect the other departments on Saturdays, when they are not in use.

If an outbreak of measles occur in a boarding school the cases should be at once isolated, and all scholars who have been in the same dormitory during the previous week or sat next to them in class-rooms during that time should be placed in quarantine. All scholars who show any signs whatever of an ordinary cold should be separately isolated.

For four or five days before the typical rash appears the child begins to show evidence of being out of sorts. The commencement is usually shivering, hot dry skin, and headache. Then signs of a cold appear. The child sneezes, the eyes get red and watery, the nose runs, and the voice gets hoarse. A child showing any of these signs during an epidemic of measles should be at once sent home. In an infants' school it is advisable to send such a child home at once whether measles is prevalent or not. If teachers could only be persuaded to adopt this course, it is probable that most epidemics of measles would be avoided.

After about four days of these symptoms the typical rash appears, and it is only at this stage that the diagnosis of measles can be definitely made. But by this time the child, if it has continued to attend school, will have infected dozens of other children. The rash appears first on the face, which becomes flushed at first and then develops the characteristic appearance of raised, blotchy, dark red patches. This afterwards spreads to the rest of the body.

A child is infectious from the time of the first symptom until the end of the illness, usually a period of about four weeks.

GERMAN MEASLES.

This is a mild infectious disorder which has symptoms bearing some resemblance to both measles and scarlet fever. It is quite a distinct disease, having an incubation period of about sixteen days.

The preliminary symptoms are usually very mild. There may be headache, vomiting, and signs of a cold. The eruption appears first on the face, as in measles, and consists of slightly raised patches of a rose-red color. It then

spreads to the body, where the rash is often like that of scarlet fever, but is more patchy. The glands at the back of the neck, in the armpit, and in the groin are enlarged, tender, and hard like peas. The disease itself is very mild, but it may be the forerunner of tuberculous infection of the glands.

WHOOPING COUGH.

People at any age may be attacked by this disease, though it is commoner and more fatal among infants than among older children and adults. Its incubation period is about eight days. It is highly infectious before the cough appears, and the infectiousness may continue for months. Although regarded by the average parent as a trivial complaint, yet it is actually the most fatal of all the infectious complaints of children under five years old. It causes twice as many deaths as scarlet fever.

The preliminary symptoms are those of a cold, viz. sneezing, running nose, watering eyes, and slight cough. These may persist for one or two weeks, during which time the infection is being spread broadcast if the child attends school. This is yet another reason why all children showing signs of a cold should in every instance and under all circumstances be excluded from school. By making this a routine practice it is impossible to exaggerate the important effects that would be achieved. Epidemics would be prevented in many instances, and a great number of fatalities avoided. The rule should be most rigidly observed in infants' schools.

The actual attack of typical whooping cough is unmistakable and painfully noticeable. A child who has had several attacks of the typical fits of coughing knows when one is coming on, and often appears frightened and begins to cry. A rapid series of short coughs are given until the

chest is emptied of air, during which time the face becomes congested and livid. Then the breath is drawn in with a long crowing whoop. The fit of coughing may be followed by vomiting. Afterwards the child becomes bright and cheerful again. Infected children should be excluded for at least two months, or for a longer period if the paroxysms of cough, followed by vomiting, have not disappeared.

A distressing characteristic of whooping cough is the tendency that it seems to confer upon the lungs to acquire disease. It appears to weaken the resisting power of the lung tissue, and to predispose to attacks of pneumonia and to consumption.

MUMPS.

Epidemics of this disease are frequent in cold wet weather in spring and autumn. The incubation period is over a fortnight. Both children and young adults may be attacked and boys are more liable to be infected than girls. The outbreak is often associated with an epidemic of measles.

The first signs are pain, stiffness, and tenderness at the angle of the jaw, below the ear. This is followed by swelling. One side is affected first, usually the left, and the other side may or may not follow suit. The pain, stiffness, and tenderness may spread down the side of the neck and there may be great difficulty in opening the mouth. When both sides are affected with considerable swelling the appearance is very grotesque.

The condition is intensely infectious and it must be remembered that serious complications and sequelae are not uncommon. Cases should not be regarded as free from infection until the end of four weeks from the commencement of the disease.

Swellings at the angle of the jaw, closely resembling those caused by mumps, are occasionally seen in bad cases of scarlet fever and diphtheria.

DIPHTHERIA.

During the last twenty or thirty years there has been a progressive increase in the rate of mortality from diphtheria in England and Wales, and the increase is mainly in densely populated districts. The disease used to be regarded as one peculiar to country districts, but its character has now changed and it is practically always present in large towns. This is probably due to the fact that the diphtheria bacillus is extremely common in towns, and is present in many healthy throats without causing any disease. When, however, the bacilli gain access to an unhealthy throat they are able to set up the disease known as diphtheria.

After the attack is over and the throat is apparently healthy the bacilli may still persist in the throat and the child may be still able to give others the disease. Also healthy children may have the bacilli in the throat and may hand them on to other children without themselves suffering from the disease. Such cases are known as "carriers" and play an important part in the spread of the disease.

A consideration of the above facts shows plainly that in order to prevent the occurrence and spread of diphtheria we must devote ourselves to two objects, the exclusion of all children who have in their throats the bacilli of diphtheria and the removal of all conditions that are liable to produce a morbid condition of the throat, such as bad ventilation, over-heating, access of sewer gas or ground air into schools, bad drainage, and insanitary conveniences. It is most important to remember that the bacillus probably

has no effect upon a healthy throat and that some predisposing cause must be at work before the disease diphtheria can be set up. In every school epidemic of diphtheria investigated by the author it has been possible to find some undesirable condition such as those enumerated above, and when these have been eliminated and those children possessing diphtheria bacilli in the throat have been excluded the disease has always disappeared. There is never any reason for school closure for diphtheria unless some structural alterations are urgently necessary.

By means of a bacteriological examination of the material from the throats of the children it is possible to know exactly which of the children are capable of giving the disease to others, and these children can be excluded until they are found to be quite free from the bacilli. If the school is closed for alterations or for holiday while cases of diphtheria are associated with it a good plan is for the medical officer to make this examination the first time that the scholars re-assemble.

If bacteriological examination cannot be obtained the best plan is to send home all children suffering from sore throat, but this plan cannot be relied upon to stamp out the disease, because many children who are acting as carriers may have no throat trouble at all.

The incubation period of diphtheria averages between two and five days. The greatest number of cases and the maximum mortality occur between the ages of three and twelve years. The first symptom is a sore throat. The glands round the jaw and throat often become inflamed, enlarged, and tender. Upon examination of the throat one or more patches of a greyish white membrane may be seen over the tonsils, the palate, or the back of the pharynx.

The disease may attack the trachea (causing "croup") or the membrane lining the nose, and it is by no means

uncommon to trace mysterious recurrences of the disease in a school to an unrecognised and long standing case of nasal diphtheria. Wherever the germs may have taken hold they may persist there for long periods, and in many cases they can be still found after the lapse of twelve months. Usually, however, before the expiration of so long a time they have lost their virulence and are no longer able to set up the disease diphtheria.

The infection spreads rapidly through a school by the breath of those suffering from the disease (as well as the "carriers") and by infected pens, pencils, books, papers, modelling clay, towels, drinking cups, etc.

The use of diphtheria antitoxin in rendering the children temporarily immune to the disease has not been adopted in this country to any considerable extent, but it is a method full of promise for the future.

All cases of diphtheria and all children from infected houses should be excluded from school until a bacteriological examination proves them to be free from the diphtheria bacillus.

The following table gives a summary of some of the facts concerning the above diseases:—

TABLE OF INFECTIOUS DISEASES.

Disease.	Signs or Symptoms.	Incubation, from exposure to first sign of Disease. (Days.)	Day of definite illness on which Rash appears.	Mode of Infection.	Period of Exclusion from School.	Quarantine Period.
SCARLET FEVER	Headache, shivering, vomiting, sore throat and hot dry skin ; 2nd day, bright red rash ; skin peeling follows, and later on discharges often occur from the nose and ears. Face very pale in later stages.	1—7	1st or 2nd	Discharges from throat, nose, and ear. Peeling of skin?	Till peeling has quite finished, and discharges from nose or ears have ceased (generally not less than six weeks).	12 days.
MEASLES ..	Begins like a cold in the head ; with feverishness, shivering, running from the nose and eyes, and sneezing ; blotchy rash about 4th day on the face, which looks swollen and heavy.	7—14	4th or 5th	Discharges from lungs, throat, nose and ear. Peeling of skin.	Till cough and discharges have ceased, and the skin is smooth ; not less than four weeks.	18 days.
GERMAN MEASLES	Like both Measles and Scarlet Fever, but generally mild. Sneezing, blotchy rash, enlarged glands.	10—14	1st to 3rd	Breath (*i.e.* throat discharges).	Three weeks.	18 days.
DIPHTHERIA ..	Sore throat, with lassitude and weakness as a rule ; white points or patches on the back and sides of the throat ; stiffness of neck ; pallor. Sometimes merely like a mild sore throat.	1—8	No rash	Discharges from throat, nose, and ear.	Till two successive examinations for diphtheria bacilli have given negative results.	Till bacilli are proved absent.
WHOOPING COUGH	Begins like a common cold, followed in a few days by fits of coughing, which gradually develop the charactersitic long-drawn whoop, and are often followed by vomiting.	7—14	No rash	Breath (*i.e.* discharges from lung).	Till cough and vomiting have ceased. Two months at least.	18 days.
MUMPS ..	Pain and stiffness in jaws, feverishness and limb pains ; swelling in front of ears and under the jaws. May be on one side only.	7—21	No rash	Breath (*i.e.* discharges from parotid glands)	Four weeks.	21 days.
CHICKEN POX	Scarcely any preliminary illness ; small red spots changing in about 24 hours to blisters (vesicles) containing clear fluid ; these burst and form scabs. Spots at different stages of development.	10—14	1st—3rd	Breath and scabs.	Till all scabs have fallen off and skin is clear.	18 days.
SMALL-POX ..	More severe than last ; headache, backache, vomiting, with rash similar to last ; vesicles become pustules, then scabs on forehead, face, and hands.	12	3rd	Breath and scabs.	Till all scabs have fallen off and skin is clear.	14 days.

CHAPTER VII.

SCHOOL CLOSURE AND DISINFECTION.

CLOSURE.

This is an exceedingly difficult problem at present because the public have a firmly fixed idea that the only way to combat a school epidemic is to close the schools. As a matter of fact the process is extremely clumsy, unscientific, and unsatisfactory, and the only purpose it serves is to mask the true state of affairs, and to confer upon the locality that state of bliss which is said to be the invariable accompaniment of ignorance. In towns especially it probably has no effect whatever in preventing the spread of the disease.

Article 101, which ceased to operate in March 1903, protected the school authorities against the pecuniary loss that they might suffer by the exclusion of infected children and also children from infected houses. The reason for its withdrawal is not obvious. The result is that only by obtaining an order for the schools to be closed can the education authority prevent its grant being seriously reduced. As a consequence the local medical officer of health is besieged by requests to close the school directly a few cases of infectious disease have occurred, and in many cases he thinks it wise to give way to the clamour. The

Board of Education have therefore taken the ill advised step of helping to perpetuate an antiquated and unscientific system. In country schools alone does the mere fact of closure influence the spread of an epidemic.

Occasionally it is necessary to close a school for the purpose of making alterations and remedying such defects as have been revealed by the systematic inspection and examination of the premises, or for the purpose of cleansing and disinfecting. If a school is closed for any reason it should be thoroughly cleaned and disinfected.

During epidemics of diphtheria the best procedure has already been discussed. Every infected child and every "carrier" of the disease can be detected by means of bacteriological examination. By the exclusion of all such cases, combined with the proper disinfection of the premises, and other steps that are discussed under the subject of disinfection, the spread of the disease can be arrested.

In the case of measles if the teachers received definite instructions to always send home all infants showing signs of a cold there would be fewer epidemics. When an epidemic does occur the carrying out of vigorous measures, and systematic medical inspection combined with the exclusion of all children from infected houses, is often successful in stamping it out. If these measures prove to be unsuccessful it is only necessary to close the infants' department. With regard to the other departments it may be advisable to exclude those children who have never had measles, but information of this kind is difficult to get exactly, and such a step should rarely be necessary.

Epidemics of scarlet fever can usually be arrested by taking such steps as have already been outlined.

It should be particularly borne in mind that school closure is often reduced to a farce by the continuance of

the Sunday school and week-day meetings in the building in question. No school should be closed under any circumstances unless its complete closure for the period named can be arranged.

The Codes up to and including that of 1907 contained provisions for school closure, or the exclusion of certain scholars from school, somewhat similar to those in the present Code. School closure, however, under Article 45 (*b*) used to be possible when recommended by Medical Authority of any kind, and the ease with which the closure could be thus arranged for probably accounts for the habits of closure that so many districts appear to have acquired.

In the present Code, however, this has been altered, and the vague reference to "Medical Authority" is eliminated. In its place is the distinct ruling that a school can be closed only by the advice of, or with the approval of, the School Medical Officer, or by the Sanitary Authority of the district acting on the advice of the Medical Officer of Health. That this alteration is not yet fully appreciated is shown clearly by the fact that there are still schools closed suddenly and without reference at all to either the School Medical Officer or the Medical Officer of Health.

The recent Memorandum, issued jointly by the Local Government Board and the Board of Education, will serve a most useful purpose if it succeeds in setting the question of school closure upon definite lines. Unfortunately, there is a tendency to regard it as the beginning and end of the treatment of an outbreak of infectious disease. Until the public can be taught that this is merely one step among many that may be taken in order to combat the spread of disease, the process of school closure cannot possibly be of any very great value.

After a school has been closed on account of infectious disease, it is extremely common to find infected children

mixing, inside the house and outside, with the healthy ones, while in several districts the methods of disinfection after infectious illness leave very much to be desired, and probably account largely for the fact that the disease continues to spread, quite independently of the school conditions. It is common also to find the day school closed while Sunday schools and meetings for young children are continued.

The value of school closure as a means for the prevention of the spread of infectious disease is undoubtedly misunderstood. In the past it has apparently been regarded as the first and essential step to take directly any infectious disease makes its appearance. There is no doubt that in the majority of cases the mere fact of closing the school has no effect whatever in checking the spread of disease, but merely serves to mask the situation, and to prevent such exact knowledge of the progress of events as would obviously be available if the school were kept open. A careful daily supervision of the scholars, with a weeding out of all suspicious cases, is a far more effectual way of dealing with the question. In the case of some diseases, such as diphtheria, there are means at our disposal whereby it can be definitely ascertained whether any of the scholars in the school have become infected or not, and therefore, for this disease, there should never be any necessity for closing the school, except for disinfection.

Another unfortunate result of an early closure of the school is the subsequent alarm that usually spreads through the district. When a school is once closed it is very difficult to reopen while there is any trace of the disease in the neighbourhood, and if an attempt is made in this direction the result is that very few scholars put in an appearance at the school. This fact in its turn is made a further excuse for again closing the school.

There is no doubt that careful supervision of the scholars,

with effectual disinfection of the school premises and apparatus, is far more likely to influence the spread of any infectious disease than the mere hasty and haphazard system of closure adopted at present in many instances.

DISINFECTION.

By the term disinfection is meant the total destruction of all bacterial life. Substances or processes that are capable of effecting this are called disinfectants. It is probable that upon no subject in connection with disease is there denser ignorance than upon that of disinfection. It is still common, for instance, to hear in popular lectures, and to read in the lay press, the ancient advice about having saucers, filled with substances of more or less value as disinfectants, placed about a sick room. It is difficult to imagine what useful purpose such a process could possibly fulfil unless these well-meaning people consider that the microbes or germs of disease are willing and anxious to take the necessary suicidal plunge. Surely it should be unnecessary to state that no room can be disinfected while human beings are in it. It is much easier to kill human beings than to exterminate the microbes scattered about a room. So long as the room is inhabited it is only possible to keep things as clean as possible and to flush the room with fresh air.

Another common error is to use the term disinfectant to broadly denote deodorants and antiseptics as well as true disinfectants and germicides. A deodorant such as eau de Cologne, camphor, tobacco smoke, eucalyptus, etc., merely masks a bad smell and has no action upon germs. The term antiseptic should be applied to those substances which prevent the development and multiplication of germs without destroying them, *e.g.* Condy's fluid, iodoform, common salt, boracic acid.

Disinfectants may be classified into liquids and gases. Among the liquids are carbolic acid, solution of corrosive sublimate, formalin, and many patent substances. Any of these may be used for disinfecting pencils, desks, slates, or the walls and floor of rooms. Gaseous disinfectants include chlorine, formaldehyd, sulphur dioxide, hot air, and steam. If a gaseous disinfectant is desired for school disinfection, the best is probably formaldehyd.

Room Disinfection.

The choice of a disinfectant for school purposes is difficult, and the selection of the most suitable method of disinfection is still more so. It is customary to point out that bacteriological experiments have shown sulphur dioxide gas to be practically useless as an actual disinfectant, but it must not be forgotten that not only does the clinging odour of such gaseous disinfectants compel thorough flushing of the premises with fresh air afterwards, but also impresses upon the public mind the fact that such processes are being carried out. The use of formaldehyd has much more justification, and has been found by the author to be an extremely active germicide when diffused with steam into the air by means of some such apparatus as Lingner's. For good results, however, it is necessary to use large quantities of formalin. Formaldehyd also has the advantage of a penetrating and clinging odour, necessitating flushing with air and scrubbing after its use.

The use of disinfectant sprays is probably the method of the future. The liquid used can be applied in a known dilution, and is accordingly more trustworthy than gases or vapours. For dirty surfaces the spray will usually have a higher capacity to penetrate the dirt than will any gas.

Schoolrooms should be regarded as places that are bound to become infected from time to time, and so it should

become the universal practice to disinfect the surfaces of schoolrooms regularly as a routine process. This has been done for some time in America. A considerable decrease in infectious diseases, particularly scarlet fever, measles, infectious colds, etc., has followed the systematic disinfection of school books and school premises.

The insanitary condition of many of the non-provided schools is notorious. Such buildings are usually overworked, and there is no time for proper cleaning. Unless ample time for cleaning, disinfecting, and flushing with fresh air can be arranged, no premises should be allowed to be used as a school. Moreover the average public elementary school is not clean. While the buildings are new they look bright and fresh, but the condition of the majority of schools leaves a great deal to be desired.

For the periodic routine disinfection of floors the best plan is to run over the floor with a mop soaked in a disinfectant solution, and leave the floor thus well moistened until the following morning. Of course the disinfecting liquid must be of the necessary strength.

Associated with school disinfection is the dust problem. It is impossible to estimate how many children acquire some form of tuberculosis, especially consumption, from school dust. The author's experiments show an enormous difference in the number of organisms in the air when the floor is covered with dust-preventing preparations.

Pens, Pencils, Slates, etc.

These can be easily disinfected by soaking in disinfectant solutions. In most schools these articles are used in common, and must be carefully attended to. Modelling clay that may have been infected should be disinfected by heat and thrown away.

Books, Papers, etc.

When these may have been infected the best plan is to burn them. If this is objected to on the score of economy they may be suspended on lines across the room when the premises are being disinfected by formaldehyd. Or they may be placed on end, with open pages, in an air-tight receptacle, and subjected to the action of formaldehyd for twenty-four hours.

Probably no ordinary system in use gives really satisfactory bacteriological results, and it is quite possible that a good dusting and exposure to sunlight in the open air would be quite as reliable. Steam disinfection is impossible on account of its disastrous effects upon leather and also upon the glutinous material used in the binding. The only really satisfactory solution of the problem is the provision of separate books to be reserved for the use of individual scholars.

Dr. Kaye suggests as an alternative that each scholar on using a book should write his name and the date therein. "This would tend to impart an idea of the value of books and the care necessary in handling them. It would also enable the books recently used by a sick scholar to be discovered and destroyed; and it might furnish valuable clues in tracing the course of a disease."

Desks, etc.

If gaseous disinfection is used for the rooms the desks are left in during the process. Afterwards they must be thoroughly scrubbed with disinfectant soap and water. If a spray is used the desks must be sprayed thoroughly and then washed.

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