# ELEMENTS OF HYGIENE AND PUBLIC HEALTH

*FOR THE USE OF MEDICAL STUDENTS AND PRACTITIONERS*

BY

RAI BAHADUR JAISING P. MODI, L.R.C.P. & S. (Edin.), L.F.P.S. (Glasgow),

Fellow of the Royal Institute of Public Health; Lecturer on Medical Jurisprudence, King George's Medical College, Lucknow; formerly Lecturer on Medical Jurisprudence, Hygiene, Chemistry & Physics, Agra Medical School, and Special Health Officer, Hardwar; Author of "Text-Book of Medical Jurisprudence and Toxicology."

WITH AN INTRODUCTION BY

LIEUT.-COL. E. J. O'MEARA, F.R.C.S. (Eng.), D.P.H. (Camb.), I.M.S.,
Principal, Agra Medical School.

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**This Book is Dedicated**

TO

LIEUT.-COL. E. J. O'MEARA,

F.R.C.S. (Eng.), D.P.H. (Camb.), I.M.S.,

Principal, Agra Medical School,

AS A MARK OF RESPECT AND IN ADMIRATION
OF HIS KEEN INTEREST IN MEDICAL
EDUCATION.

BY THE AUTHOR.

*The Author regrets that owing to a printing error due acknowledgment was not made in the Preface to the Publishers and Authors of Parkes and Kenwood's HYGIENE to reproduce figure 25 on page 226, figure 28 on page 232 and figure 26 on page 228.*

*It was the Author's intention to make full acknowledgment in all cases where subject matter and illustrative figures had been borrowed from other books (vide Appendix G) but they are somewhat numerous and if there should remain any which are not specifically mentioned this is due to inadvertence and not to any desire by the Author to claim originality for anything which had already appeared in the many excellent works which he consulted.*

# PREFACE TO THE SECOND EDITION.

I HAVE been much gratified at the very favourable reception accorded to the first edition of this book. This has resulted in the publication of a second edition within a short space of time.

I have taken the opportunity of carefully revising the book, so that it can be adopted as a text-book in the Medical Colleges of India. Hence, though nominally a second edition of "Elements of Hygiene and Public Health," this is, generally speaking, almost a new book. Several chapters have been amplified and rewritten. New chapters on industrial hygiene, occupational diseases, offensive trades, hospitals, school hygiene, and some infectious diseases have been added. As a practical guide to the sanitary inspectors and health officers the model bye-laws have been given as an appendix at the end.

I have endeavoured to adopt some of the valuable suggestions offered by my friends, as well as contained in the reviews which appeared in the medical press on the publication of the book. I desire to express my best thanks for the assistance received from my friend, Honorary Captain K. V. Amin, D.P.H., Health Officer of Ahmedabad. I am also indebted to Mr. H. M. Rogers, of Messrs. Butterworth and Company, Calcutta, for helping me in correcting the proofs.

J. P. MODI.

*Lucknow*, 1920.

# PREFACE TO THE FIRST EDITION.

THIS book has been written in response to a demand from the medical students for a text-book on Hygiene and Public Health. As a lecturer on this subject for over ten years in one of the largest medical schools in India, I always found that the students were very much handicapped in their study of such an important subject for want of a proper text-book suitable to their needs. With a view to supplement that want this book has been written, mostly in accordance with the Syllabus laid down for the qualifying examination of "L.M.P." by the State Board of United Provinces for Medical Examinations.

I do not pretend any originality in this book except the way in which the facts and certain subjects have been so arranged as can be easily understood by the class of students for whom it is meant; but I must admit that the subject-matter has been largely borrowed from various text-books, periodicals, etc., to the authors of which I am very grateful; and a list of these has been appended at the end of the book.

Two special chapters on village sanitation, fairs and famine camps have been written with a view to enlighten the would-be Sub-Assistant Surgeons, as they are the proper persons to carry the torchlight of modern sanitation to villages and that they should know the rules and regulations, which are ordinarily required of them when on fair or famine duty.

I must acknowledge my thanks to Col. O'Meara and Prof. Pandya for their having gone through the manuscript and for their valuable suggestions—to Col. O'Meara especially, for without his encouragement this book—my humble attempt—would never have seen the light of day.

THE AUTHOR.

*Agra*, 1918.

# LIST OF ILLUSTRATIONS.

# INTRODUCTION

BY

LIEUT.-COL. E. J. O'MEARA,

F.R.C.S. (Eng.), D.P.H. (Camb.), I.M.S.,
Principal, Agra Medical School.

THERE are many books on European Hygiene, which are not adaptable or suitable to the conditions existing in India and the East; there is, therefore, a great demand for a small practical book such as Dr. Modi has written, based on the Syllabus of the largest medical school in India.

Dr. Modi has a long experience of teaching, having been a lecturer for over ten years, and the book is the outcome of repeated demands from students and practitioners for a concise book on Hygiene and Public Health, treated from the Indian standpoint, especially as regards food, malaria, plague, cholera and dysentery.

I would invite attention to the chapters on Village Sanitation, a question of vital importance in this country as affecting the health of the great majority of the people and a subject which has not been so fully dealt with in any previous work on Hygiene. The sanitary arrangements for fairs, the chief cause of the spread of cholera in Northen India, is another important chapter, also the measures recommended for famine and segregation camps.

In conclusion, I have much pleasure in congratulating Dr. Modi on the energy and public spirit he has shown in compiling this excellent little book.

# CHAPTER I.

## WATER.

WATER is a prime necessity of life not only as an article of diet but also for the proper cleanliness of person, clothing and things. Without it there would be no life, animal or vegetable. It forms about two-thirds by weight of the human body. Water exists in three states, *viz.*, solid, liquid and gaseous. As a solid it is met with in the form of snow and ice ; as a liquid it is met with in the sea, in rain, in streams, rivers and lakes; while as gas or vapour, it forms one of the constituents of the atmospheric air, and of the breath which we exhale from our lungs.

Water is a chemical compound, consisting of two parts of hydrogen and one of oxygen ($H_2O$), and is formed whenever hydrogen, or a combustible substance containing hydrogen, is burnt. It is very difficult to obtain water chemically pure, but for practical purposes water that has the following characteristics may be taken as pure:—

(1) It should be clear, transparent, tasteless, inodorous and colourless in small quantities, but slightly green or blue through a deep column of water.

(2) It should not contain an undue amount of solid constituents, specially when such constituents are lime and magnesia. The amount of solids should not exceed 8 grains per gallon, one grain of which should be dissipated by heat.

(3) It should be practically free from nitrogenous organic matter. Any sample of water, which along with a considerable quantity of free ammonia, yields 0.05 parts of albuminoid ammonia per million, should be viewed with suspicion.

(4) There should be a certain lustre or sparkle indicating the presence of carbon dioxide gas.

## SOURCES OF WATER.

The natural sources of water are rain and snow falling on the surface of the earth; but a common classification is as follows:—

(1) Rain water; (2) Surface water, including lakes, streams and rivers; and (3) Ground water, including springs and welis.

## (1) RAIN WATER.

This is produced by the condensation of aqueous vapour present in the air, derived from the surface of vast sheets of water by evaporation. It is the clearest and purest of waters, but it absorbs various gases and solid substances in its downward progress. Part of the rain that falls is at once evaporated or absorbed by vegetation, part flows along the ground surface to form rivers and lakes, and the remainder percolates through the interstices of the soil until it reaches an impervious stratum. The amount of the rain water that percolates into the soil depends chiefly on the nature of the soil. It is none in clay, about 20 per cent. in limestone, 40 per cent. in chalk, and 90 per cent. in sand and gravel. The nature and slope of the soil, the season of the year and the amount of rainfall are the chief factors in calculating the relative amounts of the three portions. On an average $\frac{6}{10}$ths of the actual rainfall is available for storage.

Rain water is ordinarily collected from the surface of the roofs, and stored in masonry tanks or small reservoirs sunk below the ground level in some part of the house. These tanks should be built on a bed of concrete. lined on the inside with hydraulic cement and surrounded externally with at least a foot of well-puddled clay so as to prevent the entrance of surface or sub-soil water. Such water is, however, liable to be much polluted with soot, vegetable and animal matter being washed off from the surface of the roofs, especially the tiled ones. It is, therefore, necessary to reject the first part of a rainfall, and to collect and store it after the roofs have been thoroughly washed. Any mechanical arrangement, such as Robert's or Gibb's Rain Water Separator, for letting the washings may be attached to the rain water pipe. It is so ingeniously arranged that it allows the first part of the rainfall to run to waste but, after a time, tips over and directs the remainder into the collecting channel and reservoir. Sir William MacGregor has introduced an arrangement by which clean water can be stored, and can also be protected from mosquito eggs and larvæ. The amount of water that can be collected from a roof can be estimated by the following formula:—

The area of a roof in square feet multiplied by half the amount of rainfall in inches equals gallons of water per year.

In calculating the surface of a roof its slope need not be taken into account, but the flat surface actually covered by the roof.

When rain water is required for a small population as in a prison, military camp, etc., it should first be received on a large area of the ground constructed of concrete or other impervious material, and then conveyed into underground reservoirs by means of pipes. The ground, which is known as *catchment area,* must be kept scrupulously clean, and well protected by an impassable fence to keep away animals. No cultivation of the land should be allowed, nor should habitations within the area be allowed. The supply channel to the tank from the catchment area should be frequently inspected and kept clean.

As a source of domestic supply rain water is unreliable owing to the uncertainty of rainfall, and the length of the dry season in some localities.

Rain water is specially useful for cooking and washing as it is soft water, *i.e.*, it does not contain salts of lime or magnesia dissolved in it. These salts when dissolved in water render it hard and, acting upon the soap, prevent the formation of a lather. Hence, there is a great waste of soap if hard water is used for washing. It is not good for culinary purposes also, as meat and vegetable material, if cooked by boiling in hard water, get hardened. Hardness of water may be temporary or permanent. Hardness, due to the presence of bicarbonate of calcium is temporary, because, on boiling, the soluble bicarbonate is changed into insoluble carbonate and can be filtered off. It may also be softened, by the addition of lime, as in Clarke's process. Permanent hardness is caused by the presence of certain sulphates and chlorides, notably calcium sulphate. It cannot be removed by boiling. The addition of washing soda, however, softens permanently hard water.

## (2) SURFACE WATER.

This is the rain water which has run over the surface of a soil without penetrating it, and has formed lakes, impounding reservoirs, streams and rivers.

**Lakes.**—These are natural reservoirs from which a great many places in India obtain their water supply. When collected from unpopulated, hilly or mountainous districts, such water affords an excellent supply, being usually soft and containing but little chlorine. It does not contain ammonia, nitrates and nitrites more than are usually found in rain water. It, however, contains more dissolved matter than rain water. On the other hand, the water collected from low land surfaces usually contains much peaty matter, as well as phosphates and nitrates washed from the manures of cultivated fields, and becomes yellow or brownish in appearance.

**Impounding Reservoirs.**—These are artificial ponds or lakes, usually made by building a dam or barrier across the narrow valley. They are frequently made along the course of a small stream. These are constructed by excavations or embankments. The embankments should be of great strength to bear the tremendous pressure of water behind them, and should be made of puddled clay on the inside, and their sloping sides should be covered with dressed stones bedded with hydraulic cement on the inner side and with grass on the outer side. They should be of such a size as to contain a sufficient quantity of water to supply the population of the district for a period of 150 to 180 or more days. The chief points to be taken into consideration in providing reservoirs are the amount of water to be supplied per head per day, the size of the catchment area, the minimum annual rainfall, the proportion of annual rainfall available for storage, and the longest period of continuous drought. According to Hawksley's rule the average rainfall of twenty years less one-third corresponds to the amount of rain in the driest year; while the average of twenty years plus one-third gives the amount of rain in the wettest year. The total quantity yielded by a catchment area may be calculated by Pole's formula, *viz.*, $Q=62A\ (\frac{4}{5}\ R-E)$, where Q=the total yield of water in gallons ; A = the size of the catchment area or gathering ground in acres ; R = the mean rainfall of the three driest consecutive years; and E=the loss of water by evaporation, waste and percolation; this varies from 10 to 20 inches.

The chief sanitary advantage of these impounding reservoirs is that most pathogenic bacteria die a natural death during storage, and probably one month is sufficient to produce this result. However, owing to their being stagnant, and open to air and light they favour the growth and subsequent decay of algæ, which give the water a bad taste and foul smell. This is rendered harmless by treating it with copper sulphate, hung in a piece of cloth from the sides of a boat, which is rowed on the surface of the reservoir.

In addition to impounding reservoirs compensation reservoirs must be constructed into which at least one-third of the total quantity impounded and collected during heavy rainfall can be directed, and afterwards allowed to pass down the stream for the use of mill-owners, etc.

**Rivers.**—The nature and amount of the impurities found in river water will depend upon the strata over which the water flows and upon the nature of the surface. It is frequently muddy, and contains solid matter in suspension. Rivers generally form the natural drainage channels of the surrounding land and towns situated on their banks, and thus are always liable to be polluted by sewage, refuse and the dead bodies of men and animals. But the water is naturally purified to a certain extent by oxidation due to sunlight, by deposition and by dilution. Hence the shallow and small rivers, which usually dry in the summer, are dangerous from a sanitary point of view.

In estimating the water supply of a community from a river or stream the average yield of a stream may be roughly estimated by selecting some fifteen yards of the stream when the channel is fairly uniform and free from eddies. Measure its breadth and depth at several places and take the average. By multiplying these two averages together the sectional area is obtained. Drop in a chip of wood and note the time it takes to travel over the selected distance, say, 30 feet. From this the surface velocity can be calculated in feet per second. Four-fifths of this will give the mean velocity, and this multiplied by the sectional area will give the yield per second in cubic feet of water.

## (3) GROUND WATER.

This is the water which, having fallen as rain, has percolated through the permeable layers of the soil down to the impermeable layer, and forms another source of water supply in the form of springs and wells. This water is greatly purified, as it undergoes natural filtration during its passage through the soil. It, however, absorbs a large quantity of carbon dioxide from the ground air. Water, thus acidulated, is capable of dissolving lime and other mineral constituents, so that the ground water is apt to be harder than the surface water.

**Springs.**—These are natural outcrops or overflows of the underground water, where the geological formation is favourable. They are commonly found on the side or foot of a hill, in valleys, in the bed of a river, a lake, or a sea. Springs are usually classified as land or superficial and main or deep springs.

Land springs are formed by water percolating through the porous layers of sand or gravel overlying an impervious stratum of clay, and are the outlets of the limited collections of the underground water. They are unsatisfactory as a source of water supply, as they are often intermittent, ceasing to flow during the driest period of the year.

Main or deep springs are those, which, as a result of hydrostatic pressure, issue through fissures or cracks from regular geological formations, such as chalk, green sand, sandstone and oolite. The water of these springs is clear and sparkling, and is generally safer, having been filtered in its passage through the earth, and the flow is also constant. The water can, however, be contaminated from surface washings and manure containing human excreta. As a safeguard against such contamination the spring should be protected above with a masonry or concrete wall, and a ditch should be dug around its sides to carry off the surface water, and the neighbourhood kept clear of weeds. Grass should be planted about the spring so as to keep out dust, and prevent erosion of the soil. Animals should not be allowed to come near the spring, and stables and latrines should not be located in the near vicinity. If necessary, they may be constructed on another slope.

The yield of a spring may easily be determined by noting the time which it takes to fill a vessel of known capacity, *e.g.*, a 30-gallon cask.

Spring waters possessing medicinal properties or a saline taste are known as mineral waters. Their water is unfit for ordinary drinking purposes. There are several springs of this nature in India. The mineral springs containing sulphuretted hydrogen and various sulphides in solution are referred to as sulphur springs; waters containing iron or magnesium sulphate in solution are known as chalybeate or magnesia waters.

**Wells.**—There are three kinds of wells—shallow, deep and artesian. Shallow or surface wells are those that have a depth of less than 50 feet, and are not carried through an impervious stratum. They draw their supply from sub-soil water. Deep wells tap the water-bearing stratum beneath the impervious stratum, and are usually more than 100 feet in depth. They are sometimes of greater depth, and are called artesian wells, having been first sunk in the province of Artois, in France. The water from these wells is generally pure, but it is much harder than other waters. Wells furnish water supplies to most of the villages and towns in

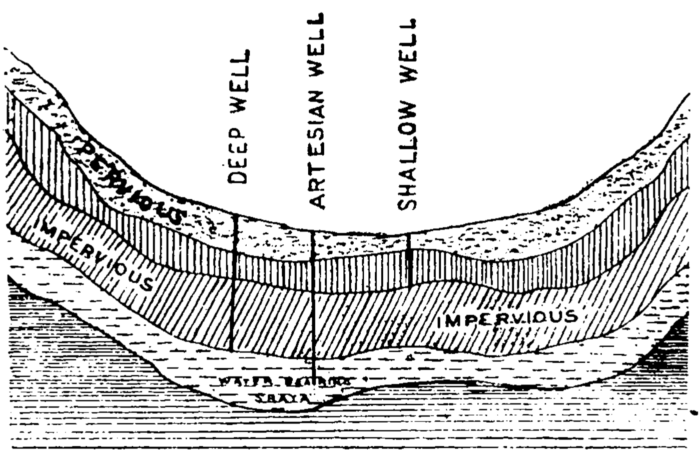



Fig. 1—Soils and Wells.

India. Shallow wells may yield good water, provided there is no risk of pollution from surface washings or from their proximity to drains and cesspools, but too much reliance cannot be put on these, and so it is always safe to take water from deep wells, the sides of which are protected by steining with brick and cement up to a level below that of the sub-soil water. This brick work should be carried to at least about a foot above the ground-level.

**Detection of the Source of Pollution of a Well.**—To ascertain if a cesspool or collection of sewage actually drains into a well, fluorescein may be added to it, and after a time its presence may be detected in the well water. One-quarter to half a pound of the fluorescein dissolved in water and added to the suspected source of contamination will be detected in the well water by giving it a fluorescent tint, if it is present in the proportion of only one part to 100 million parts of water. It should be remembered that fluorescein does not give any

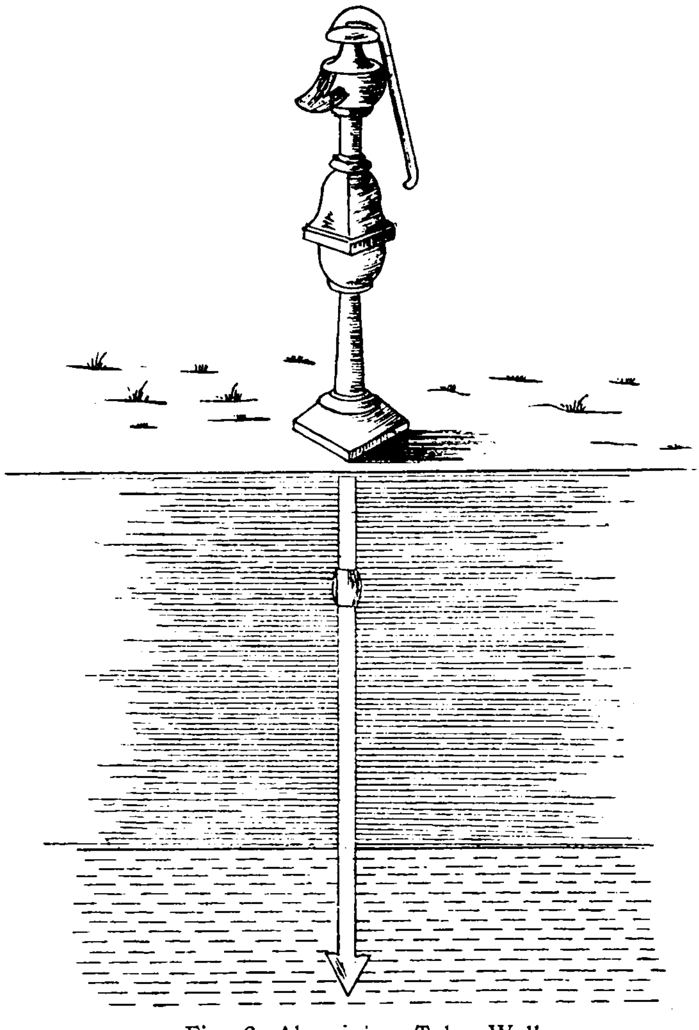


Fig. 2—Abyssinian Tube Well.

colour to the acid water. Hence caustic potash should be added, if the water is acid, which is, however, a rare occurrence. Instead of fluorescein a large amount (10 lbs.) of ammonium or sodium chloride may be added to the source of contamination, but in this case the chlorine content of the water should be ascertained before and after the addition. Similarly, cultures of the Bacillus prodigiosus will be found rearing in the well water, if they have passed through it from the suspected source of pollution. Lastly, kerosene oil may be poured on the ground to find out if there is any direct drainage from the surface to the well.

**Examination of a Well.**—In the examination of a well the following points should receive attention:—

1. The leakage and position of a well.
2. The depth of water in the well.
3. The distance from the surface.
4. The effect of pumping.
5. The surroundings and the distances from possible sources of pollution.
6. The nature of the soil.
7. The method of disposal of waste water.

**Yield of a Well.**—The test for calculating the yield of a well consists in lowering the level of water in the well to a considerable depth by pumping, and noting the rise of water in it at intervals of 15 or 30 minutes.

**Tube Wells.**—These are commonly known as Norton's Abyssinian tube wells, and are used when a temporary supply of water is required, as in famine camps, in big fairs or for the Army in times of war. They are made by driving into the soil lengths of hollow iron tubes having a diameter of $1\frac{3}{4}$ to 3 inches, which are screwed together, the lowest being pointed and perforated with holes, until a good supply is struck. The water may be obtained by attaching a pump to the top of the tube.

The pump yields on an average about 7 gallons per minute. The water at first pumped is turbid, but soon becomes clear, if the pumping is continued. The advantages of the tube wells are that they prevent pollution from surface contamination, do not allow mosquitoes to reach, and can be shifted from place to place.

These wells are useful in loose gravelly soils, especially when the depth is about 25 feet or so. They are largely used in the Punjab, where the conditions of the soil favour their use.

**Comparison of Waters derived from different Sources.**—The Rivers Pollution Commissioners classify the qualities of these waters as follows:—

| | | |
|---|---|---|
| (*a*) Wholesome | 1. Spring water.<br>2. Deep well water. | Very palatable. |
| (*b*) Suspicious | 3. Upland surface water<br>4. Stored rain water. | Moderately palatable. |
| (*c*) Dangerous | 5. Ordinary surface water from cultivated lands.<br>6. River water to which sewage gains access.<br>7. Shallow well water. | Palatable. |

**The Quantity of Water Needed.**—The quantity of water required by individuals depends upon their habits and the season of the year. In cold climate less amount of water is necessary than in the tropical. On an average an adult man will drink from 50 to 60 ounces of water daily, exclusive of the amount contained in his so-called solid food ; but this quantity even varies according to the season and the occupation. In Europe about 30 gallons a day are allowed for each grown-up person and about 15 gallons for each child. In India the supply is more limited, the average being 16 to 20 gallons per head, which includes the amount required for cooking, bathing, washing clothes, utensils and other domestic purposes. Besides these, for calculation of the water supply of big towns and cities, allowance should always be made for watering roads, cleaning surface drains and latrines, and that required for horses and other animals, as also for mills, factories, parks and gardens. In hospitals a very much larger supply is required, and generally the amount used is double the ordinary supply, the average being 40 gallons per head.

**Storage of Water.**—Water should always be stored in clean and bright copper or brass vessels, which must be kept covered so as to prevent dirt and dust from falling in. They should not be placed under staircases, for dust is likely to fall in when someone is moving on the stairs. These vessels should not be kept in bath rooms, otherwise foul gases may be absorbed. Water in these vessels is likely to get hot in summer, and so, to keep drinking water cool, it is necessary to use *Surais* or earthen vessels. But these are likely to absorb injurious gases owing to the pores in them, therefore they should be changed very often, or it is still better to use glazed earthenware vessels as *Matkas* or *Gharas.* Wooden tubs should never be used to store water as they get rotten and decayed very soon.

## DISEASES CAUSED BY IMPURE WATER (WATER-BORNE DISEASES).

**Dyspepsia and Diarrhœa.**—Permanently hard waters often cause dyspeptic symptoms and diarrhœa. The chlorides, sulphates and nitrates of calcium or magnesium are the more injurious salts. Similar symptoms are produced from brackish water drawn from wells near the sea coast. Such waters contain a larger excess of chlorides of sodium, calcium and magnesium. Mica suspended in water causes diarrhœa called sprue. Temporary hard waters are not injurious at all. Water polluted with sewage produces diarrhœa, often of a severe choleraic type with violent purging, vomiting and cramps. Infantile diarrhœa so often fatal in summer is due to water pollution in some cases. Vegetable matter, such as peat in water, is generally harmless but, if present in large excess, may produce diarrhœa.

**Dysentery.**—This is very frequently caused by drinking water which is fouled with sewage or which has passed through a cemetery or other impure soil. It may also be spread by the evacuations of patients suffering from this disease contaminating the water used for drinking purposes.

**Enteric Fever.**—This is more often spread through the medium of water than by any other means. It oftentimes happens, that water already contaminated by the evacuations of patients suffering from this disease is consumed by quite healthy individuals, causing them to fall ill.

**Cholera.**—This is, as a rule, propagated by drinking water to which the specific disease poison has had access. Sometimes it is spread by taking food in utensils washed in a tank or a lake contaminated by this poison.

**Worms or Entozoa.**—The embryos or eggs of the following parasites have been found in water, and may be taken into the stomach of man, when such water is used for drinking. They are **Tænia solium** (Tape-worms), **Bothriocephalus latus, Ascaris lumbricoides** (Round worms), **Oxyuris vermicularis** (Thread-worms), **Filaria sanguinis hominis, Bilharzia hæmatobium, Ankylostoma duodenalis, Distoma hepaticoma** and

**Filaria dracunculus** (Guinea-worm). Leeches may fix themselves in the pharynx, and cause hæmorrhage.

Oriental sores and skin affections are caused by washing the hands with infected water.

Metallic poisoning may be caused by drinking water contaminated with trade refuse and drainage from metalliferous mines. Lead poisoning may be caused by using lead pipes as service pipes. Soft water has a solvent action on lead and zinc, and should not therefore be stored in vessels made of either of these metals.

## PURIFICATION AND DISTRIBUTION OF WATER.

Since impure water has been found to be a source of so many diseases, it is essential to supply purified water to the community, for which purpose municipalities have constructed waterworks in several big cities. If this is not possible, people should purify water in their houses, before it is consumed by them.

**Purification on a large scale.**—This is carried out by filtration and sterilization.

**Filtration.**—For this purpose two forms of filters are now in common use—(1) slow sand filters, (2) rapid mechanical filters.

**1. Slow Sand Filters.**—Water is first collected into a settling tank, where the solid matters in suspension gravitate to the bottom. The solid matters have to be removed by scraping at the bottom from time to time, and hence it is necessary to have many settling tanks. In Agra there are five such tanks, which are cleaned periodically. After a time varying from 24 to 48 hours the water from these tanks is passed on to the surface of filter-beds, which consist of large rectangular watertight tanks usually built of brick lined with cement. At the bottom of these beds two layers of bricks are arranged in the form of drains and channels for the passage of the filtered water. Above these bricks and in the spaces between the bricks is placed a layer of broken stone or gravel about 3 to 4 feet of varying in progressive degrees of coarseness from above downwards. On the gravel is supported the filtering material consisting of sand from 2 to 3 feet in thickness. The water about 2 to 3 feet in depth is allowed to pass through such a filter very slowly, from above downwards. The finer the sand is, the better suited it is for filtration. The diameter of the sand grains should be, on an average, 0.3 to 0.4 millimeter. It is either taken from the sea-shore, from river beds or from sand banks. The solid particles which had not settled in the first tank are usually held up in the sandy layers of the second. After the filter has been in use for two or three days,

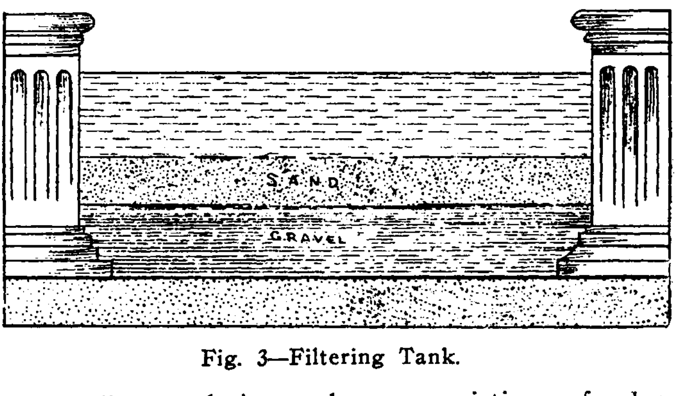



Fig. 3—Filtering Tank.

a thin slimy gelatinous layer consisting of algæ, fungi, and other low vegetable organisms is formed upon the surface and between the superficial particles of sand. It is this layer which retains the bacteria of the water. Practically this gelatinous layer is the most important factor in purifying water in these filter-beds, and so it is not disturbed as long as filtration is not obstructed. However, after some time the layer becomes thicker, and the water cannot pass through it except very slowly; it then becomes necessary to remove the soiled layer of the sand, about half an inch in thickness, which is washed with filtered water and stored in boxes, and then replaced, when the sand layer reaches a depth of about 12 inches.

For efficient filtration of water through these filter-beds the rate of flow should not exceed 4 inches per hour, or 60 gallons daily per square foot of the surface, or 2,500,000 gallons per day per acre of the filter-bed. In India the rate of flow usually does not exceed 30 to 36 gallons per square foot in 24 hours. As a rule 96 to 98 per cent. of bacteria present in the unfiltered water are removed, if the filter-beds are properly constructed, and duly looked after.

When the unfiltered water is turbid due to the presence of certain particles of clay sufficiently fine to pass through a sand filter, it is necessary that such water should be passed through a series of beds of diminishing degrees of coarseness situated in tiers one above the other before conducting it to the proper filter-bed. These are known as filters dé grossisseurs of Puech and Chabal. This system of filtration has been recently introduced into Cawnpore.

**2. Rapid Mechanical Filters.**—Owing to the expense, care and time required in their cleaning and resting, the slow sand filters have been much criticised. Hence mechanical filters have been devised. These are less expensive, simple and easy in manipulation, and require a very small area of ground. The rate of filtration is very rapid, one filter being capable of dealing with 250,000 gallons in a day. They have been in use in America for some years, and are well suited for purifying muddy river waters. Only recently they have been introduced in India. The essential feature of these filters is to add a chemical coagulant to the water for forming a slimy layer and then to pass it rapidly through sand. To form the coagulum sulphate of alumina in amounts varying from $\frac{1}{10}$ to 1 grain per gallon is added, which immediately produces a gelatinous layer of insoluble hydrate of alumina. The equation representing the reaction is—

$$Al_2 (SO_4)_3 + 3\ CaCO_3 + 3\ H_2O = Al_2 (OH)_6 + 3\ CO_2 + 3\ CaSO_4.$$

Chalk is necessary to break up the alum, and if not normally present in the water, some must be added along with alum. This gelatinous layer forms on the top of the filtering sand, which is contained in large iron cylinders or drums about 7 feet high. The sand is about 4 feet in depth. The layer serves the same purpose as the vital gelatinous layer forming on the surface of the slow sand filter. The water to be filtered is forced through the cylinders at high pressure, and in passing through the filtering material of sand loses its dirt, colour and about 98 per cent. of its micro-organisms. The filters are easily cleansed by reversing the current, and stirring up the sand by means of rotating arms or other mechanical arrangement. The types of these mechanical filters in common use are the Jewell Filter, Paterson's Filter and Bell's Patent Filter.

Another type of mechanical filter in use for public supplies is known as the Candy Filter. In this system water is first saturated with dissolved oxygen from the air and then passed through a filtering medium composed of prepared silica and an oxidizing agent contained in cylinders 5 feet deep.

**Sterilization.**—The sterilization of water on a large scale has not been introduced into India, but it has been practised for many years past in America, as well as in Western Europe. This is effected by (a) chlorination, (b) ozonization, and (c) by the action of ultra-violet rays.

**(a) Chlorination.**—This is carried out by treating the water free from suspended matter with bleaching powder, or a solution of calcium, sodium or magnesium hypochlorite so as to maintain in the water 1 part per million of available chlorine for about half an hour. This removes all deleterious organisms, and is more certain than sand filters. But the chlorine gives to the water a disagreeable taste and flavour. Hence the residual chlorine has to be removed before it is supplied to the public. This can be done by means of sulphite of soda or by straining the sterilized water through filters containing vegetable charcoal, which absorbs the residual chlorine, and removes the bad odour and taste.

**(b) Ozonization.**—As a sterilizer for large public water-supplies ozone has been used successfully in some continental towns, though the method is expensive. It destroys the water bacteria, as also the pathogenic micro-organisms, except a few resisting spores, but these are harmless when swallowed with the water. It, however, has practically no action on the mineral salts. 1 to 3 milligrams of ozone is sufficient for the purification of 1 litre of water.

For the purification of water ozone is prepared in a chamber by the silent electric discharge, and is then conveyed to the bottom of the sterilizing tower, where in its upward passage it is mixed with the descending water. The volume of the ozonized air necessary for purification of water is about 40 per cent. of the water to be treated.

**(c) Ultra-Violet Rays.**—The ultra-violet rays of light which destroy the water bacteria directly without the formation of chemical compounds have been recently used in Marseilles and other towns. The rays are obtained by passing electric currents through mercury vapour enclosed in rock crystal or quartz lamps. These are placed in the water or above it. Turbidity of the water or the presence of colloid matter greatly retards the sterilization of water.

**Distribution of Water.**—In those cities where water-works are erected, water is either taken first from rivers as at Agra, or from canals as at Meerut, or from wells dug in the beds of rivers, as at Ahmedabad and Surat, or from tanks as at Ajmer, or from artificial lakes as from the Vihar, Tulsi and Tansa lakes of Bombay. From whatever source the water is derived, it is first purified by filtration through filtering beds, unless it is guaranteed pure as at Ahmedabad.

Water, after having passed through this filtering tank, is collected in a third receptacle known as a storage reservoir constructed ordinarily below the ground-level. From this storage reservoir, water is eventually distributed to the city by means of closed conduits or pipes. The pressure required for its distribution is usually supplied by force of gravity; but where water has to be supplied to localities situated on a higher level than the reservoir, preliminary pumping becomes necessary to supplement the mechanical force ordinarily sufficient. The storage reservoirs should be so constructed as to have a capacity that will hold a water-supply for at least 8 days. They should, however, be cleaned every 3 months. At some places gardens are made on the roofs of these reservoirs. This is very harmful, if the roofs are not impervious, for water is then liable to be contaminated with the manure used for the gardens. The ventilators are provided for aëration of water. They should be placed 3 or 4 feet above the ground so as to prevent anything from falling into them.

In large cities it becomes necessary to erect overhead supplementary or service reservoirs at various places to facilitate the distribution of water in certain areas. These are made of such a size as to hold at least 8 hours' average supply of water.

The pipes which convey water from the storage reservoirs to streets are called mains and are constructed of cast iron. These should never be less than 3 inches in diameter, and should be coated on the interior with Angus Smith's varnish consisting of coal tar pitch, resin and linseed oil, or a glassy lining to prevent rusting. They should be laid at least 3 feet deep from the surface of the ground, so that they may not be affected by traffic, heat and frost. From the mains in the streets, water is supplied to houses by small pipes called supply pipes or service pipes, which are made of lead, wrought iron, or galvanized iron. If possible, lead pipes should not be used, as soft water acts on lead, an oxide being formed which dissolves in water and acts as poison. Lead being a cumulative poison the continuous use of water containing even $\frac{1}{10}$ gr. of lead per gallon may lead to plumbism. This plumbo-solvent action of soft water is very much increased, if the water is acid, as in peaty water due to the formation of humic acid. But it is prevented by the presence of half a grain of silica and two grains of slaked lime, or sodium carbonate per gallon. The advantage of the lead pipes lies in the ease with which they are bent. The service pipes are connected to the main by a brass screwed ferrule, and are controlled in the house by stop-cocks.

The joints of mains and service pipes should be made perfect so that there is no leakage. They should not be laid near sewers, drains, or gas pipes lest they may be contaminated.

Stand posts are generally erected in the streets for the convenience of poor people who cannot afford to have house connections. These stand posts should have taps of such a kind as to allow a minimum of water. Self-closing taps are better. Taylor's taps are so made as to allow 3 to 5 gallons of water to come at a time by turning the handle.

In some cities, where it is difficult to obtain enough supply of pure water, a double supply—one of filtered water and the other of unfiltered water—has been in vogue. But this system of a double supply is not very safe, as mistakes are liable to occur in joining the pipes of filtered water with those of unfiltered water; however, there can be no objection, if the supply of unfiltered water is only limited to trade purposes, to watering of parks and gardens, and to street cleansing.

Water-supply may be constant, *i.e.*, water may be obtainable from supply pipes at all hours during the day and night; or intermittent, as in many big cities, when water is only obtainable for a few hours during the day. In constant supply there is no need to store water and thus no fear of water pollution by filth, dust, etc., but there is always a considerable wastage which can, however, be regulated by Deacon's water-meters attached to mains. These meters register the flow of water by day and night, and hence by examining them at midnight the loss in water head may be noted. The wastage in houses can then be determined by visiting the houses when the vibrations produced by the leakage of water can be heard by means of a stethoscope applied to the service pipe.

In the intermittent system the pipes become corroded being empty for a greater portion of time, and are liable to be contaminated by foul gases and sewage impurities. Water has to be stored, and thus is liable to be contaminated while, in the case of an outbreak of fire, water is not immediately available.

**Domestic Purification.**—In those cities and towns, where water-works cannot be constructed owing to their cost, or any other reason, it is necessary that water should be purified in the houses of the people before it is used by them. Water may be purified by means of (1) distillation, (2) boiling, (3) filters, and (4) chemicals.

**1. Distillation.**—In distillation the vapour is condensed into a liquid by means of a continuous cold application. Its object is generally to free water from its impurities. This method is used in chemical laboratories, on boardships, and at places like Aden where fresh water is difficult to obtain; but distilled water being flat and insipid requires to be aerated before use.

**2. Boiling.**—This is a very good method of purifying water. It removes solid matters, such as chalk and iron, obnoxious gases, and organic matter, and kills disease-producing micro-organisms, such as those of cholera and enteric fever. Some harmless spores are not affected. Boiled water is flat and tasteless, and should by aerated before use. Boiling is very often resorted to by the Jain community in India, but they generally allow boiled water to cool in big open saucers where it is liable to be contaminated by dust, gases, etc. Water should, therefore, be kept boiling for a few minutes, and must be allowed to cool in covered vessels. Another method of purifying water prevalent in most parts of India is to put a red hot piece of iron, silver, or brick in an earthen pitcher of water. Water purified in this manner is given to patients. Nowadays, sterilizers are supplied for the use of the army in manœuvres or in action.

**3. Filters.**—An ordinary method of filtering water in India is by straining it through a muslin cloth, but this is most objectionable, as it cannot prevent bacteria, foul gases and finely divided solid particles from passing through its fabric; besides such a cloth is not usually kept clean, and is discarded only when it becomes very dirty or totally impervious. Efficient filters are ordinarily constructed with materials, such as charcoal, sand, silicated carbon, porous iron, etc. Besides, whatever materials are used, they should not only be sufficient in quantity, of a durable consistency, and capable of retaining impurities and germs for a reasonable period, but also their construction should be so arranged as to allow easy inspection or renewal.

Charcoal is very much used as a filter. Its particles should be well pressed together, so as to delay the passage of water; and the compressed layer must have sufficient depth to thoroughly purify it. It is, however, not the best filtering medium, because it absorbs impurities from the water, or air, and becomes a source of danger unless it is often cleaned with boiling water, and renewed. It also adds to water nitrogen and phosphates, which form a nidus for micro-organisms to grow and develop, especially if it happens to be animal bone charcoal.

A common variety of filter, which is seen at almost every railway station in India, is three *gharas* placed one above the other on a wooden or bamboo stand. The top *ghara*, containing sand, is filled with water, which percolates—through a hole made at its bottom along a piece of cloth or cotton introduced into the hole—into the second *ghara* which contains a mixture of sand and vegetable charcoal. Water passing through the layers of sand and charcoal percolates through a hole at its bottom into the third and lowest *ghara* which will now contain filtered water. The mouths of the *gharas* should be kept covered, and the sand should be frequently washed in boiling water as it is liable to contain disease germs; because it is very often taken from near the river-bed, which is used as a rule by the people for answering nature's calls. Charcoal should also be changed at least once a week, or it should be cleaned by taking it out and putting it in an oven or an iron plate over a strong fire and heating it to redness and then it should be boiled in a mixture of Condy's fluid and hydrochloric or sulphuric acid. Proper care should be taken in looking after this filter, if it is used, lest the filtered water in the lowest *ghara* might not be mixed up with unfiltered water. However, it is not possible to take all the necessary care in private houses; hence this system of *ghara* filtration must be condemned, and should never be used.

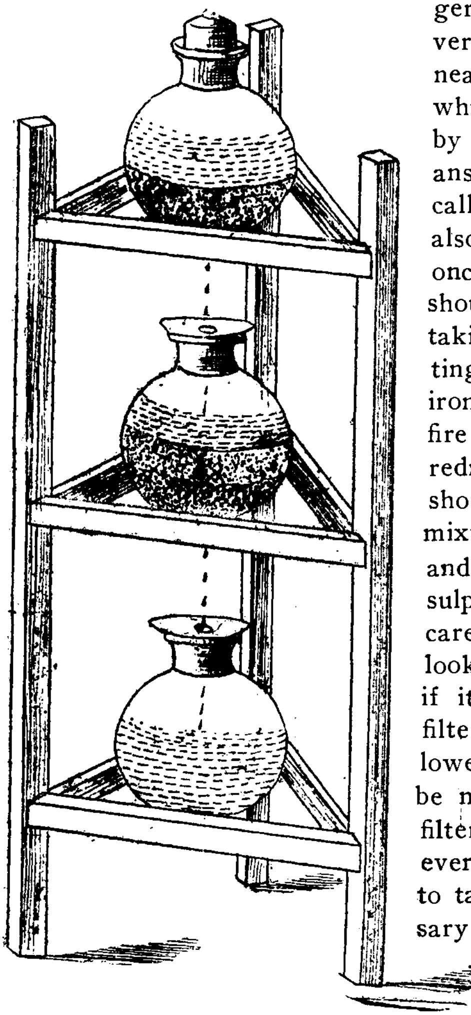


Fig. 4—Filtration of Water by Three-Ghara System.

The best domestic filters which are capable of removing bacteria from the water are those made of porcelain and clay, and moulded into candles or bougies. The candles are enclosed in metal cylinders

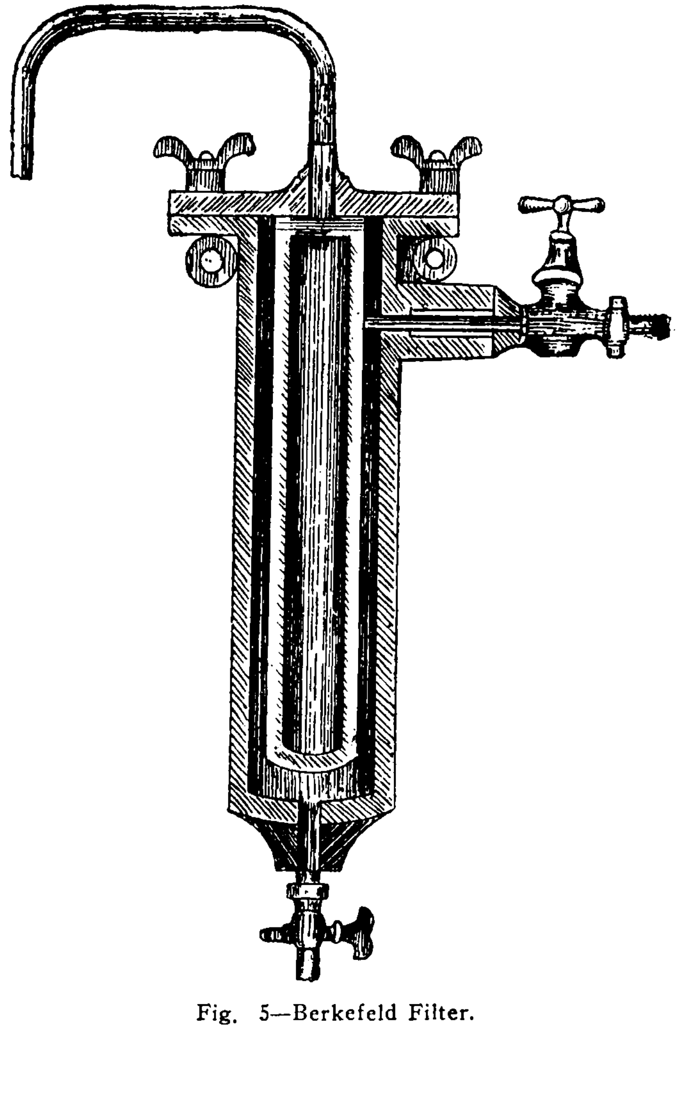


Fig. 5—Berkefeld Filter.

by means of which they can be screwed on to ordinary water taps. Two main types of this variety are the Pasteur-Chamberland and the Berkefeld. One is made of fine unglazed procelain, and the other of infusorial earth. In these filters the water is forced through either by its own pressure in the main or by the use of a force pump. The filter candles become readily blocked up; hence it is necessary to scrub their outer surfaces with a brush and to boil or sterilize them by heat every third or fourth day.

**4. Chemicals.**—The chemicals that are used in purifying water are (1) Alum, (2) Nirmali **(Strychnos Potatorum),** (3) Copper sulphate, (4) Chlorine, (5) Bromine, (6) Iodine, (7) Sodium bisulphate, (8) Potassium permanganate.

(1) Alum, when added to water containing calcium carbonate which is found in nearly all waters, is decomposed and insoluble calcium sulphate and alumina hydrate are precipitated carrying with them suspended impurities and bacteria as well, and leaving the purified water quite clear. This method is used to purify the muddy waters of rivers in China, and is used in water-works on a large scale in India. The quantity of alum will vary with the turbidity and the amount of calcium carbonate contained in the water. One to four grains are usually sufficient to add to each gallon of water. Instead of alum a double alumina-ferrous compound (a mixture of alumina sulphate and ferrous sulphate) is used. One-and-a-half grains of this salt is enough for one gallon of water, but it has the disadvantage of imparting permanent hardness to water.

(2) Nirmali (the fruit of Strychnos Potatorum) is usually rubbed with a little water on a stone slab, and the resulting paste is dissolved into water, stirring it up thoroughly within the receptacle. After a few

minutes all the mud settles to the bottom. Thirty grains on the average are required for treating a hundred gallons of water. This is, however, not a safe method.

(3) Copper sulphate kills cholera and typhoid germs present in water, and prevents the growth of algæ. It is used in the proportion of 0.1 to 0.25 part per 1,000,000 parts of water. Chloride of copper is more efficient than copper sulphate. Probably it is owing to this germicidal action of copper salts that Hindus use copper vessels in storing water.

(4) Chlorine gas is produced by the action of hydrochloric acid on potassium chlorate, and is then added to water in a strength of 1 in 500,000, which is said to kill all disease germs. This is a very convenient and cheap method of purifying water, and was used on a large scale during the last great war. Instead of chlorine gas bleaching powder or hypochlorite of lime can be used in the proportion of one grain per one gallon of water. It is nowadays used for disinfecting wells, for which 2 to 6 ounces are sufficient. The salt should give 30 per cent. of available chlorine. It being an unstable compound deteriorates on exposure to the air.

(5) .06 gramme of bromine added to a litre of water kills the bacteria in five minutes. The offensive smell of bromine may be removed by further treating the water with sodium sulphite. This method was first proposed by Schumberg.

(6) Vaillard uses iodine to destroy micro-organisms present in water. He employs three tablets, *viz.*, blue, red and white. The blue tablet contains 0.1 gramme of potassium iodide, 0.016 gramme of sodium iodate and methylene blue. The red tablet contains 0.1 gramme of tartaric acid and fuchsin. The white tablet contains

0.12 gramme of sodium hyposulphite. One blue and one red tablet are added to a litre of water, when free iodine is liberated. It destroys typhoid and cholera germs in 5 to 10 minutes. After 15 minutes one white tablet is added which neutralizes the free iodine by forming iodide of sodium and renders water fit to drink.

(7) Sodium bisulphate in the proportion of 15 grains to one pint of water has been used by Rideal and Parkes. It kills disease germs, such as those of cholera, typhoid and dysentery in half an hour, but it imparts a somewhat acid taste to the water.

(8) Potassium permanganate oxidizes all organic matter, and also serves as a deodorant. Hankin was the first to recommend its use for disinfecting cholera-infected wells. Hence the process is called "Hankinization." It is now largely used for disinfecting wells. The disinfection is done by dissolving one ounce of potash permanganate in a *dol* full of water. The water is then poured into the well and down its sides, and the process is repeated until all the crystals in the *dol* are dissolved. The water, when thus treated, has a faint pink colour, which, if retained after four hours, is taken as an evidence of satisfactory disinfection. If, on the other hand, the colour be light-brown instead of pink, it should be taken as an indication that further treatment with the salt is necessary. Again, if a bad smell appears in the water two or three days after adding it to a well the treatment with permanganate should be repeated. Condy's fluid is a solution of sodium permanganate, and is equally efficacious with potassium permanganate. The objection to using it in village well water is that Hindus may object to addition of a liquid to their drinking water. Sodium permanganate does not crystallise well. Hence it does not occur in commerce in the dry form.

## COLLECTION OF SAMPLES OF WATER FOR ANALYSIS.

If water has to be collected for chemical analysis, white Winchester quart stoppered bottles of the capacity of half a gallon should be used. They should be first washed with strong HCl or $H_2SO_4$, and then washed with distilled water. They should again be washed with some of the water to be sent for examination. For bacteriological examination it is convenient to use Pasteur's bulbs. These consist of glass tubes blown out at one end to a bulb and drawn out at the other end to a fine point.

If the sample has to be taken from a lake, tank, pond or a river, the bottle should be submerged about 12 inches below the surface of the water, not near the bank. It should be filled and corked under the surface of water, care being taken to allow some air space in the bottle. If water has to be taken from a well, the bottle made by Dr. Thresh should be used. It has got a contrivance by which water can be made to enter at any required depth below its surface. If water has to be taken from a water pipe, some water should be allowed to run to waste for at least 5 minutes, the tap should be washed and then the bottle should be filled. The bottle should not be exposed to light, but should be kept in a cool place and after packing it in a wooden box, with plenty of ice and sawdust, should be sent for analysis as soon as possible without any delay. Full particulars should be described on the labels as follows:—

(1) Source of water, whether from a tank, pond, lake, river, well or a water pipe; (2) position of the source and nature of the soil in which the source is situated; (3) whether there are any cultivated fields, stables, cesspools, drains, latrines, etc., in the vicinity;

(4) if any infectious diseases have been raging in the vicinity; (5) meteorological conditions; and (6) nature of analysis required. Lastly, each bottle should be labelled with a number corresponding to the number of the official letter for purposes of identification.

## ANALYSIS OF WATER.

The examination of water is most commonly carried out to determine the presence or absence of evidence of sewage contamination. No one is likely to use for domestic purposes water that is turbid or muddy, or which has a disagreeable taste and unpleasant smell. Yet a water may be quite clear, bright, sparkling and sweet in taste, and still may be highly dangerous for domestic use. Hence it is necessary that a thorough examination should be carried out by specially trained chemists and bacteriologists, before the water is used by a community.

The examination of water consists of—

1. Physical examination.
2. Chemical examination.
3. Microscopical examination.
4. Bacteriological examination.

## PHYSICAL EXAMINATION.

This is conducted by the senses, and includes the following points:—

(*a*) **Taste.**—Hard waters have a brisk saline taste. Iron, existent in quantity to $\frac{1}{5}$ grain per gallon, imparts its chalybeate taste. Lime salts impart their taste, when present in quantities of 10 to 25 grains per gallon. The taste of sodium chloride is not detected, unless present to 75 grains per gallon, and sodium carbonate to 60 grains.

(*b*) **Odour.**—This is detected by adding a few drops of KOH, or by gently warming the water in a corked flask, and then by smelling at once on removal of the stopper.

(*c*) **Colour.**—This is determined by looking through a column of water contained in a 2-foot tube with a ground glass bottom held against a white surface. A bluish green colour is observed in pure water. A yellowish hue may be due to clay or sewage contamination. A reddish brown colour indicates the presence of iron. The colour should be compared with that of distilled water.

(*d*) **Suspended Matters.**—Suspended matters may be found by holding a clear glass vessel containing water against a good light. To establish their character, water should be allowed to stand in a conical glass for a few hours, and a few c.c. should be pipetted off from the bottom, centrifuged and examined microscopically by preparing several slides with the deposit. They may consist of—

1. Mineral matter, such as sand, clay, chalk, etc.

2. Vegetable matter, *viz.* (a) *living*, such as yeasts, moulds, diatoms, desmids; and (b) *dead*, such as vegetable cells, cotton, linen or flax fibres, husks of grain, starch grains, etc.

3. Animal matter, *viz.* (a) *living*, such as ova, insects, worms, etc.; and (b) *dead*, such as debris of insects, wool, hair, epithelial scales, etc., indicating sewage contamination.

## CHEMICAL EXAMINATION.

1. **Reaction.**—The reaction of water is usually neutral. Sewage contaminated waters are generally alkaline. Waters polluted by refuse from chemical or dye works are sometimes acid in reaction. Upland surface water is frequently acid owing to the formation of humic and ulmic acids which dissolve lead.

2. **Total Solids.**—To find the total solids dissolved in a sample of water, evaporate to dryness 100 c.c. of the water in a weighed platinum or porcelain dish, allow it to cool in a dessicator and weigh it. The number of milligrammes of residue represents the number of total solids per 100,000. If the residue is incinerated at as low heat as possible, it chars and gives off an odour. If heat is still continued, the black colour of charring is changed to white showing that all the volatile organic matter has been incinerated. The dish is then allowed to cool, and is again weighed. The loss in weight corresponds to the volatile solids present in 100 c.c. of water, which consist of the organic matter, nitrates, nitrites, salts of ammonia, combined carbonic acid and sometimes chlorides, while the remaining weight is that of the total fixed mineral solids.

3. **Chlorine.**—To ascertain the presence of chlorine as chloride, the sample of water must be colourless and neutral. It should never be acid. It is estimated by placing 100 c.c. of the water in a clean porcelain basin and adding a few drops of a 5 per cent. solution of potassium chromate, which

gives the liquid a yellow tinge. A standard solution of silver nitrate contained in a burette is allowed to run in drop by drop while stirring, until a reddish colour persists. The silver nitrate solution is made by dissolving 4.797 grammes of silver nitrate in 1 litre of water, so that 1 c.c. is equal to 1 milligramme of chlorine or 5.8 milligrammes of silver chloride. Pure water usually contains less than two parts of chlorine per 100,000 parts of water.

4. **Hardness.**—The amount of hardness present in water is usually expressed in degrees. Each degree corresponds to one grain of calcium carbonate or its equivalent of other calcium or magnesium salts in a gallon of water. It is determined by Clarke's soap method, which is carried out in the following manner:—

A solution of soap is made by dissolving 10 grammes of finely powdered castile or soft soap in a litre of 35 per cent. of alcohol. It is standardized with a solution of lime, made by dissolving 1.11 grammes of pure calcium chloride in a litre of distilled water, so that 1 c.c. is equivalent to 1 milligramme of calcium carbonate or an equivalent salt, *i.e.*, 1 grain to a gallon. 100 c.c. of the water is taken in a bottle, to which the standard soap solution from a burette is added in small quantities at a time, shaking the bottle briskly after each addition, until a lather is formed, which persists for 5 minutes, after the bottle is laid on its side. The number of cubic centimetres of the soap solution used, corresponds to the number of grains of lime per gallon or to the degrees of total hardness. One c.c. must always be subtracted, as 100 c.c. of distilled water requires 1 c.c. of soap solution, before it forms a lather.

To estimate permanent or fixed hardness half a litre of the water is boiled until it is reduced to half its volume. and distilled water is added to make up its original volume. It is then tested with the standard soap solution. The temporary or removable hardness is the difference between the total and the permanent hardness.

The total hardness should not exceed 30 parts per 100,000, in a water used for domestic purposes, while a soft water contains from 8 to 15 parts.

5. **Organic Matter.**—This is of vegetable and animal origin. and exists both in solution and in suspension. The vegetable matter is harmless, unless it is in excessive amount, when it may

produce diarrhœa. Animal matter is often associated with the presence of micro-organisms, and hence the danger of drinking water polluted with sewage lies in the possible danger of taking in pathogenic bacteria. Owing to its decomposition in water much of the organic matter passes off as nitrogen and carbonic acid, a large part is united to form ammonia and some of it at a later period, and under the action of nitrifying organisms, becomes changed into nitrites of calcium, sodium, potassium, etc., and still later these are oxidized into nitrates. The presence of these singly or combined indicates the degree of pollution, e.g., ammonia shows present active contamination, nitrite that it has recently taken place, and nitrate that some little time has elapsed, and that the water has undergone a certain amount of self-purification. Ammonia and nitrates may, however, also result from the reducing action of lead or iron salts.

**Wanklyn's Method of estimating Organic Matter.**—Introduce into a retort 500 c.c. of the water to be analysed, rendered alkaline by adding some recently heated sodium carbonate. Connect it to a condenser in such a way that the distillate may be directly received into Nessler tubes which are graduated to contain 50 c.c. Try to carry on distillation so that 50 c.c. should condense in 15 minutes. Three tubes should be thus collected from the first portion that comes over.

**Free Ammonia.**—The amount of free ammonia is determined by adding 2 c.c. of Nessler's reagent to each tube and comparing the depth of colour with a set of standard tubes prepared with a known quantity of ammonium chloride solution, to which is added an equal quantity of Nessler's reagent.

Nessler's reagent is prepared by dissolving 50 grammes of potassium iodide in a minimum quantity of distilled water. To this is added a saturated solution of mercuric chloride, until a slight red precipitate remains permanent. 125 grammes of caustic potash dissolved in 250 c.c. of water are now added to the mixture. The whole is made up in bulk to one litre with more distilled water, decanted, and is then ready for use. It gives a yellow precipitate to ammonia but reddish brown if in excess. The standard solution of ammonium chloride is prepared by dissolving 3.82 grammes of ammnonium chloride in a litre of water. 10 c.c. of this solution is again diluted to a litre of the ammonia-free distilled water. One c.c. will then contain one-tenth of a milligramme of ammonia.

Free ammonia seldom exists in water as dissolved ammonia, but as the carbonate, chloride or nitrate of ammonium. On boiling, these are easily broken up into ammonia.

**Albuminoid or Fixed Ammonia.**—Much organic matter may remain in the retort, after 150 c.c. of water has been distilled over. To determine this, it must be oxidized and converted into ammonia. After the contents have cooled, 50 c.c. of the alkaline solution of potassium permanganate are added, and distillation continued until three portions of 50 c.c. each of the distillate have been collected in separate Nessler tubes. The ammonia in each is estimated by Nessler's reagent. The summation gives the total amount of albuminoid ammonia in the half-litre of water. It cannot be stated with certainty from this test, whether the organic matter is derived from animal or vegetable substances, but if the ammonia comes over quickly and in large amount, it is presumably of animal origin; whereas if it comes over slowly with no marked difference in the amounts in the three tubes, the organic matter is presumably of vegetable origin. The results of Wanklyn's process may be converted into organic nitrogen by multiplying by 0.824.

**Oxygen Absorption or Consuming Power.**—This is estimated by Tidy's method, which is based on the fact that much of organic matter is able to use up the oxygen, and so reduce the strength of a solution of potassium permanganate. Take two stoppered flasks or bottles, and into one put 100 c.c. of sample water and into the other put the same amount of distilled water. Add to both a 10 c.c. of a standard solution of potassium permanganate and 2 c.c. of dilute sulphuric acid. Place both on a water bath at 80° F. or 26° C. At the end of 15 minutes the amount of potassium permanganate, which remains, is estimated indirectly by liberating iodine and titrating it with sodium hyposulphite. The difference between the amount used for the distilled and that for the sample water is equal to the oxygen consumed to easily oxidize the nitrogen in the water under examination, and corresponds to the free ammonia in the Wanklyn's test.

**Nitrites.**—The presence of nitrites is indicated by the formation of a pink colour within half an hour when 2 c.c. of sulphanilic acid and 2 c.c. of naphthylamine solution are added to 50 c.c. of sample water in a Nessler tube.

Their amount is estimated by adding to 50 c.c. distilled water from ¼ to 2 c.c. of a standard solution of sodium nitrite, each c.c. of which equals .0001 milligramme of nitrite and comparing the colours as in Nessler's test.

Water which contains nitrites is not safe for domestic purposes, and should be condemned.

**Nitrates.**—The method for testing nitrates depends upon the fact that, when acted upon by phenol-disulphonic acid, they form a compound resembling picric acid, which is yellow in the presence of an alkali. For this purpose, evaporate to dryness in a porcelain basin 10 c.c. of the sample water after adding a drop of sodium corbonate solution. To this add one c.c. of phenol-disulphonic acid and thoroughly mix the whole. Now add ammonia, and make up the solution to 50 c.c. by adding distilled water. If nitrates are present, the yellow colour will be produced. The amount can be determined by comparing the colour with a standard solution of potassium nitrate added to distilled water after the same procedure is gone through.

**Mineral Constituents.**—Under this heading are usually included lead, iron, zinc, copper, lime, magnesia, phosphates and sulphates.

**Lead.**—To detect the presence of lead, water is first acidified by acetic acid, and then hydrogen sulphide is added to it when a black precipitate is produced. The colour remains unchanged on the addition of dilute hydrochloric acid, but the chloride is thrown down, and dissolves on boiling the mixture. A solution of potassium chromate gives a yellow turbidity in the presence of lead. With 1|10 grain per gallon this turbidity is seen in half a minute on looking down at a dark surface. With larger amounts of the metal the turbidity appears more rapidly. The amount present may be estimated colorimetrically. Equal quantities, say, 100 c, of sample water and distilled water, are taken in Nessler tubes, to which 1 c.c. of potassium chromate is added. If lead be present, the sample water assumes a yellow turbidity. This colour must be matched in the other glass by adding a sufficient standard lead solution. Calculation will bring out parts per 100,000 or in any other proportion. The standard lead solution is made by dissolving 1.6 of nitrate or 0.1831 grammes of acetate per litre of freshly distilled water, of which 1 c.c. corresponds to one milligramme of lead. Water containing the minutest quantity of lead must be condemned for domestic use.

**Iron.**—This is detected by ammonium sulphide giving a black precipitate to the water, which is dissolved by adding dilute hydrochloric acid. Its presence is then confirmed by adding potassium ferrocyanide, when a blue coloration is produced. Potassium sulphocyanide produces a blood red colour after the ferrous salt contained in water is oxidized to the ferric state by adding nitric acid. The amount of iron is estimated by comparing the blood red colour thus obtained with the colour produced in a distilled water by adding enough quantity of the standard iron solution after nitric acid and potassium sulphocyanide have been added to the same quantity of the distilled water. The standard solution is prepared by dissolving 4.96 grammes of ferrous sulphate in a litre of water, so that 1 c.c. is equivalent to 1 milligramme of iron.

Iron is perceptible to taste when present to the extent of ½ grain per gallon or 1 part in 350,000 parts of water. When present in water, it supports a fungus, which may grow in pipes in sufficient amount to obstruct the flow of water or even completely choke them.

**Zinc.**—Hydrochloric acid and potassium ferrocyanide added to water gives a white turbidity, if zinc is present in water. The amount is estimated colorimetrically. It is often found in waters which have been stored, for some time, in galvanized vessels, or in those collected from zinc galvanized roofs.

**Copper.**—This is a rare constituent of natural water. It is detected by adding hydrochloric acid and potassium ferrocyanide to the water, when a reddish brown colour is produced. It is estimated quantitatively as for lead by using a standard solution of copper sulphate made by dissolving 3.95 grammes of the salt in 1 litre of distilled water, so that 1 c.c. contains 1 milligramme of copper.

**Lime.**—Ammonium oxalate gives a distinct turbidity with 8 parts of lime per 100,000 and a white precipitate with anything over 20 parts per 100,000.

**Magnesia.**—If ammonium chloride, ammonium hydrate and sodium phosphate are added to the water containing magnesia, the crystalline precipitate of ammonium-magnesium phosphate is formed after allowing it to stand for 24 hours. As lime and magnesia are often present together from strata, it is necessary first to precipitate and filter any lime present, before the test for magnesia is applied.

**Phosphates.**—Strong nitric acid and ammonium molybdate give a yellow precipitate, if phosphates are present.

**Sulphates.**—These are found in hard waters in combination with lime and magnesia. Their presence is indicated by adding dilute hydrochloric acid and barium nitrate, when a heavy white precipitate is obtained, which is insoluble in all acids.

The quantity of lime, magnesia, phosphates and sulphates present in water is estimated gravimetrically by obtaining a precipitate as above, and collecting the precipitate after 12 hours. This is then filtered, washed, dried, ignited and the residual ash is weighed. The amount found is counted as milligrammes and multiplied by 4 will give parts per million.

**Sulphides.**—These are detected by adding a solution of lead acetate to the water, when a black precipitate of lead sulphide is obtained. If caustic soda be added to equal quantities of water and nitro-prusside of sodium solution, a violet colour is produced. This is a delicate test for detecting minute quantities.

## BACTERIOLOGICAL EXAMINATION.

Bacteria are present in almost all natural waters. Most of these bacteria, which are ordinarily known as water bacteria, are harmless. The number and variety of these bacteria vary greatly in different places and under different conditions. The bacteria are washed into water from the air, from the soil, and from every imaginable object. The human excreta as well as those of animals pollute water with innumerable micro-organisms, but it is the infection with certain pathogenic organisms derived from fæcal matter, which renders water most dangerous to the consumers.

The object of bacteriological examination of water is to determine the number and the kind of micro-organisms it contains in a cubic centimetre. According to Koch there ought to be 100 c.c. of water bacteria per c.c. as a maximum number for a properly filtered water, but it is not safe to depend upon the number of bacteria alone for the purity of water. Roughly speaking the number of bacteria in water corresponds to the amount of organic pollution. Chemically pure water contains but few organisms, whereas water rich in organic matter contains them in abundance.

The examination should be conducted as soon as possible, after the sample of water is taken, so that the organisms may not multiply or die out. Small quantities of water to be examined are added to tubes of sterile, melted nutrient gelatine, which are then poured into sterilized Petri dishes. The gelatine solidifies and the dishes are incubated at 20—22° C. Colonies appear in from one to eight days. These must be identified by making subcultures in test tubes in suitable media of gelatine, broth, milk, bile, sugar, etc., and counted by placing the dishes over ruled squares or circles. The most important pathogenic organisms to note are those associated with typhoid, cholera, dysentery and perhaps diarrhœa. These bacilli are not easily separated and isolated, but if the Bacillus coli communis, the Bacillus enteritidis sporogenes, and streptococci which, being the common intestinal bacteria, are known as sewage bacteria be present, they may also occur, as these all result from sewage contamination. These organisms live for many days in water. The mere presence of one or two colon bacilli in 100 c.c. of water is of little consequence, but the presence of 10 or more per c.c. of water should be regarded as grossly contaminated with animal matter and very likely to contain infection. The Bacillus enteritidis indicates sewage pollution, and its presence in bacillary form or as spores is a certain sign of showing recent or remote contamination. Streptococci not being hardy show recent sewage contamination, but are not regarded by some to indicate dangerous contamination, unless accompanied by B. coli.

**Tests.**—The presence of the colon bacillus is determined by planting small quantities of the water sample in lactose bile or lactose bouillon in fermentation tubes and incubating at 40° C. If the colon bacilli are present, fermentation is produced with the evolution of gas, but this test is used as a presumptive test, inasmuch as some colon bacilli may not ferment sugar owing to the preponderating presence of other more active species, while many organisms other than the colon bacillus often found in water ferment sugar with the evolution of gas. Hence it is necessary to isolate the suspected organism in pure culture and pass it through the well-known tests before it is labelled "Bacillus coli."

The Bacillus enteritidis is detected by adding 1 c.c. of the suspected water to 10 to 15 c.c. of fresh sterilized milk, which is then heated in a water bath at 80° C. for 15 minutes. It is then cooled and incubated in a Buchner's tube at 37° C. In forty-eight hours the milk is coagulated into white, stringy masses, with coagulated casein, enclosing a number of gas bubbles. The greater portion of the tube contains a colourless, thin, watery whey.

The streptococci grow more rapidly than the pyogenic variety, and produce a pinkish colony on lactose litmus agar at 37° C.

**Interpretation of Bacteriological Examination.**—The bacteriological examination is much more important than the chemical examination. It is the most direct and delicate test of the safety of a water for drinking purposes, for by it we obtain exact information as to the evidence of sewage pollution regarding its potentiality to cause infective diseases. It is, however, very difficult to deduce the conclusions from the results of the examination, as this requires much experience and knowledge, especially in a country like India. Major Clemesha, I.M.S., has, therefore, proposed the following tentative standards for judging the bacteriological results of water analysis:—

**Good lake water should contain**—

(1) Less than 100 colonies per c.c. in agar at 37° C.
(2) No lactose fermenting organisms in 20 c.c.
(3) No non-resistant organisms in 50 c.c.
(4) Plentiful bacillus lactis ærogenes.

**Usable lake water should contain**—

(1) Less than 200 colonies per c.c. in agar at 37° C.
(2) No lactose fermenting organisms in 5 c.c.
(3) No non-resistant organisms in 20 c.c.
(4) Very plentiful bacillus lactis ærogenes.

**Unusable lake water.**—Bacillus coli found in 1 c.c. Fæcal organisms present in proportions similar to those of fresh. Bacillus lactis ærogenes few or absent.

**Good river water.**—Less than 100 colonies per c.c. No Bacillus coli in 50 c.c. Fæcal organisms not more than 1 in 10 c.c.

**Usable river water.**—Less than 300 colonies per c.c. No Bacillus coli in 20 c.c. Fæcal organisms not more than 1 in 1 c.c.

**Unusable river water.**—800 colonies per c.c. Bacillus coli 1 in 5 c.c. Lactose fermenting organisms 10 per c.c. Numerous varieties of fæcal organisms.

**Deep waters.**—Less than 50 colonies per c.c. No fæcal bacilli in 20 c.c.

## CHAPTER II.

### AIR.

AIR is absolutely necessary for the maintenance of life. A man can live a few weeks without food, a few days without water, but dies within three minutes, if he is deprived of air. The two main functions of the air that are especially concerned with health are interchange of gases in respiration, and regulation of bodily temperature. It should also be remembered that the combustion of the food in the body depends upon the oxygen of the air that is breathed, and that digestion and metabolism are stimulated and improved by an abundant supply of fresh air or rendered sluggish and retarded by prolonged exposure to polluted air.

The atmosphere, which is commonly spoken of as air, is the gaseous envelope encircling the earth. We do not feel or see it except in motion, when it is called wind. It offers resistance to our bodies while running. The air, like other gases, has weight, exerts pressure and has the power of diffusion and expansion. It is a mechanical mixture of several gases and not one chemical compound, because its chief constituents, oxygen and nitrogen, when brought together in the proportion in which they are found in the atmospheric air, do not exhibit any rise of temperature or any change in volume, while they may be separated by such simple physical processes as solution or diffusion; again, the ratio between the weights of these two gases in air has no chemical relation to that of their atomic weights.

Besides oxygen and nitrogen, there are also other gases present in small quantities. They are argon, carbon dioxide, watery vapour or aqueous vapour, and traces of ozone, ammonia, organic matter and mineral salts held in suspension. The composition of air is as follows:—

| | | |
|---|---|---|
| (1) Nitrogen | 77.11 | |
| (2) Oxygen | 20.66 | |
| (3) Argon | 0.80 | |
| (4) Carbon dioxide | 0.03 | |
| (5) Aqueous vapour | 1.40 | though it varies with temperature. |
| Total | 100.00 | |

**Nitrogen.**—This constitutes four-fifths of the atmospheric air. Its chief part is to dilute oxygen and to render it less active, for pure oxygen is much too strong for healthy animal life. It is also an important factor in plant nutrition, since not only are portions of it converted during thunderstorms into nitric acid, which is washed into the soil for plant use, but some plants are able to fix the nitrogen of the air through the agency of certain bacteria through the root nodules. It is a constituent of animal and vegetable tissues and no form of life can exist without it. It is a colourless, tasteless and inodorous gas, which does not support life nor combustion. It is, therefore, called azote (without life).

It may be obtained by removing oxygen from air by burning phosphorus, or passing air over heated copper. It may also be derived by heating ammonium nitrate or by passing a current of chlorine through a saturated solution of ammonia.

**Oxygen.**—This exists in free state in the air, and forms about 1|5th by volume of air ; but this is lessened by respiration, combustion, fermentation, putrefactive processes, manufacturing and trade operations and fog, while it is increased by vegetation and rainfall.

Oxygen is an important constituent of the air, so far as human life is concerned. It is absorbed by the lungs, passes into the blood, combines loosely with the hæmoglobin of the red blood corpuscles, and is thus carried to all the tissues and cells of the body. The amount of oxygen that is absorbed varies with the age, condition of health, and activity. During twenty-four hours a person on an average inhales about 34 pounds of air, which corresponds to a little over 7 pounds of oxygen. As the lungs absorb about one-fourth of the oxygen inhaled, it appears that the average amount of oxygen absorbed daily is nearly two pounds.

Oxygen is a colourless, inodorous and tasteless gas. It can be obtained from air by heating various metallic oxides and peroxides. It is obtained on a larger scale by heating barium monoxide, which is known as Brin's manufacturing process.

**Argon.**—The presence of argon in the atmosphere was discovered in 1894 by Lord Rayleigh and Professor Ramsay. It is an inert body, and does not enter in chemical combination with any other elements. It has not been found in the body, and hence it has no hygienic significance. It may be obtained from the atmosphere as a residue by removing all the other constituents of air.

**Carbon Dioxide.**—This is called carbonic acid gas or carbonic acid anhydride. It is present in the atmospheric air in the proportion of 0.03 per hundred. For calculations in connection with ventilation the amount generally taken is 0.04 per cent. or 0.4 per 1,000. This proportion is liable to considerable variations. It is increased by respiration, combustion, fermentation, and various chemical actions in the soil and organic matter. The balance is, however, maintained by the green colouring matter of plants which, in the presence of sunlight, have the power of splitting up carbonic acid gas, absorbing carbon to build their tissues and setting free oxygen; but in the dark the action is reversed, that is, they take in oxygen and give off carbon dioxide, and hence the danger of sleeping at night near trees. Rain and high winds also help to keep down the amount of carbon dioxide, the former by dissolving it, the latter by diffusing it.

It is a colourless, inodorous gas with a slightly acid taste. It is not combustible, nor does it support combustion or life. The amount of carbon dioxide is greater in the air of towns than in the country and is greater in badly ventilated and crowded rooms than in properly-ventilated rooms. The amount of carbon dioxide is usually taken as the index of atmospheric impurity, which is regarded as prejudicial to health and comfort.

**Aqueous Vapour.**—This is contained in the air in varying quantities in different localities and at different times, and mainly depends upon the temperature of the air. Air cannot contain more than a certain quantity of moisture at a given temperature; and when it has taken up this maximum quantity, it is said to be saturated with aqueous vapour. The air when thus saturated generally contains from 50 to 70 per cent. of this aqueous vapour. When the proportion of aqueous vapour present is more or less, the air becomes unpleasantly moist or dry. When air saturated with moisture is cooled, the vapour is deposited in the liquid form in very small droplets, known as mist, fog or dew.

**Ozone.**—This is an allotropic modification of oxygen—a compound molecule made up of three atoms of oxygen. It is formed when an electric discharge takes place. It is present in small quantities in the air probably to the extent of one part in 10,000. It is a powerful oxidizing agent, and therefore it is not met with in the air of towns or inhabited localities, as it is decomposed by the organic matter present in such air. It can be found in the air of mountainous regions and of the seaside, where its presence can be detected by its peculiar smell.

Ammonia, and mineral and organic matters that are found suspended in air, are considered to be its impurities.

**Ammonia.**—This is always present in air either free or as a carbonate or nitrate, in minute traces rarely exceeding three parts in ten million. It is derived from the decomposition of decaying nitrogenous matter. Plant life derives its nitrogen in part from this source, specially when it is washed out of the air by rain, and carried down into the soil.

The suspended matters, both mineral and organic, are found floating in the air and seen as motes in a sunbeam. These suspended matters are always present in air in more or less quantities, except on the tops of mountains or near the sea. They can be removed by filtration through cotton wool. The mineral matters are usually minute particles of common salt, sand, coal, clay and oxides of iron. The organic impurities are vegetable débris, pollens of grasses and flowers, minute seeds of plants, fine fragments of flax, wool, etc., and germs of disease.

## IMPURITIES OF AIR.

The chief impurities are due to—

(a) Respiration,
(b) Combustion,
(c) Decomposition of organic matter,
(d) Dust.

(a) **Impurities due to Respiration.**—A grown-up man respires about 17 times in a minute, and with each act of respiration 500 c.c. (30.5 cubic inches) of air pass in and out of his lungs. During the process of respiration the carbon dioxide and watery vapour produced by the oxidation of carbon and hydrogen, which enter into the composition of animal tissues, are given off from the lungs. The expired air contains about 16 per cent. of oxygen, 3 to 4 per cent. of carbon dioxide, 5 per cent. of watery vapour and more organic matter than in the inspired air. By comparing this with the composition of the atmospheric air it has been found that the proportion of oxygen is lessened by one-fourth and that of carbon dioxide increased by one hundred per cent. There is no change in nitrogen, which remains constant. Besides these changes, the temperature of the expired air is raised to that of blood heat, viz., 98.04° F.

The amount of $CO_2$ evolved by an average adult male during gentle exertion is considered to be 0.9 cubic foot per hour and possibly as much as 1.8 during hard work owing to increased metabolism. The amount of carbon dioxide given off by an adult female under similar circumstances is about one-fifth less, and the amount given off by an infant is 0.5 cubic foot per hour. In a mixed assembly at rest, including male and female adults and children, the $CO_2$ given off per head is, therefore, taken as 0.6 cubic foot. About 30 ozs. of watery vapour are given off by the lungs and the skin in the day, which is enough to saturate the air with moisture. Animals usually contaminate the air to a greater extent than do human beings.

The organic matter given off by the skin and the lungs varies with the individual and the state of his health. It is nitrogenous and oxidizable, and readily putrescible. The discomfort felt in a crowded room was formerly supposed to be due to the organic matter exhaled from the lungs; but it is really due to high temperatures and unpleasant odours from the volatile products of decomposition emanating from the mouth, due to the decayed teeth or digestive troubles, and from volatile fatty acids given off by the skin and clothing soiled by perspiration and other secretions. The organic matter forms a very good material of food for micro-organisms to grow; and milk, meat and other kinds of food become tainted, when they come into contact with it.

Expired air contains fewer microbes in ordinary quiet respiration, but people suffering from influenza, pneumonia, diphtheria, tuberculosis, etc., exhale these pathogenic micro-organisms during coughing, sneezing and loud talk. These are then liable to infect other people living in the same room. These disease germs first get deposited on the mucous membranes of the nose, mouth and throat, most of which are got rid of by their excretions, though a few may manage to reach the air cells or bronchi.

(b) **Impurities due to Combustion.**—The products of combustion of coal are particles of carbon, carbon dioxide, carbon monoxide, sulphurous and sulphuric acids, carbon disulphide, sulphuretted hydrogen and water. The combustion of wood and charcoal results in $CO_2$ alone, when there is a sufficient supply of oxygen; but the monoxide is also produced when the oxygen supply is limited; as, for instance, in a room with doors and windows closed. These products of combustion, when they escape into the outer air, are rapidly diluted and diffused, but the solid sooty particles of carbon gravitate to the lower strata of the atmosphere, and are only dispersed by winds and rains.

Candles, oil and coal gas are used for artificial lighting. The first two add to the impurities of air by producing soot, carbon dioxide and water; while the latter adds to $CO_2$ and water the products of combustion of sulphur.

The light given out by a sperm candle burning 120 grains per hour is called one candle-power. It gives off 0.41 cubic foot of carbon dioxide during its complete combustion.

Various kinds of oils are used for lighting purposes; the chief of which used in India are castor oil, cocoanut oil, rapeseed oil and kerosene oil. The last is much used owing to its cheapness, and its strong illuminative power. It gives off 0.28 cubic foot of carbon dioxide and 0.22 cubic foot of watery vapour per hour.

In some of the big cities coal gas obtained by destructive distillation of coal is used for illuminating purposes. One cubic foot of ordinary coal gas yields on combustion 0.52 cubic foot of carbon dioxide, and 1.3 cubic foot of watery vapour; the vitiating element thus being the dioxide gas.

From a hygienic point of view the electric incandescent lamp is the best, as it does not vitiate the air by any decomposition products, since it is contained in vacuum globes; nor does it heat up the air in the room to an appreciable extent.

(c) **Impurities due to Decomposition.**—Animal and vegetable matters, when they putrefy, give off offensive poisonous gases, such as $CO_2$, $H_2S$, $NH_4HS$, $CS_2$, $NH_3$, $CH_4$, etc. They mostly emanate from cesspools, sewers, drains, stables, cowsheds, etc. Besides, traces of ptomaines and leucomaines may also be found in emanations from urinary and fæcal excretions of the animal body. Bacteria, moulds and fungi grow rapidly in such air. Food and meat are soon tainted, when exposed to it.

(d) **Impurities due to Dust.**—Dust is not only a nuisance, but under certain conditions is known to be prejudicial to health. It exists everywhere in the atmosphere, and should, in reality, be considered a normal constituent of the air, since it limits the humidity of the air by causing the moisture to precipitate in the form of rain, and helps in controlling the temperature by the formation of clouds, mists and fogs. Dust consists of solid particles of both organic and inorganic matter. Among the organic particles are found those of fat, scales of hair or skin, pus cells, dried particles of sputa, and dried scales of skin from those suffering from small-pox, measles, etc., floating in air.

Bacteria are the most important constituents of dust from the hygienic point of view. They are almost absent in sparsely populated districts, while they are more numerous in densely populated districts. They are also more evident in crowded rooms than in well-ventilated rooms. These bacteria are almost invariably non-pathogenic, though, under exceptional circumstances, the organisms of suppuration, tuberculosis, enteric fever and some other diseases have been found.

The inorganic particles of dust to be met with in the atmospheric air are chiefly composed of silica, aluminium silicate, carbonate or phosphate of lime, magnesia, sodium chloride, iron, carbon, etc. Those found in the air of houses are from the debris arising from the wear and tear of articles in domestic use, such as dust, soot and ashes. Mineral particles from neighbouring factories may likewise find access into houses.

All these minute suspended particles settle down on the floors, walls, and furniture on account of their weight, in the confined air of the houses, but they may again be made to float in the air, when it is set in motion for purposes of cleanliness as in dusting and sweeping. It is, therefore, necessary that all furniture should be cleaned with a damp cloth (*jharan*) and not flicked with a dry one. The durries and carpets should be taken out in the open air well away from the house, brushed and shaken at frequent intervals and exposed to sunlight. It is no use sweeping them inside the room as the disturbed dust will again settle on the walls and furniture. Bedrooms should not be crowded with furniture in order to leave as much unoccupied space as possible. The curtains should not be heavy and thick, but must be made of light muslin cloth, so that they can be washed at intervals.

## EXAMINATION OF AIR.

The examination of air is conducted to determine odour, humidity, dust, micro-organisms, organic matter, carbonic acid, ozone and gaseous impurities.

**Collection of Samples.**—The collection of the samples of air to be analysed is very important. Large, wide-mouthed jars, with rubber caps, having a capacity of 4 litres should be used, after they have been thoroughly cleansed with distilled water and dried. The following are the methods which may be used to collect the samples of air:—

1. Place the jar in a room, where a sample is to be taken. and blow in air by bellows having a long nozzle reaching down to the bottom of the jar, so that the contained air may be displaced from its bottom.

2. Fill the jar with distilled water, and empty it by inverting it at the place where you have to take a sample. After it is drained dry, cover the mouth with an India-rubber cap.

The jars should always be labelled. On the label should be inscribed the capacity of the jar, and the temperature and pressure of the air observed at the time of collecting the sample.

**Odour.**—The presence of minute particular matter is detected by perceiving a peculiar fœtid odour on first entering an inhabited room from outside. After a time this is hardly noticed. as the sense of smell soon gets blunted. De Chaumont was the first to point out that this odour was due to the influence of atmospheric humidity on organic matter.

**Humidity.**—The presence of moisture or humidity may be ordinarily tested by putting ice in a glass vessel containing water when a film of moisture will be noticed to appear on the outer surface of the glass. The amount of its presence in the air is estimated by the hygrometer, the wet and dry bulb thermometer, or weighing it. This is done by aspirating a known volume of air through glass bulbs containing pumice-stone saturated with pure sulphuric acid when the watery vapour will be absorbed, and the increase in weight of the bulbs will represent the amount of humidity or moisture in the air.

**Dust.**—(1) A qualitative estimation may be made by Pouchet's æroscope. This consists of a funnel-shaped tube drawn out to a fine point, and brought almost in contact with a drop of glycerine smeared on a glass slide. The whole is enclosed in an air-tight chamber. and as air is aspirated through this, the dust is impinged on the viscid slide, which can be examined under the microscope.

(2) A quantitative estimation may be made by drawing a known volume of air through a tube filled with pure sodium sulphate crystals. These are dissolved in water, and filtered through filter paper of known weight. The paper is reweighed after it is dried. The increase in weight represents the quantity of dust present in the air.

**Micro-organisms.**—Hesse has devised an apparatus for estimating the number of micro-organisms in air. It consists of a hollow glass cylinder 50—70 c.m. long and 3—5 c.m. bore, one end of which is covered by a double India-rubber cap, the other end being connected with an aspirator of known capacity. The cylinder is first carefully sterilized, and then coated on the inside with 40 or 50 c.c. of sterilized nutrient gelatine, which is allowed to solidify. The outside rubber cap is now removed, a small pinhole is made in the inner cap through which 10—20 litres of air are slowly aspirated. so that the micro-organisms may be deposited on the gelatine coating. The cylinder is properly plugged and incubated at 37° C. In two or three days the number of colonies which grow on the gelatine can be counted.

A simpler method suggested by Koch is to expose sterilized Petri dishes of gelatine or agar for short periods of time to the air to be examined. These are then incubated, and the number and kind of organisms determined.

**Organic Matter.**—This may be determined by slowly aspirating a known large volume of air through distilled water, and then examining the latter by Wanklyn's method as in water analysis. Carnelly's method is sometimes used, though it is not very reliable. In this method the amount of organic matter is determined by the volume of air required to decolorize a definite quantity of a standard solution of potassium permanganate prepared by dissolving 0.316 gram of the salt in a litre of distilled water. The solution is added to a jar containing the air sample, and shaken frequently, until its pink colour disappears.

**Carbonic Acid.**—The presence of carbonic acid or carbon dioxide may be demonstrated by exposing lime water in the air or passing a current of air through lime water; which will be turned milky owing to the formation of insoluble calcium carbonate. The amount of its presence is determined by the following methods:—

1. **Pettentkofer's Method.**—This consists in shaking up a known volume of air with a measured quantity of a 0.5 per cent. solution of barium hydrate, which absorbs the carbon dioxide present in the air, and becomes precipitated as an insoluble salt of barium carbonate, and hence less of the hydrate is left in solution. The strength of the solution of barium hydrate left after the experiment is determined, and the difference between the two calculations (before and after the experiment) denotes the amount of carbon dioxide present in the air. A standard solution of oxalic acid is used to estimate the strength of the baryta solution, and is prepared by dissolving 2.822 grammes of oxalic acid crystals in a litre of distilled water, so that 1 c.c. of the solution equals 0.5 c.c. of carbon dioxide at normal temperature and pressure. Phenol-phthalein is used as an indicator of neutrality, being crimson in alkaline but colourless in acid solutions.

2. **Lunge-Zeckendorff's Method.**—This consists of a 500th normal standard solution of carbonate of soda (.02 gramme per litre) coloured pink with phenol-phthalein as an indicator. The air is driven slowly through this by means of a bellows of a definite capacity, until the fluid becomes colourless from the carbonate being converted into the bicarbonate due to the absorption of carbon dioxide from the air. The number of bellowsful of air used is counted, and by reference to a table supplied with the apparatus the percentage of carbonic acid present in the air examined is obtained.

3. **Wolpert's Method.**—This is exactly the same, but the air is added in definite amounts and shaken in an apparatus.

4. **Haldane's Method.**—This requires a special apparatus, but it being portable, the analysis can be made on the spot, and thus the carrying to and fro of samples is avoided. The method consists in subjecting 25 c.c. of air to exposure to the caustic potash solution which absorbs the carbon dioxide and the diminution in volume is measured under the same conditions of temperature and pressure, and the divisions on the narrow graduated portion of the burette are each $\frac{1}{10,000}$th part of the capacity of the burette, so that the result is read off in parts per 10,000.

**Ozone.**—The property of ozone to liberate iodine from potassium iodide is generally made use of in detecting its presence. Strips of paper dipped in a starch solution to which potassium iodide has been added become blue on exposure to the air containing ozone. This is a very delicate test, but it cannot entirely be relied on, as the oxides of nitrogen and the peroxide of hydrogen react similarly, and are also likely to be present in the air. Hence, a further test should be supplied with a view to confirmation. For instance, test papers soaked in an alcoholic solution of "tetramethyl base" are not affected by hydrogen peroxide, but are turned violet with ozone. This is recommended as a more reliable test.

**Gaseous Impurities.**—Under this heading may be considered the following gases met with as impurities in the air :—

1. **Carbon Monoxide.**—This may be determined quantitatively by passing a measured quantity of air through a solution of copper sulphide, which absorbs the gas. The best qualitative method is by Vogel's blood test with the spectroscope. It is based on the fact that carbon monoxide combines with hæmoglobin of the blood, and forms a stable compound of carboxyhæmoglobin.

2. **Ammonia.**—This can be absored by aspirating a definite amount of air through distilled water, and then estimated by Nesslerization as in water analysis.

3. **Hydrochloric Acid.**—To detect hydrochloric acid in air, a known volume of the air should be aspirated through a dilute solution of caustic potash, when potassium chloride would be formed. The chlorine in the solution is then determined by means of a standard solution of silver nitrate.

4. **Sulphurous Acid.**—This is absorbed as in the preceding, and titrated with a standard permanganate solution.

5. **Sulphuretted Hydrogen.**—This gas is absorbed by passing air through a lead acetate solution, and estimated as the black sulphide of lead.

## CHAPTER III.

### VENTILATION.

Even though the atmosphere is being polluted in so many ways, the composition of the air has been found to be constant almost everywhere. Even in big cities the air of the open spaces differs very little in its composition from that of the places remote from habitation, for instance, mountains, valleys and seas. This is because air is purified by great natural forces, such as wind, rain, oxygen, ozone and chlorophyll of plants.

Wind dilutes and carries away impurities to a distance and brings pure air instead. Rain absorbs several gaseous and solid suspended impurities, and carries them down with it in its fall on the earth. Oxygen and ozone oxidize the organic matter present in it, and the chlorophyll of plants takes up carbonic acid. But in the case of larger towns and congested cities these natural forces are unable to effect this necessary exchange of impure air and, therefore, the process of ventilation has to be relied upon largely in purifying the vitiated air of dwelling houses.

The term "ventilation" means the removal or dilution, by a supply of fresh air, of all the unwholesome gases and suspended impurities collected in dwelling houses. This process of exchange is known as internal ventilation; but to admit fresh air into houses it is necessary to look to the ventilation of streets and to the surroundings and positions of the dwellings, which is called external ventilation. There must not be too many residences on any part of the site. All dwelling houses must be constructed with due interspacing and in regular lines, so that each house may have the advantage of the prevailing wind which is a natural force for purifying the air by diluting and carrying away its impurities to a distance and bringing in pure air instead. Where small huts are built scattered in the midst of large and lofty buildings as in factories and warehouses, or where houses are crowded together irregularly having only a few narrow and blind alleys, the air naturally stagnates in them, as the current of the wind suffers obstruction by the larger and loftier buildings in the vicinity. Also the light of the sun cannot have access into such dwellings, and hence the humidity is also greater. The death-rate in such places is especially high. The vitality of persons living in them is very much lowered, and they are predisposed to attacks of diseases caused by impure damp air. Houses built "back to back" or with the courtyard crowded with outhouses for cattle, etc., are equally bad and unhealthy. Plenty of space in front, if not all round it, must be provided for each dwelling. The streets and roads must be broad and wide, the minimum width being 40 to 50 feet; but the streets, which are meant to be used for heavy traffic of carriages should be 60, 80 or 100 feet wide. In India it is necessary to have broader streets than in England, where the winds are more prevalent and less stagnant, and where a constant interchange of air is going on owing to the air currents set up by differences in temperature between the inside and outside of dwelling houses. The streets should be laid out straight, and should intersect one another at right angles. No projections of any kind likely to interfere with the free passage of air should be allowed over the streets. Trees should be planted on the footpaths in such a way as to give shade but not to obstruct the ventilation. There should be many open spaces and parks as they are considered the lungs of a town, and factories of manufacturing processes should not be allowed to be erected near any habitation. The drains and sewers should always be kept clean, and the roads should be well watered, so that the dust may not float in the air.

**Amount of Fresh Air needed.**—An average adult exhales 0.6 cubic foot of $CO_2$ per hour which cannot be distinguished by smell from the pure air, but if the $CO_2$ exceeds .6 per 1,000, the air begins to be perceptibly close to a person entering from outside and this is regarded as the standard of efficient ventilation. The quantity of $CO_2$ present in towns is, on an average, 4 per 1,000 cubic feet, and therefore .2 cubic foot of $CO_2$ per 1,000 of air, or .0002 per cubic foot of air is considered the **permissible limit** of impurity.

By dividing the amount of $CO_2$ exhaled in an hour by the permissible limit, the late Professor de Chaumont suggested the number of cubic feet per hour required for one person. This is expressed by the equation $D = \frac{E}{R}$ where D = the delivery of fresh air expressed in cubic feet, E = the amount of $CO_2$ exhaled per hour per head, *i.e.*, 0.6 cubic foot, and R = the respiratory impurity allowed per cubic foot of air. Therefore $D = \frac{0 \cdot 6}{0 \cdot 0002} = 3{,}000$ representing the number of cubic feet of fresh air required per individual per hour. Similarly, if D and E are known, we can find R. Men doing hard work require more air. The amount of air required for artificial lights is 2,250 cubic feet of air per hour in the case of a gas burner, and the same quantity as is required by an adult man, in the case of a paraffin lamp.

In mines 6,000 cubic feet per hour are required to keep up the energy of the working people.

It is necessary that animals should be supplied with fresh air. Like human beings they keep better health in well-ventilated sheds and stables. The amount of fresh air needed for housing them well depends upon their body weight, a common rule being to allow at least 25 cubic feet of it per pound of the body weight.

**Amount of Cubic Space needed.**—The amount of cubic space required for each person is a thousand as would be available, for instance, in a room 10 feet long, 10 feet wide and 10 feet high. Under such conditions, even if the whole amount of air inside it be exchanged three times in an hour necessary through wind or ventilation, it would not cause injurious draught in the cold weather. A larger cubic space is apparently unnecessary, as it encourages stagnation of air, but in the case of temporary failure of wind or other means of ventilation, it has an advantage of affording a reserve of air and becoming vitiated less rapidly than a small space. A larger cubic space per head should be provided in small rooms than in large ones, as the latter are more easily ventilated than the former.

In public halls, theatres, etc., much less cubic space, *viz.*, 250 to 300 cubic feet is, as a rule, allowed per individual, as these buildings are occupied only for short periods. In hospitals, where sick people are congregated, organic matter and organisms are given off in large amount, hence at least 1,200 cubic feet should be allowed to each patient, and the floor area should be at least one-twelfth of the cubic space.

In jail barracks the minimum superficial and cubical space allowed to each prisoner is 36 square feet and 648 cubic feet, and in jail hospitals 54 square feet of superficial area and 900 cubic feet of air space are allowed for each patient. A separate cell for solitary confinement should have a cubical capacity of 1,000 feet and a ground area of 75 square feet.

Having thus determined the amount of air and cubic space required for an individual it is now necessary to consider how the ventilation of a room can be accomplished. There are two methods of ventilation. One is called natural and the other is artificial.

**Natural Ventilation.**—This depends for its action upon (1) diffusion of gases, (2) the differences in weight of masses of air of unequal temperatures, and (3) the wind.

(1) **Diffusion of Gases.**—Gases diffuse with a velocity which is inversely as the square root of their densities (Graham's law), and thus the air of rooms diffuses through cracks and crevices of doors and windows even though they are closed and also through bricks and mud-walls; but one cannot depend on diffusion alone, as it is unable to remove the solid impurities that tend to gravitate to the floor.

(2) **Differences in Weight of Masses of Air of Unequal Temperatures.**—According to the law of physics heat expands and cold contracts. The air heated by products of respiration of men or by fire and rendered more moist expands, and being lighter bulk for bulk than the cold air, rises and escapes through openings. The equilibrium is maintained by the cold air rushing in to occupy its place from outside. Too much reliance cannot be put on this force, as there is very little difference in India between the outer air and that inside the dwellings.

(3) **Wind.**—The wind is a powerful ventilating agent, and acts by perflation and aspiration. Perflation means the forcing of the air through open doors, windows and even through porous bricks into the room as a result of the movement of natural air currents. Aspiration signifies the sucking action of the wind which draws air out of a space that it is blowing across. Thus a wind blowing across a chimney or past a window tends to aspirate or suck the air from the room, and into the

partial vacuum thus created fresh air rushes in to take its place. A strong wind, however, is likely to offer an obstruction to the efficient operation of this method of ventilation as it presses the ascending column of air back into the conduit. To obviate this difficulty, a cowl is constructed over a chimney. It is either fixed

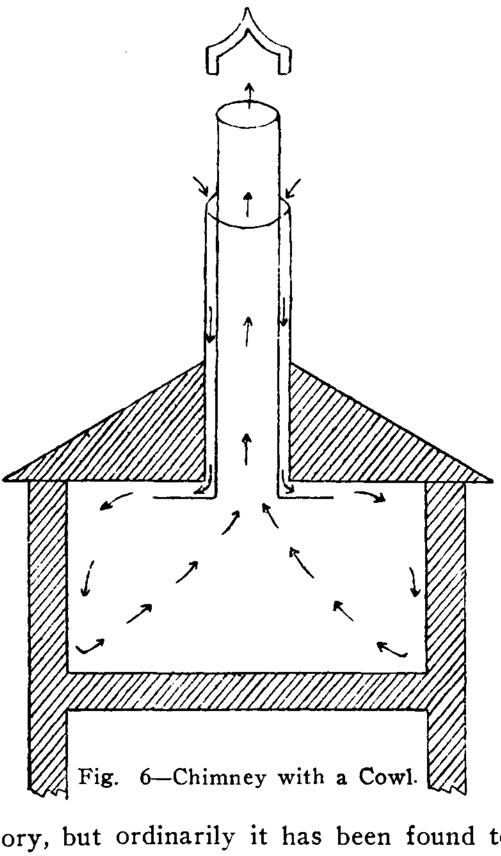


Fig. 6—Chimney with a Cowl.

or rotatory, but ordinarily it has been found to be inefficient in its action, though it may prevent ingress of foreign bodies, birds and insects and may also serve as a protection against rain. In India the action of the wind is largely relied on for ventilating houses, but the difficulty arises when the wind is blowing very forcibly, or when it entirely fails. For small rooms of moderate height efficient natural ventilation is secured by providing a sufficient number of doors and windows. These should be placed opposite to each other, and should be kept open as much as possible. If it is not possible to place windows in opposite walls, the next best arrangement is to place them in adjacent walls. To keep the room cool it is advisable to have its height from floor to roof more than 12 feet, viz., 15 feet or even more, in which case openings for the exit of the foul hot air should be provided near the ceiling or in the roof, so that it may not accumulate in the space between the tops of the windows and the ceiling.

For seasons when doors and windows have to be kept closed, as also for cold countries where these have usually to be kept closed, several devices of ventilating openings known as inlets and outlets have been suggested. These should be kept clean from dirt, so that they may not become choked up.

**Inlets.**—For admitting fresh air inlets should always be placed 5 to 6 feet above the level of the floor, and be directed obliquely up towards the ceiling to avoid cold draughts. To prevent cold draughts or excessive warmth the proportion of the inlet ought to be 1 square inch for every 60 cubic feet of room space or 24 square inches, *i.e.*, 6 inches by 4 inches for each individual, so that the velocity of the air entering the room must not exceed 5 feet per second. A velocity of 2 to 3 feet is the most satisfactory.

As a further aid to an efficient working of these inlets, their openings should be constructed on a conical design, their wider mouth being placed towards the room and the narrower towards the exterior. When it is intended to deliver heated air through the inlets, their openings should be constructed near the floor. The process of heating a column of air for diffusion into the room consists in allowing it to pass either over hot water pipes or through an air chamber provided behind a stove or a grate.

**Types of Inlets.**—The following are the chief types of inlets, which are commonly used :—

(1) **Inlets in Windows.**—*a.* **Hinckes-Bird's Method.**—In this the lower sash of the window is permanently raised upon a block of wood 4 inches deep and running the entire length of the window, so that it leaves an interval of space between the upper and lower window-sashes through which fresh air can pass from without inwards.

*b.* **Louvred Window Panes.**—These resemble a venetian blind in their arrangement, and can be closed and opened at will.

*c.* **Cooper's Ventilator.**—This is used in railway carriages. It consists of a series of apertures in the window glass pane, arranged in a circle, which is capable of moving on a central pivot.

*d.* **Hatton's Hopper Ventilator.**—This is usually used as a substitute for the upper half of the window or a part of it if large, and is made to fall inward. It not only serves the purpose of a window sash, but acts as a ventilator, and when so acting, not only prevents direct draughts, but screens the air from particles.

(2) **Inlets in Walls.**—The types of inlets applicable to the outside walls of rooms are :—

*a.* **Ellison's Bricks.**—These are perforated with conical holes, the wider ends opening inside, so that the air passing through them becomes gradually distributed over a gradually increasing area, and thus does not cause a draught.

*b.* **Sheringham's Valve.**—This is a vertical flap door fixed on each side of the room 5 or 6 feet from the floor, balanced by a counterpoise, and hinged below so as to fall forward towards the room; it is closed in at the sides and front, so that the air current can only pass upward through a perforated plate, which has an opening of 9 inches by 3 inches, *i.e.*, an area of 27 square inches.

*c.* **Stevens' Drawer Ventilator.**—This is like a drawer lacking its back. It is made to fit into a hole in the wall in such a way that when the drawer is open, the air can enter.

*d.* **Jenning's Inlet.**—This is another variety which allows a varying amount of air to enter into the room by opening it to a greater or less extent.

(3) **Special Air Inlet Shafts.**—The best known types are—

*a.* **Tobin's Tube.**—This consists of a large upright and rectangular tube about 5 or 6 feet high placed against or inside the wall of the room. The lower end opens on to the outside wall, so that the fresh air is directed upwards. The incoming air may be purified by making it pass through a layer of wool, or moistened by impinging it on a tray of water or warmed by passing it over heated pipes.

*b.* **McKinnell's Tube.**—This is very useful for a room, which has no other apartment over it. It consists of two tubes one inside the other and carried upwards through the ceiling. The inner one which acts as an outlet, projects beyond the outer tube, both above and below, and may be made more efficient by heating the air by gas burners or lamps placed at the bottom of it. The outer one, which is a short but wide tube, acts as an inlet, the fresh air being deflected towards the sides of the room by a horizontal rim attached to the longer and narrower inner tube. The apparatus is fixed in the roof, and is well adapted for large one-storeyed buildings, such as churches, halls, schools, etc.

**Outlets.**—These are meant for the escape of impure air. They should be of the same size as inlets, and should always be placed in or near the ceiling, as heated impure air tends to rise. The lamps placed near the outlets assist the escape of foul air. With

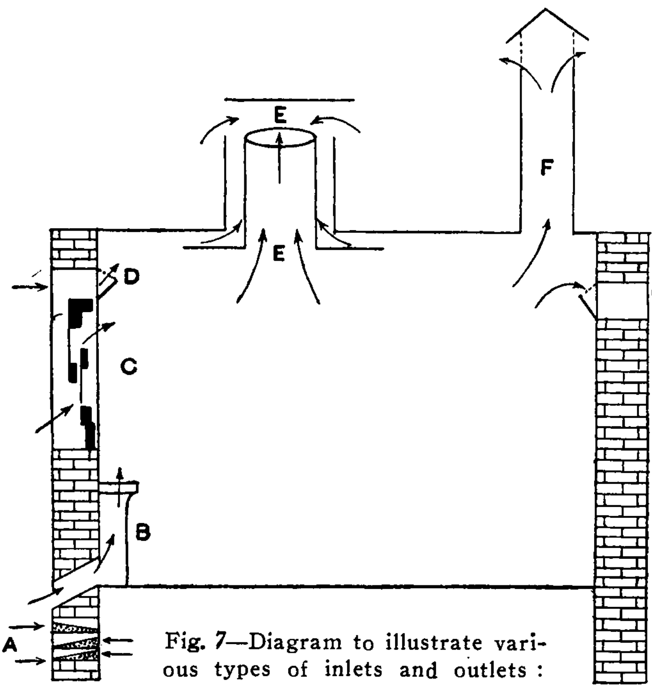



Fig. 7—Diagram to illustrate various types of inlets and outlets : *A*, Ellison's Bricks; *B*, Tobin's Tube; *C*, Hinckes-Bird s method; *D*, Hopper Ventilator; *E*, McKinnell's Tube; *F*, Ventilator Shaft; *G*, Sheringham's Valve.

terraced roofs the simplest plan is to insert a 9 or 12 inch pipe through the terrace fitted with a cover and wire gauze round the openings. Ridge ventilation may be used with tiled roofs. If there is a chimney in the room, the outlet may be provided by placing a shaft either around the chimney or against one side of it. The forms of this arrangement are Arnott's valve and Boyle's valve.

**Arnott's valve** consists of a light metal flap opening into the chimney flue near the ceiling. It allows impure air to be sucked into the chimney, but closes up tightly on any down-draught in the latter. **Boyle's valve** consists of mica flaps. The clicking noise made by this apparatus may be obviated by using silk instead of mica.

**Artificial Ventilation.**—In this system mechanical means are used to facilitate the renewal of air. It is designed to work only when all the doors and windows are kept closed. The three methods, which are in use, are (1) the plenum method, (2) the vacuum method, and (3) a combination of the plenum and vacuum methods.

(1) **The Plenum Method.**—In this method the air is mechanically propelled into buildings through conduits by means of large fans or blowers working in circular boxes, and the foul air escapes by the greater pressure in the room through special openings. The fans may be run by electricity, gas or steam power. The air in this method should always be introduced low down and extracted from the upper part of the rooms.

(2) **The Vacuum Method.**—This method consists of the mechanical extraction of the air out of the room by means of extraction shafts. The best example of ventilation by extraction is the action of an ordinary open fire with a chimney placed in a room. The fire heats the neighbouring air, which expands, ascends and is replaced by the colder air from without. The ventilation of mines is ordinarily secured on this principle. Air is first made to pass down the downcast or intake shaft, and then made to pass through all the workings before it

reaches the upcast shafts; at the bottom of which a furnace is provided.

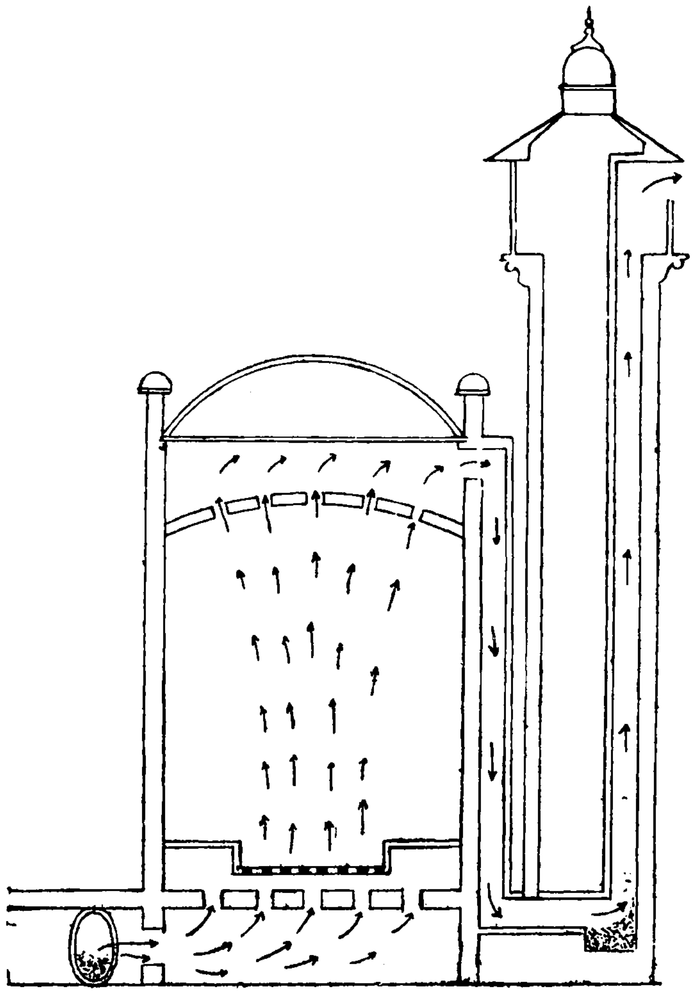


Fig. 8—Ventilation of a Big Hall by "Extraction" System.

Theatres, public halls and hospitals are very often ventilated on this extraction principle.

The air in the extraction shaft may be heated by gas, steam or hot water pipes. Extraction by fans is often used. A fan is placed at the top of a shaft, and is made to revolve by a gas engine. This is specially used in the textile trades in the cotton, woollen, silk and flax factories.

(3) **The Combined Method.**—The combined method is probably the most satisfactory. When the plenum and vacuum systems are combined to ventilate large buildings, such as public halls, theatres, hospitals, workshops, etc., power in the shape of a fan is used to force the air in, and power, either heat or a fan, is also used to draw the air out of the rooms.

The chief advantages of artificial ventilation are that the air can be warmed, cooled or filtered as necessary before allowing it to enter the building, but the disadvantage is that such air being liable to lose much of its freshness in its passage through long shafts is likely to cause lassitude, and a feeling of depression among the inmates. Again, the installation and maintenance of the system are very costly.

**Effect of Overcrowding on Health.**—The bad effects of overcrowding are due to the impurities of air vitiated by respiration, the chief exciting causes being its heat retention and organic impurities. Hence people dwelling in overcrowded, ill-ventilated, back-to-back houses and factories, suffer from weak health, and complain of headache, lassitude, heaviness, nausea and fainting. Their vitality being lowered they are predisposed to attacks of infectious diseases, and especially of phthisis. They also very often suffer from bronchitis and pneumonia. Children usually suffer from rickets.

If overcrowding is associated with impure air, emanating from badly constructed drains, sewers or cesspools, the usual symptoms are morning headache, drowsiness, vomiting, diarrhœa, dysentery, glandular enlargements, petechial rashes, fever, albuminuria and acute prostration. Children suffer more than grown-up persons. They suffer from sore-throat, fever, headache, vomiting, tonsilitis, anæmia and diphtheria. But the scavengers working in the sewers or drains do not appear to suffer, because they acquire immunity by constantly absorbing this poison.

Overcrowding is, as a rule, met with in the houses of the poor people. Hence the minimum standard of cubic space allowed per adult in tenement houses should be at least 400 cubic feet for rooms which are used both as living and sleeping rooms, and 300 cubic feet for rooms, which are solely used as a workplace. Half the amount should be for children. Some municipalities have made bye-laws which enjoin that every dwelling room of a tenement house should have a clear superficial area of 144 square feet and a height of at least 7 feet 6 inches. Such rooms should also have a door and a window, but they do not lay down the maximum number of individuals to occupy such rooms, with the result that these rooms are, as a rule, overcrowded, and much of the space is occupied by household furniture.

**Determination of the Efficiency of Ventilation of an Inhabited Room.**—In determining the efficiency of any scheme of ventilation, the cubic space of the room must first be ascertained. This can be determined by multiplying the length, breadth and height of a room, if it is regular in shape, but a height above 12 feet in ordinary dwelling-rooms need not be taken into consideration for calculating the cubic space. Solid articles of furniture must be deducted from the cubic content. For a bed 10 cubic feet and for an adult 3 cubic feet are usually deducted. In the case of an irregularly shaped room it is convenient to divide it into rectangles and triangles, and to add together the cubic contents of each. The following rules of mensuration may be helpful in obtaining the cubic content of a room :—

**Mensuration of Superficial Surfaces.**

(1) Area of a circle=Square of Diameter × 0.7854.

(2) Circumference of a circle=Diameter × 3.1416.

(3) Area of an ellipse=Product of both diameters × 0.7854.

(4) Circumference of an ellipse=Half the sum of both diameters × 3.1416.

(5) Area of a segment of a circle

$$= (\text{Chord} \times \text{height} \times \tfrac{2}{3}) + \frac{\text{height}^3}{2\ \text{chord.}}$$

(6) Area of a square, rectangle, rhombus, or rhomboid, the opposite sides of which are parallel=Base × perpendicular.

(7) Area of a triangle=Base × ½ perpendicular.

(8) Area of a parallelogram=Bisect into two triangles by a diagonal, and take the sum of the areas of the two triangles.

(9) Area of a trapezoid, two sides only being parallel=Mean length × perpendicular.

(10) Area of a trapezium or any irregular figure= Areas of triangles into which the figure may be divided.

(11) Surface of a sphere=Diameter$^2$ × 3.14159.

**Mensuration of Cubic Spaces.**

(1) Cubic capacity of a cube or solid rectangle= Length × breadth × height.

(2) Cubic capacity of a solid triangle=Area of triangle × $\frac{1}{3}$ height.

(3) Cubic capacity of a cylinder=Area of one end × length.

(4) Cubic capacity of a cone=Area of base × height × $\frac{1}{3}$.

(5) Cubic capacity of a dome=Area of base $\times$height $\times\frac{2}{3}$.

(6) Cubic capacity of a sphere=Diameter $^3\times 0.5236$.

The next step is to ascertain the number of occupants in each room. The allowance of cubic feet of air per head per hour multiplied by the number of occupants gives the total number of cubic feet of air to be supplied per hour. The direction of the air currents must then be determined. This can be ascertained by examining inlets and outlets. Inlets can be distinguished from outlets by observing the directions of the smoke emanating from smouldering brown paper or cotton velvet when held close to the apertures. The sum of the superficial areas of inlets or outlets divided by the number of occupants will give the inlet or outlet area per individual.

The rate of velocity of the air is usually tested by employing an anemometer and observing the numbers of feet of air which it records as having passed in one minute. The instrument should not be in the centre of an inlet, but at a point about two-fifths of the diameter from its side, as this point best gives the mean velocity. If the instrument be placed in this position for one minute, the volume in cubic feet of air, which flows in, is arrived at by multiplying the area of the inlet by the linear velocity recorded by the instrument. Celluloid bulbs filled with hydrogen may also be used to estimate the rate of velocity of the air.

The temperature of the air of the room at the inlets and outlets should be taken.

Besides these points it is well to inspect the outside of all rooms to find out if any rubbish, filth, etc., is lying about.

# CHAPTER IV.

## HEATING AND COOLING.

### HEATING.

In India artificial heating of a building does not become necessary except in the north and hill stations, where the cold is very severe during winter. Heating and ventilation are so closely associated, that no system of heating that does not to some extent assist ventilation, should be considered. In any system of heating, heat is distributed by radiation, convection and conduction. In radiation the heat rays pass in straight lines to the nearest objects, where they are absorbed or reflected, just as the sun's rays pass through space independent of the atmosphere. There is no substance known, which absorbs all the heat radiated upon it, but dull black objects absorb more heat than bright ones, and lamp-black or soot is said to absorb more than 90 per cent., whatever be the source of heat. In conduction the heat absorbed by bodies passes through them from particle to particle. Metals are good conductors of heat, but air is a bad conductor. Convection is the process by which heat is conveyed to the various particles of liquids and gases. In this process the heated particles being lighter rise up, and their place is taken up by cold particles carried down from above, and thus the convection currents are established.

The chief methods of heating are six, *viz.*, (1) Open fires; (2) Stoves; (3) Gas fires; (4) Hot air; (5) Hot water or steam pipes; and (6) Electricity.

**1. Open Fires.**—In India rooms are ordinarily heated by open *angethies*, in which charcoal is burnt, but in better classes of houses a fireplace with a flue attached to it is coming largely into use, in which coal or firewood is burnt. The open fireplace heats a room chiefly through radiation. It has the advantage of being cheerful and a good ventilator, but has the disadvantage of being very unequal in its heating effect in different parts of the room, as the intensity of radiant heat varies inversely as the square of the distance from its source. It is also wasteful of fuel, as it burns about 8 lbs. of coal per hour, and the heat available in warming the room is only one-sixth or one-eighth of the total heat generated, and the rest is lost in unconsumed smoke or cinder, and in the hot gases passing up the chimney. These disadvantages can be minimised to a great extent by attending to the following points in constructing a fireplace:—

1. Little iron should be used in its construction; the back and sides should be made of fireclay so as to retain much heat and give it out slowly when the fire begins to fail.

2. The sides should be splayed widely out, and the back should be bent forward so as to facilitate radiation of heat.

3. The flue should be throated and provided with a movable mantle, and the outlet should be made as narrow as possible in order to economize heat.

**2. Stoves.**—These consist of coal or charcoal fires in a cast-iron stove, which is joined to a flue to carry away the products of combustion. The heating of the room is largely done by convection. These stoves are easily overheated, render the air excessively dry and give rise to unpleasant odours by the organic dust in the air being charred from falling upon the hot surface. The gases of combustion, such as carbon dioxide and carbon monoxide escape through the joints of the stove and the flue, and may cause poisonous symptoms or even death. Hence their joints should be made strong and air-tight and the stove should be coated on the inside with fireclay or silicate, or it should be made of earthenware or wrought iron instead of cast iron.

There are many forms of ventilating stoves, which are provided with an air-duct under the floor for driving cold fresh air into a chamber surrounding the fire, in which the air is heated and then ascends into the room. Stoves have a disadvantage of making the air hot and dry, which causes dryness of the skin and mucous membranes, irritation of the throat and thus predisposes to cold and respiratory affections. This objection may be met by placing shallow vessels of water on the stoves, from which evaporation will take place and keep the air moist.

**3. Gas Fires.**—These are handy and clean, not forming ashes, and are useful in warming small rooms, such as bed-rooms, where they are used only for a short time. They can also be used for cooking purposes. They must always be provided with a flue of sufficient size to conduct away the gases of combustion either into a chimney or to the outside. In gas fires, asbestos contained in the grate is heated to redness by means of a Bunsen burner.

**4. Hot Air.**—The fresh air is driven into a basement furnace, where it is heated, and then supplied to the various rooms in the house by means of a series of air ducts. This is largely used in Russia and America.

**5. Hot Water or Steam Pipes.**—In this system the rooms are warmed by means of hot water or steam circulating in a system of closed pipes. The hot water system is especially applicable to small buildings, and steam pipes to large buildings. Hot water may be used under low pressure or under high pressure (Perkin's system). When water is heated under low pressure a boiler is provided at the lowest part in the basement with an inlet pipe or return below and, an outlet or flow pipe above. The pipes usually 4 inches in diameter are provided at intervals with radiators, and an open hot water cistern is situated at the highest part to allow of expansion of the water. Radiators serve to increase the heating surface and are known as "direct," if they are exposed directly in the room so as to warm it by radiation and convection. They are known as "indirect," when they are placed under the floor so as to warm the air passing over them, before it enters the room through gratings provided. In the direct-indirect system the radiators are placed in a special box against an outside wall, where the air from outside is heated, and this heated air passes by thermal circulation through ducts into the rooms where wanted.

In Perkin's high pressure system the water is heated under pressure to three or four atmospheres. It consists of wrought-iron pipes, ⅞ths inch in internal diameter and ¼ inch thick, to withstand the internal pressure. No boiler is employed, but one-sixth of the total length of the pipes is coiled and heated in a furnace. The heat causes the water to expand, and to circulate through the pipes; 8 feet of this high pressure pipe and 12 feet of the low pressure pipe are considered sufficient for heating an air space of 1,000 cubic feet.

**6. Electricity.**—This is an expensive method of heating a room. Resistance coils are used as radiators, which heat the room mainly through radiation and convection. The system is very clean, as no products of combustion are formed, and is easily regulated.

## COOLING.

In India the artificial cooling of the dwelling rooms becomes a necessity from a health point of view during the summer months, when the day temperature rises to 112° F., or even more, and the hot winds are blowing forcibly throughout the greater part of the day.

To keep the rooms cool the window glass panes are generally painted green, the doors and windows are kept closed, and thick heavy curtains or screens are hung on the verandahs from 8 or 9 in the morning to 4 or 5 in the evening, so as to prevent the passage of radiant heat and hot air into the rooms. But the devices adopted in actually cooling the temperature of the room depend upon the principle that when a body passes from the liquid into the gaseous state, it absorbs or renders latent a large quantity of heat. This heat is taken from the surrounding objects which, therefore, become correspondingly cool. Water is used for this purpose, as it has a greater latent heat than any other substance.

The time-honoured swinging *punkhah* hung up from the ceiling causes greater movement of air; hence it aids the rapid evaporation of perspiration from the body, which feels much cooler. A better result may be obtained by attaching a moist sheet of towel about a yard wide to the *punkhah* frill. Electrically worked fans are certainly a great improvement in this matter, as they increase considerably the velocity of the movement of the air. The incoming fresh air may be cooled to an appreciable extent by blowing it by means of a thermantidote or fan-wheel over a moist screen or a "khus tattie," kept at the door or window (inlet), and constantly kept moist by a spray of water flowing over it. If water is from a suspicious source it is much safer to permanganate it before it is used. Cooling of a room may also be produced by the expansion of air. Thus, if a jet of air were driven into a room under a pressure of ten inches of mercury above the ordinary barometric pressure, the sudden expansion of this compressed air would reduce the temperature to a great extent. But in all these artificial methods of cooling a room, efficient ventilation can only be carried out, if there are sufficient outlets in size and position.

# CHAPTER V.

## INDUSTRIAL HYGIENE AND OCCUPATIONAL DISEASES.

### INDUSTRIAL HYGIENE.

VARIOUS industries are developing in India in rapid strides. Hence it is essential that industrial hygiene should be included in the curriculum of medical schools and colleges. It deals with the health, the welfare and the human rights of a vast population of the working classes. It is a subject, which is directly connected with the social and economic conditions of these people, and aims at the carrying on of the industries under conditions as little injurious as possible to them.

In order to improve the hygienic conditions under which people work, and in order to prevent the incidence of occupational diseases, the Governor-General of India in Council passed in 1911 an Act called the Indian Factories Act (Act No. XII of 1911). According to this Act the Local Government can appoint inspectors, who can enter any factory and inspect its premises and machinery and the prescribed registers, which he thinks necessary for carrying out the purposes of the Act. By virtue of his office the District Magistrate is a factory inspector under this Act.

The Act defines a factory as any premises wherein or within the precincts of which, steam, water or other mechanical power or other electrical power is used in aid of any process for, or incidental to, making, altering, repairing, ornamenting, finishing or otherwise adopting for use, for transport or for sale any article or part of any article. A textile factory is defined as a factory wherein is carried on any process for, or incidental to, making, altering, repairing, ornamenting, finishing or otherwise adopting for use, for transport or for sale cotton, wool, hair, silk, flax, hemp, jute, tow, china-grass, cocoanut fibre or other like material either separately or mixed together or mixed with any other material, or any fabric made thereof, provided that the term textile factory shall not be deemed to include the following factories, *viz.*, cloth-printing works, bleaching and dyeing works, lace ware-houses, paper mills, flax scutch mills, silk filatures, factories for ginning cotton, decorticating fibre, pressing cotton, jute or other fibre, rope works and hat works.

**Construction of Factories.**—The plans of new factories must be submitted to the factory inspector for his approval before their construction is taken in hand. The foundations must be well laid, and the supporting walls and the superstructure must be very strong to bear the weight of the heavy machinery, with which the factory will be equipped. The factory should be sufficiently lighted, and the doors of every room in the factory in which more than 30 persons are employed should, except in the case of sliding doors, be so constructed as to open outwards. There should also be adequate provision for the escape of the persons employed in the case of fire occurring in the factory. To avoid overcrowding at least 250 cubic feet of air space should be allowed for each worker, and 400 cubic feet for each woman during overtime. The general ventilation in every room of a factory must be so efficient as to render harmless, as far as practicable, any gases, vapours, dust or other impurities generated in the course of the work carried on therein that may be injurious to health. If necessary exhaust fans or other mechanical means must be provided to prevent this nuisance.

**Humidity.**—When the textile fibres contain a certain amount of moisture, they become elastic, and then easily carded, drawn out, spun into yarn and woven into cloth. Hence it becomes necessary to increase the humidity of the atmosphere of the factory rooms, which also increases their temperature. Workmen exposed to such conditions are apt to attacks of catarrhal colds, bronchitis, pneumonia, tuberculosis and other respiratory affections, especially when the air is also surcharged with organic dust emanating from cotton fibres. To avoid these bad effects on the health of the operatives it is necessary to lay down a maximum standard of temperature and humidity to be maintained in the workrooms of every factory. But in a country like India, where the climatic conditions vary so much in every province, it is difficult to lay down any standard. Again certain textile processes require a high temperature and a high degree of humidity. However, the temperature should not exceed 100° F. in any room of a factory in winter or in summer, and for humidity the temperature in the wet and dry-bulb thermometers should vary between 70 and 80°F. Hence these thermometers must be kept in the rooms, and readings taken daily at certain hours. The water used for the purposes of producing artificial humidity should be taken either from a public supply of drinking water, or from some other source of water ordinarily used for drinking, or should be effectually purified before being used for the purpose of producing humidity.

In factories in which women and children are employed, and in which the floors are liable to get wet, adequate drainage must be provided for removing the excess of the fluid.

**Sanitary Accommodation.**—Every factory must be provided with sufficient and suitable latrine accommodation and, with separate urinal accommodation for the persons employed in the factory. There should be at least three latrine seats in a factory employing not more than 50 operatives. Four latrine seats should be provided when 51 to 150 operatives are employed, and five latrine seats when 151 to 200 operatives are employed. For a factory employing more than 200 operatives one latrine seat for every 50 or fraction of 50 operatives is considered sufficient, provided there is adequate urinal accommodation. When women are employed, separate latrines properly screened off should be provided for them. The latrines must be placed, though detached from any other factory building, at a convenient and accessible position, and must be well ventilated and lighted. When any general system of underground sewerage is in force in a municipality, all factory latrines and urinals should be connected with the sewerage system. When no underground drainage sewerage system exists, the dry-earth system with separate vessels for solid and liquid excreta must be adopted, and arrangements maintained for the regular removal and disposal of excreta. All drains carrying waste or sullage water should be constructed in masonry or impermeable material, and should be regularly flushed and connected with some recognized drainage line.

**Water Supply.**—In every factory a supply of pure potable water should be provided from either a general municipal water service, or one or more wells so situated as not likely to be polluted. When taps are not used, a suitable establishment must be maintained for the drawing, protection and distribution of the water. Proper arrangements must be made for maintaining, in a drained and cleanly condition, the area around the spot set apart for the distribution of the water.

**General Cleanliness.**—The compound of a factory

**General Cleanliness.**—The compound of a factory should be maintained in a strictly sanitary and cleanly condition. All the inside walls and ceilings or tops of the rooms of every factory whether polished or not and all the passages and staircases, if they have not been painted with oil or varnished, once at least within seven years, should be lime-washed once at least within 14 months, and if they have been so painted or varnished, should be washed with hot water and soap once at least within 14 months. The floors of factories should be swept at least once a week or oftener, if to do so is necessary to maintain them in a cleanly condition.

**Accidents.**—With a view to prevention of accidents, all mill-gearing and other parts of the machinery, such as fly-wheels, water-wheels, hoists, teagles, hoist-wells, trap-doors or similar openings near which any person is liable to pass or be employed must be securely fenced, when these are in motion or use. Women and children are forbidden to clean any part of the mill-gearing or machinery of a factory, while the same is in motion, or to work between the fixed and traversing parts of any self-acting machine, while such machine is in motion. Women and children are also not employed in the part of a factory for pressing cotton in which a cotton opener is at work.

Every accident which occurs in a factory causing death or bodily injury, whereby the person injured is prevented from returning to his work in the factory during the forty-eight hours next after the occurrence of the accident, has to be notified to the factory inspector and to other authorities appointed by the Local Government. To encourage the workmen an Act on the same lines as the Workmen's Compensation Act of England should be passed in India, which should make it compulsory on the part of an employer to compensate a workman for injuries sustained in his employment, or in the event of the workman's death, those dependent upon him.

**Hours of Work.**—It is not possible to lay down any general rule for the hours of work, which may vary with the character of the employment. However, it is much better that a man should work for eight hours, devote eight hours to the development of his intellectual, moral and physical welfare, and sleep for the remaining eight hours. The hours of work, however, depend to a large extent upon the physical exertion required upon the nervous tension and upon the sanitary conditions in which work is carried on. There should certainly be one full day's rest once in a week.

According to the Factory Act, the period of employment for men in textile factories is twelve hours a day (and between 5-30 A.M. and 7 P.M.), with an interval of half an hour's rest after every six hours of work. The continuous work for such long hours is certainly detrimental to the health of the mill hands, especially when the atmosphere in the mills is so close, sultry and vitiated and when so much of fluff and cotton fibres are floating in the air in some departments. It has been observed that the families of operatives working in such mills become extinct in three generations. Recently the mill operatives working in cotton mills in Bombay and Ahmedabad have forced a reduction to ten hours from twelve. Women are employed for eleven hours a day. To improve the health of the women it is necessary that they should have two or three days' rest each month during the menstrual period, and should be protected from undue strain and fatigue. They should also not be allowed to work during the last month of pregnancy and for one month after delivery. Children under nine years of age are not employed in factories. Between nine and fourteen they are employed for six hours a day in a textile factory and for seven hours in any other factory. It is necessary that these children must be in possession of a certificate showing that they are not under nine years, and are fit for employment in a factory. These certificates are granted by a certifying surgeon, who usually happens to be the Civil Surgeon of a district. It is time that the Government should appoint certifying surgeons in big industrial towns who should also act as factory inspectors, as through their special training they are better qualified to make necessary recommendations as regards the ventilation, overcrowding, cleanliness, sanitary conveniences, humidity, temperature, offensive efflvia, and the physical conditions of the employees. In the case of children, attendance at school during the non-working hours of the day must be made compulsory, so that they may be able to develop their mental and intellectual faculties.

## OCCUPATIONAL DISEASES.

The occupational diseases are mostly produced by the air of the factories polluted by poisonous gases, fumes and dust emanating from the manufacturing processes. These affect the workers especially when they have to work in insanitary and overcrowded factory rooms up to a fatiguing point.

**Poisonous Gases and Fumes.**—The following are the most important :—

1. **Carbon Dioxide.**—Poisoning from this gas occurs chiefly among well-sinkers, and among individuals employed in the fermenting cellars in breweries, in aerated water factories and chemical works. It gives rise to symptoms such as headache, nausea, tinnitus aurium, dyspnœa and muscular debility, and may also

cause death by asphyxia if its proportion be more than 10 per cent.

2. **Carbon Monoxide.**—This gas is evolved in large quantities in gas works, coke ovens, blasting furnaces, cement and brick kilns and in the Leblanc process of soda manufacture. Hence individuals employed in these works mainly suffer from its poisonous effects.

The gas is extremely poisonous, and more deadly in its effects than dioxide gas, as it forms a more stable compound with the hæmoglobin of the blood than oxyhæmoglobin, and therefore prevents oxygen from being given to the tissues. Less than five volumes per 1,000 produces symptoms, such as headache, malaise, drowsiness passing into deep sleep and death. It has no odour, and thus not being liable to irritate the air passages, is not usually discerned by its victims.

3. **Carbon Bisulphide.**—This volatile liquid of disgusting odour is used in the arts as a solvent for caoutchouc, India-rubber, phosphorus, sulphur, etc. Hence the workers by constant exposure to its fumes in ill-ventilated caoutchouc factories often suffer from symptoms of chronic poisoning, such as headache, noises in the ears, nausea, anorexia, tremors, muscular weakness and ataxia. In some cases peripheral neuritis, paralysis of the extensor muscles, delirium, mania and even dementia also develop.

As a preventive measure troughs containing carbon bisulphide should be covered, and the fumes emanating from them should be removed by means of exhaust fans. There should also be periodical medical inspections of the workers.

4. **Sulphuretted Hydrogen.**—This has an offensive smell like that of rotten eggs. It is a powerful poison in a pure state, causing death instantaneously, but, when largely diluted, it produces dizziness, nausea, headache

and even convulsions. Its poisonous effects are mostly met with in persons employed in chemical and gas works, in the cleaning of boilers, in soap factories where large quantities of fat are decomposed, and in the treatment of sulphuric acid to remove arsenic.

In nature sulphuretted hydrogen is formed during the decomposing process of organic substances containing sulphur. It is, therefore, found about privies, burial vaults, marshy places, and collections of filth and manure, but the quantity is too small to seriously influence the health of the inhabitants. However, owing to its action on lead and silver, it blackens the paints of pictures and silver articles, when present in the atmosphere even to a very small extent.

5. **Sulphur Dioxide.**—This has a suffocating odour, and is very destructive to plant life, high and low. Those who are employed in the manufacture of sulphuric acid and in such processes as ore burning are usually apt to suffer from its deleterious effects. It has, as a rule, very little effect on healthy persons, but persons suffering from respiratory troubles like asthma and bronchitis are liable to be worse by inhaling it. The usual poisonous symptoms from it are a feeling of suffocation, dyspnœa, coryza, cough, opacity of cornea, cyanosis and convulsions.

6. **Chlorine and Hydrochloric Acid.**—These are evolved from alkali works, and act as irritants of the mucous membrane of the respiratory tract and conjunctiva.

Chlorine, if inhaled in small quantities, produces cough, dyspnœa and bronchial catarrh, and produces great respiratory distress and immediate death, if inhaled in large quantities.

The fumes of hydrochloric acid are much less irritating, but workers constantly exposed to it even in small quantities suffer from ulceration of the trachea, bronchitis, pneumonia, irritation of the eyes, as also from destruction of their teeth.

7. **Ammonia.**—This is evolved in works where ammonia and ammonium salts are manufactured, as well as in certain other trade processes. Its fumes produce conjunctivitis, and rarely suffocation and death.

8. **Benzene.**—This is used in dry-cleaning processes and in the manufacture of aniline. The inhalation of its fumes produces excitement, flushed face, nausea, vomiting, pain in the abdomen, giddiness, headache, cyanosis, stupor, coma and death. Workmen, who are habitually exposed to its fumes, suffer from a chronic form of poisoning with purpuric hæmorrhage from the mucous membranes of the nose and throat and into the skin, and fatty degeneration of the heart, liver, and kidneys.

9. **Aniline.**—Poisoning from this occurs among those who are exposed to its fumes in industrial arts, as it is largely used in making several dyes. The symptoms are eczematous ulcerations, cough, nervous symptoms and blindness.

10. **Nitrous Fumes.**—These are met with in the manufacture of nitric acid, and also in the manufacture of explosives. The fumes chiefly irritate the respiratory tract, and may produce death if inhaled for a long time.

**Dust.**—This is the great enemy of working people. It is a product of the various industrial occupations, and is found in the form of fine solid particles suspended in the air, which are of mineral, animal or vegetable origin. The inhalation of these particles causes catarrh, bronchitis, pneumonia and fibroid phthisis. If the particles are hard, sharp and angular, instead of being smooth and rounded, they are particularly injurious, as on being embedded in the air cells of the lungs they cause irritation and inflammation of the surrounding tissues. Workmen who have to work in hot, closed, overcrowded and ill-ventilated factories with air saturated with aqueous vapour suffer more than persons working in the open or well-ventilated workshops.

Coal miners are not so much affected by phthisis as tin miners, even though they work in mines with air vitiated by respiration, combustion and blasting, because coal particles are very minute, without any sharp angles, and are supposed to be capable of preventing the development, and arresting the growth of tuberculosis ; but they generally suffer from nystagmus owing to insufficient light in mines.

Potters in India do not seem to suffer from bronchial affections as they work at their proverbial wheel in the open, but in England they suffer from bronchitis, emphysema (potter's asthma) and phthisis as they have to work in closed, heated factories, and are exposed to sudden variations of temperature.

Steel grinders suffer largely from phthisis, bronchitis and pneumonia, but the diseases can be averted by introducing improved methods of ventilation. Grinding should be done under water, and metallic and stone dust should be collected in extraction tubes attached to each grindstone and removed by exhaust fans; or magnetic shields should be used to attract and collect the steel dust. In addition to these, the workers should wear respirators.

**Lead Poisoning.**—File makers, plumbers and painters suffer from lead poisoning by inhaling volatilized particles of oxide and carbonate of lead. They also take it along with their meals by eating with dirty hands. Gout, renal disease, and diseases of the heart and brain are the chief complications to be met with in these trades.

The precautions to be adopted are as follows:—

1. The work-rooms should be kept clean and well-ventilated.

2. Workmen should be enjoined absolute cleanliness, especially of their hands, and prohibited from taking their meals inside the factories.

3. They should take drinks containing minute doses of sulphuric acid, as also a lot of milk. The former acts by rendering the ingested particles of lead chemically inert by converting them into sulphates.

4. There should be proper arrangement for collecting and discharging lead fumes and dust as soon as they are formed.

5. Women and children being particularly susceptible to lead poisoning should not be employed in lead factories.

6. There should be periodic medical inspection of workers.

**Phosphorus Poisoning.**—Match manufacturers used to suffer largely from necrosis of the jaw owing to yellow phosphorus being used ; but this danger has been now obviated by the introduction of red or amorphous phosphorus, which is non-volatile and thus harmless. In India an Act was passed in 1913 against importation of crude yellow phosphorus.

**Mercury Poisoning.**—Workers in mercury, especially those engaged in making vermilion, barometers and thermometers, suffer from mercurialism. The chief symptoms are salivation, spongy gums and palsy. The preventive measures are to keep mercury covered as much as possible, so that its vapours may not be diffused, to keep the mouth and the teeth clean, and to have carious teeth removed or filled in. The floor of the workshop should be constructed in such a way as might render easy the collection of spilt mercury.

**Arsenic Poisoning.**—Scheele's green, a compound of arsenic, is used in making wall papers, artificial flowers, carpets and curtains. Hence persons employed in the manufacture of these articles, and those who cure and mount skins of animals, suffer from arsenic poisoning ; the chief symptoms being painful rashes, sore eyes, vomiting, and diarrhœa. Wall papers should not be used in rooms, as particles of the paint are liable to be easily detached, specially in a tropical clime, and on account of their fineness are likely to contaminate the air. The use of arsenical colours and dyes should also be minimized as far as possible.

**Brass Founders' Ague.**—Brass founders suffer from bronchitis, asthma and a disease called "brass founders' ague" owing to inhalation of the fine metallic particles of zinc oxide, as brass is an alloy of zinc and copper. People suffering from these complaints should drink a lot of milk, and occasionally adopt means to induce free vomiting.

**Chromate Poisoning.**—Persons engaged in the manufacture of chromate and bichromate of potassium, and exposed to the dust are apt to suffer from destructive ulceration of the nasal septum. To prevent this the workers should use nasal plugs or paint the septum with paraffin.

**Tobacco Poisoning.**—Persons working in the manufacture of tobacco suffer from nausea, giddiness and irritation of the eyes, but they soon become able to tolerate the smell of the tobacco fumes.

**Anthrax.**—Wool sorters suffer from anthrax, a dangerous form of blood poisoning, which can, however, be guarded against by making shafts over the benches, where people work, and through which the dust will pass out by an exhaust fan, and be collected into settling chambers, where it can be burnt after it is damped by steam jets. In factories dust is very much less, as wool is treated with oil.

Anthrax has also been met with in persons employed for stuffing chairs and mattresses with horse hair and in the preparation of bristles for brush-making. Anthrax may be caused, though rarely, by using an infected shaving brush. Hence it is very necessary to soak the new brush for at least ten hours in a 1 to 1,000 solution of mercuric chloride or to boil it, before it is used.

# CHAPTER VI.

## OFFENSIVE TRADES.

THE offensive trades are those that chiefly deal with animal matters. These give rise to offensive odours, and may become nuisances, especially if carried on in the midst of towns and cities. As a safeguard against these nuisances many municipalities have framed bye-laws for the proper location and carrying on of these trades.

The chief of these trades which are carried out in India are keeping and slaughtering of animals, blood and bone boiling, gut scraping, fat melting, tanning and keeping of brick and lime kilns.

**Keeping of Animals.**—Animals, such as horses, cows, buffaloes, goats, pigs and even poultry, are generally herded together on the ground floor of dwelling houses or in badly constructed stables too near the populated locality. Hence they are a source of nuisance to the inhabitants of the house and of the neighbourhood owing to the decomposition of food, and soakage of urine and excremental matter into the ground. The collections of filth and litter also serve as a breeding place for flies and a haunt for rats.

To prevent these nuisances the stables for keeping animals should be constructed at a distance of at least 100 feet from dwelling houses, and should have an open space of 15 feet in width all round them. The height of these stables should not be less than 12 feet, and their cubic capacity should be such as to allow a superficial area of 12 feet by 6 feet for each horse and of 12 feet by 4 feet for each cattle, exclusive of space taken up by any manger or drains. The floor should be one foot higher than the mean level of the surrounding open space, should be well cemented and sloped so as to prevent soakage of urine or other filth in the ground and communicate with the receptacle for urine by a drain. There should be a separate paved space in the stable, 1|12th of its floor area, for washing animals. The paved space and the stable floor should be washed and cleansed twice a day. Ridge ventilation with a ground-level inlet for fresh air at the head of each stall is necessary.

Dung, filth, sweepings or other offensive refuse should not be kept near any source of water used for potable or other domestic purposes so as to pollute it, but must be kept in suitable and closed receptacles made of masonry so as to prevent the escape of their contents or their soakage into the ground or into the wall of any building. These receptacles should have an aggregate capacity in proportion to the number of animals stabled, 1½ cubic feet of space being sufficient for each animal. They should then be emptied at such places as are fixed by the municipality for deposit of dung, etc. Hay, straw and grass should never be stored on the premises in a greater quantity than sufficient to last the animals for four days. Separate places away from human habitation must be assigned for storing them. Filtered water or water ordinarily used for domestic purposes should be supplied to the animals. Attendants and grooms should never be allowed to live in any part of the stable or in the loft.

Piggeries are a greater source of nuisance owing to the offensive odour coming from the sties in which the animals are kept, and from the sour and fermenting food with which they are fed. It is, therefore, essential that pigsties should be located at a distance of at least 100 feet from any dwelling house in urban districts. They should have a smooth, hard, impervious floor of concrete or Indian patent stone, properly sloped and provided with channels leading to a gulley, which discharges into a drain or cesspool. The walls should be painted with cement on the inside or made of stone, so that they can be easily washed. The windows should be placed in the opposite walls for ventilation and lighting. The sties should also be provided with a roof. The food should be kept in impervious vessels with closely-fitting lids, and the sties should be swept out and cleansed daily.

**Slaughtering of Animals.**—To avoid nuisances arising from slaughtering of animals a slaughter yard should be outside the town, and should not be located on low-lying land ; under no circumstances should it be situated within 100 feet of any dwelling house. It should be surrounded by a high compound wall on all sides, and the size should be sufficient to allow an open space at least 20 feet wide around the buildings. In addition to the slaughter-house proper, the yard should contain the following buildings :—

1. The cattle yard, where the cattle to be slaughtered may be collected for sale. This yard should be turfed, and proper arrangement should be made for removing dung and other refuse.

2. The lairs, where animals can be kept previous to slaughtering. These lairs should be properly paved, drained and ventilated. No habitable room should be constructed over any of them.

3. The inspection shed, where animals can be examined medically. This should be furnished with a well-equipped laboratory.

4. The offal and manure house, where the boiling of blood, preparation of manure, etc., may be carried out.

5. The cooling room.
6. The boiler house.
7. The incinerator.
8. The refrigerator and sterilizer, if possible.
9. Latrines and urinals for butchers.
10. The office for an inspecting officer.

The area required for the construction of these buildings varies with the number of the inhabitants of a town, 6½ square feet per head being necessary for towns having a population of 3,000 inhabitants, 5½ square feet per head for towns with a population of 3,000 to 5,000 inhabitants, 4½ square feet per head for towns with a population of 5,000 to 7,000, 4 square feet per head for towns of 7,000 and more, 3½ square feet per head for towns of 7,000 to 10,000 population and 2½ square feet over this number.

**Slaughter-house (Abattoir).**—To control the inspection of animals and prevent the slaughtering of diseased animals, all the animals intended for food should be slaughtered in a public slaughter-house, and not in the premises of private individuals, except on religious festivals, when the people might do so with the sanction of the authorities. In this case the earth and ashes ought to be spread in a thick layer upon the ground at the place of sacrifice so as to absorb the blood and prevent it from soaking into the ground.

Slaughter-houses are of two patterns, *viz.*, (1) the French or separate system, in which each butcher is provided with a separate room to kill animals. These rooms open at one end into a central passage and at the other directly outside the slaughter-house. This system is more suitable to India, as in many large towns butchers and salesmen are different persons ; (2) the German or block system, in which all the buildings of a slaughter-house are under one roof, or are connected to it by covered passages. This is not quite suitable for India as there will be no free space around the building.

The slaughter-house should be so constructed that the slaughtering of animals should be visible to very few, and the noises of cattle audible to a very small circle. The slaughter-house should be provided with an adequate water-supply. It should be properly ventilated and lighted by doors, windows and sky-lights. The doors and windows should be provided with wire netting or better still with automatically working "fly-proof shutters." The floor of the slaughter-house should be made of impervious material (asphalt over concrete), and should be sufficiently strong so as not to crack or break by the falling of heavy objects or with the stamping of animals, and should be laid with proper slope and channel towards a gulley, provided with a trap to prevent emanation of gases from the drains and penetrating into the slaughter-house. The corners of the rooms should be rounded off, and the surface of the walls on the interior of the slaughter-house should be covered with hard, smooth impervious materials to a height of at least 10 feet. The floors and the walls up to 3 feet from the floor should be thoroughly scrubbed and washed within 3 hours after any slaughtering.

No room or loft should be constructed over the slaughter-house. Urinals and latrines for the use of the butchers should be quite detached and at some distance from the slaughter-house. It should also not be connected with any stable.

Blood manure, garbage, and other refuse should be collected in clean vessels made of non-absorbent materials and provided with air-tight lids, soon after animals are slaughtered.

The refuse including all skins, fat and offal must be removed within 24 hours. No dogs should be kept in the slaughter-house, nor any other animals unless intended for slaughter.

**Markets.**—These are the places where grain, condiments, fruit, vegetables, meat, fish, etc., intended for human food are sold. These markets are either private or public. The private markets should be closed, unless they have been constructed on sanitary lines. Both the private and public markets must be under the control of the municipality, and must be under the inspection and general superintendence of its health officer or his assistant.

The public market should be situated on the main road, if possible, and within easy reach of the people for whom it is constructed. It should be so constructed as to face the main road, and the condiment or grain bazars should also face the road and not the inside of the market. Besides the main entrance facing the road, there should be two more small entrances at each end of the market enclosure. Very often the market is partitioned into two enclosures, the first enclosure is provided with stalls for selling vegetables and fruit, and the second enclosure which is on the back of the first and separated from it by an iron gate is provided with stalls for selling meat, beef and fish. The entrance for this enclosure must be from the back of the road and under no circumstances should be through the first enclosure. However, it is preferable to have vegetable markets quite separate and situated on different sites, especially in those towns and cities, where a large number of the population is strictly vegetarian.

The rooms used for storing grain or condiment should be provided with removable plank shutters and a ventilator protected by a fine wire-gauze netting in the back wall. The roof should also have a ventilator covered with a wire-gauze netting. The floor should be paved with stone slabs with concrete underneath, and the walls should be built of masonry. To further render the room rat-proof the top and bottom of the plank shutters should be covered with zinc sheets, 9 inches wide. In front of the store room there should be a display platform and in front of this platform a covered verandah should be constructed for buyers.

The vegetable market should have several stalls, each consisting of a platform at least 6 feet by 6 inches for each stall-holder and a store room at least 8 feet 6 inches by 6 feet for storing fruits or vegetables overnight. This room should be well-ventilated.

The meat market should have separate stalls for selling meat, beef and fish to suit the religious susceptibilities of the community. Each stall should consist of a passage 6 feet wide for buyers and a platform 6 feet long and 6 feet wide for the display of meat or beef, and a platform 5 feet by 3 feet for display of fish. An iron rod with chains and hooks to suspend carcases should be fixed in the tie beam. The platform should be covered with stone slabs, and should only project 9 inches above the floor level. Removable chopping blocks should be provided for each platform, so that they can be well scraped and cleaned. The seller should sit behind the platform.

There should be adequate arrangement for water-supply and drainage. The water-supply should be from the main pipe. In absence of a filtered water-supply, raised cisterns should be provided, which can be filled by a pump attached to a well, so that the water may be supplied to the market under pressure. The vegetable, mutton, beef and fish stalls should be flushed out daily with a hose attached to a hydrant provided to each stall.

Each stall should be surrounded with an open *pacca* drain, which should discharge into a municipal drain outside the market on the nearest road. The garbage and rubbish should be daily collected into closely-fitting vessels, and should be removed twice a day. For the convenience of those that attend the market urinals and latrines should be located at a suitable distance from the stalls. If these are not on the water carriage system, they must be properly cleaned at least twice a day.

**Blood Boiling.**—Municipal contractors collect the fresh blood at slaughter-houses, and boil it to a thick consistence before it is used as manure, or as sugar refiner. The dried powder is also used for preparing blood albumin and Turkey-red pigment.

The blood should be collected and stored in clean and air-tight vessels. The boiling of the blood should be carried out in properly constructed sheds, where suitable furnace arrangements should be made for the discharge of the vaporous products through shafts or funnels constructed well above the level of the habitable buildings in the vicinity.

**Bone Boiling.**—The bones, hoofs and hide trimmings are collected from slaughter-houses, and are boiled together to prepare gelatine, glue and fat. The bones are then used for manufacturing the handles of knives, forks, etc., or they are crushed and mixed with sulphuric acid to manufacture superphosphate manure. To prevent the offensive gases emanating during the process of boiling the bones should be boiled in steam-jacketed pans, and the furnace flue should be connected with a large hood by means of a pipe so as to collect the emanating vapours from the pans, which can be carried away to a considerable height by means of a tall chimney. To prevent the fumes arising from the steaming bones, cold water should be applied to them, as soon as they are taken out of the boiling pans. The scutch or débris left in the boiling pans should be removed from the premises as soon as possible, as it is a great source of nuisance. Fresh as well as recently boiled bones should be dried, and treated with lime, before they are stored, nor should they be stacked in piles.

**Gut Scraping.**—The process for manufacturing sausage skins and catgut is very offensive. They are prepared from the small intestines of pigs and sheep. The intestines are cleansed and soaked in salt and water for a few days to soften, and are then scraped with a wedge-shaped piece of wood, until a little of the muscular coat and the peritoneal covering are left. The premises where gut scraping is carried out should be properly ventilated and lighted. The floor of the premises should be made of concrete, properly sloped and drained. The inner surface of the walls should be smooth, and made of some such impervious material as Indian patent stone up to a height of at least 6 feet. The tables used for scraping the guts should be made of stone or preferably marble. The guts should not be stored in wooden tubs, but in closed receptacles made of some impermeable material. The waste liquors should be treated with chlorine or some other disinfectant before they are discharged into a drain.

**Fat Melting.**—This is carried out for preparing candles, soaps, leather dressings and grease for lubricating machinery. The fats to be melted are derived from beef, mutton, pork, kitchen waste, etc. These are melted over open fires, or free steam either with or without sulphuric acid and in steam-jacketed pans. If the fat is melted over an open fire, the heat should be kept at a very low temperature as far as possible, and suitable arrangement should be made for carrying away the obnoxious fumes. This process should never be carried out in the vicinity of a thickly populated locality. From a sanitary point of view the two latter methods of melting the fat are very good, inasmuch as the emanating fumes are collected and burned, and the fat is received into clean metal vessels.

**Tanning.**—Tanning of hides is usually carried out in the same premises where fell mongering and leather dressing are done. A fell monger is one who receives the recent or old skins of sheep and prepares them for the leather dresser. The fresh skins are cleared of dirt by beating them with sticks, and are then soaked in water. Afterwards they are treated with lime, and hung up until the wool becomes loose and easily detachable. After the wool is removed, the skins are known as pelts, which are cast into a pit containing milk of lime, until they reach the leather dresser.

The old skins are first soaked for a few hours in water to soften, and then are hung up until putrefaction has rendered the wool loose, so that it can be easily detached. The other process is the same as in fresh skins.

The leather dresser converts the pelts into leathers of various kinds by treating them with fatty and other matters. The tanner tans the skins by means of oak bark, mimosa, etc., and thus the putrescible hides are rendered non-putrescible. Previous to tanning the skins are softened by soaking into a solution containing dogs' dung.

All the above-mentioned processes are very offensive. Hence tanneries should never be allowed in the neighbourhood of a thickly populated locality. The buildings should be enclosed by a compound wall at least 6 feet high. The floor should be impervious, properly sloped and drained. The inner surface of the walls should be cemented to a height of about 8 feet. Each pit or vat should be covered with a closely-fitting lid except when the hides are soaking in it. All the refuse from the pit should be removed every day in a closed vessel. All the hides spread out for drying should be covered with grass or straw or such other material as would prevent the emission of stench.

**Brick or Lime Kilns.**—Organic effluvia, carbon dioxide, carbon monoxide, sulphur dioxide and hydrogen sulphide are given off from these kilns. They should be located outside the town. Dung, filth, sweepings or any kind of refuse, such as stable refuse or filthy decaying vegetable matter should not be stored in the premises. No material, which gives off any offensive smell before or after ignition should be used as fuel. The kilns should be provided with flues and lighted only at night, especially between 10 A.M. and 2 P.M. A water pipe with 100 feet of hose should always be ready within 50 feet of the kiln.

**Smoke Nuisance.**—The large volumes of smoke emanating from the chimneys of factories as well as from dwelling houses and mixing with the atmosphere of towns cause a serious nuisance, and certainly interfere with the comforts and health of the population. This nuisance can be prevented to a great extent by locating all the factories far away from the inhabited area and by properly constructing the furnaces, boilers and chimneys, as well as by substituting gas or electricity for coal, as far as is possible.

## EFFECTS OF OFFENSIVE TRADES ON HEALTH.

It is very difficult to state how far the smells emanating from offensive trades affect the health of the individuals, but they indirectly injure the health, inasmuch as they will prevent the windows from being kept open and thus interfere with the proper ventilation of the houses. Besides the continuous inhalation of the offensive gases emanating through improper storage of raw materials and boiling them in open vessels without suitable furnace and chimney arrangements for the discharge of the vaporous products through shafts or funnels constructed well above the level of the neighbouring dwellings causes anorexia, vomiting and diarrhœa, lowers the general vitality and thus renders the people more susceptible to attacks of infectious diseases. The people employed in these trades appear to be less affected than the people living in the neighbourhood.

# CHAPTER VII.

## SOILS AND DWELLING HOUSES.

### SOILS.

SOIL is derived from the gradual disintegration of the rocks through various ages and the remains of vegetable and animal matter.

It is for the sake of convenience divided into two parts, *viz.*, the upper or surface soil containing partly inorganic and partly animal and vegetable matter derived from decomposition, and the subsoil, a deeper layer, composed of inorganic materials derived from the rocks broken through the corroding action of gases, water, roots of trees, etc.

**Influence of Soil on Health.**—The health of people living in any locality is supposed to be influenced by the physical characteristics of the soil on which the dwellings are built. Some of these are micro-organisms, air and water in the soil, and subsoil heat and temperature.

**Micro-organisms in the Soil.**—Micro-organisms are always present more in the superficial layers than in the deeper ones, and they are more numerous if the soil is richer and more polluted with organic matter. These bacteria help in nitrifying organic matter, and thus convert it into nitrates and nitrites, which supply nourishment to the plants. These processes of putrefaction and fermentation cannot be carried out in the absence of organic matter, oxygen, warmth and moisture. These micro-organisms are called saprophytic, as they do not produce disease in man ; however, certain pathogenic micro-organisms are also found in the soil, the chief of which are the the bacilli of tetanus, anthrax, enteric fever, cholera and malignant œdema.

**Air in the Soil.**—All the soils except the hardest rocks contain air, which is called *ground air.* Porous soils contain more air. Its composition is very much the same as that of the atmospheric air, though the amount of $CO_2$ preponderates in it on account of the process of putrefaction of organic matter taking place constantly through the action of bacteria present in it. Its amount varies from 2.4 to 9.74 per thousand. Its quantity varies with the proportion of organic matter, rainfall, as also the temperature and depth of the soil. Besides $CO_2$, this ground or subsoil air contains moisture, ammonia, marsh gas, carburetted hydrogen, sulphuretted hydrogen and nitric acid. Its composition has, however, been known to vary on account of its constant movement. This movement is brought about (*a*) by the law of diffusion of gases, (*b*) by the action of winds, (*c*) by rainfall, (*d*) by variations in temperature and barometric pressure, and (*e*) by fluctuations in the level of the ground water. Foul air in the soil derived from broken drains or cesspools may be sucked through a considerable distance into a house, when the air inside it happens to be warmer and lighter owing to fireplaces, or when the doors are closed. To prevent suction of such foul air into a dwelling house the basement should be cemented or concreted, or the house should be built on arches.

**Water in the Soil.**—The water in the soil consists to some extent of the amount of moisture present in its interstices, but largely of ground water present in all soils at varying depths as a more or less continuous sheet.

The moisture of the soil is derived from rainfall, movements of the ground water, and from capillary attraction and evaporation of the subsoil water through its superficial porous strata, but some of it is always lost by evaporation from the surface and through vegetation. The amount of moisture present also depends on the nature of the soil. For instance, clay soils may retain as much as 20 per cent., chalk 12 to 16, humus 40 to 60, and granite ½ to 4 per cent.

Moist or damp soil can be rendered dry by draining them, opening the outflow and by clearing out clogged water-courses.

The ground or subsoil water is found below the surface of the soil at a depth varying from a few inches to a hundred feet or more. The difference in its level depends on the porosity or compactness of the soil, the amount of rainfall and the depth and distance from the surface of impervious strata. The ground water has a tendency to flow towards lakes, springs, rivers or the sea.

**Soil Heat and Temperature.**—The heat of the soil varies with the geological formation and the atmospheric temperature; but this variation is not commonly noticeable below four feet from the surface. The temperature of a soil depends upon its power of absorbing, retaining or radiating heat.

The sandy and dry porous soil becomes rapidly warm, and retains heat for a long time. The absorption and radiation of heat by moist soils, for instance, of a clay composition, are comparatively slow, as the presence of moisture in them retards both the processes. Such are, therefore, known as "cold soils." The radiating power of the soils is influenced by the colour of the surface and the thickness and growth of vegetation. The surface soil is, as a rule, warmer by day and colder by night than the surrounding air.

**Classification of Soils.**—From the health point of view those soils, whose geological formations favour slope, dryness, warmth and a moderate amount of vegetation, may be generally regarded as the healthiest. The soils are, however, usually classified into:—

1. **Sandy Soils.**—These consist almost entirely of sand. They are healthy, if pure and dry, but are unhealthy, when the level of the subsoil water is high and organic impurities are present.

2. **Clayey Soils.**—These are stiff, damp and cold soils, and are composed mainly of silicate of alumina. They are generally condemned.

3. **Alluvial Soils.**—These include marls (a mixture of sand, clay and lime), loams (a mixture of sand, clay and organic matter), and humus (chiefly containing the products of vegetable decomposition). They are practically always damp, and unhealthy, as they retain water owing to want of slope and favour the growth of rank vegetation. These characteristics are found in the deltas of large rivers.

4. **Granitic, Metamorphic and Trap Rocks.**—These are generally dry and healthy, as owing to natural slopes they do not allow water to collect. Hence vegetation is very little, and marshes are not common. Weathered rocks become disintegrated, absorb moisture, and become unhealthy.

5. **Chalk and Sandstone.**—These are healthy soils, if they are not mixed with or based on clay.

6. **Gravelly Soils.**—These are dry and healthy, except in hollows where the ground water is at a high level. Gravel hillocks are the healthiest of all sites. The water is, as a rule, pure.

7. **Limestone and Magnesium Limestone Soils.**—These are dry and healthy, as water passes quickly owing to great natural slopes. Marshes may, however, occur at any height.

**Diseases attributable to the Soil.**—It is true that the saprophytic micro-organisms being stronger do not allow the delicate pathogenic germs to grow indefinitely in the soil on the principle of "the survival of the fittest." Though doubtless some pathogenic germs are met with in the soil and are liable to exert the pathologic action through the subsoil air or water. The diseases caused by these germs are anthrax, tetanus, malignant œdema, enteric fever and cholera. It is very likely that the germs of cholera and enteric fever enter the soil from infected excretions from leaking cess-pools and drains, and thus pollute the ground water.

Malaria and yellow fever are generally met with in low-lying marshy districts, for the mosquitoes breed abundantly there owing to their being water-logged.

The vitality of persons living in houses erected on damp soils is lowered very much by constant inhalation of ground air polluted with emanations arising from decomposition of organic matter present in the subsoil, and they become particularly predisposed to attacks of phthisis, diphtheria, measles, whooping cough or any other infectious disease.

Rheumatism, catarrh and neuralgia are also liable to be caused by damp soil.

## DWELLING HOUSES.

Houses should be built on a dry porous soil, such as sandstone, gravel, limestone or chalk, which allow of free drainage, and are not likely to get water-logged. Clayey soils should particularly be avoided in selecting a site for them. The other important points that should be taken into consideration in the matter of selection of a site are those referring to its openness, the purity of air and its surface drainage. Valleys, deep hollows, ravines and *nullahs* are particularly unsuitable on account of their containing a large amount of stagnant air polluted through putrefaction of decayed organic matter.

The ideal sites for a dwlling house are the summits or sides of hills, or what are known as "saddle backs," provided that they are well shaded. In the plains, on the other hand, such houses should be built, as far as possible, on elevated sites with a gentle slope allowing easy drainage of rain and subsoil water. They should not, however, be built in the vicinity of waste jungles and shallow *katcha* tanks, *jhils* or other collections of stagnant water. The neighbourhood of sewage farms, factories, graveyards and cultivated fields is also undesirable.

In cities and towns, houses should never be built on "made soils" which are formed by filling up pits and hollows by household refuse and rubbish.

The ground water should not be nearer the surface than 10 feet, and not subject to sudden or great fluctuations. Moreover, they should be protected against the variations of prevailing winds by means of a sparsely placed vegetation round them.

They should also have some open space all round, if possible, equivalent in superficial area to their height and width which will allow a free ventilation and excess of light. The height of the dwelling houses should not be more than the width of the street, on which their frontage abuts. At any rate the height should never exceed 70 feet, and the roof should never make an angle greater than 45 degrees with the frontage. They should also be so located facing east or south-east, that they may have the advantage of direct sunlight in the morning and a protection against it towards evening. Bedrooms should, as far as possible, be placed on the second floor and made to face north-east.

Besides, they should have a few feet of ground concreted, metalled or paved all round, and next to them preferably a plot with green grass kept well mowed.

If there is much subsoil water, it should be drained separately by earthenware pipes having no connection with the house drains.

It is also necessary to have a good supply of potable water near dwelling houses in country districts in the shape of properly constructed wells protected from all sources of contamination.

**Foundations.**—The foundations must be well laid so as to support the weight of the building. They should be covered with an impervious layer of concrete, cement or stone, at least eighteen inches in thickness and extending six inches beyond the base or footing of the wall on

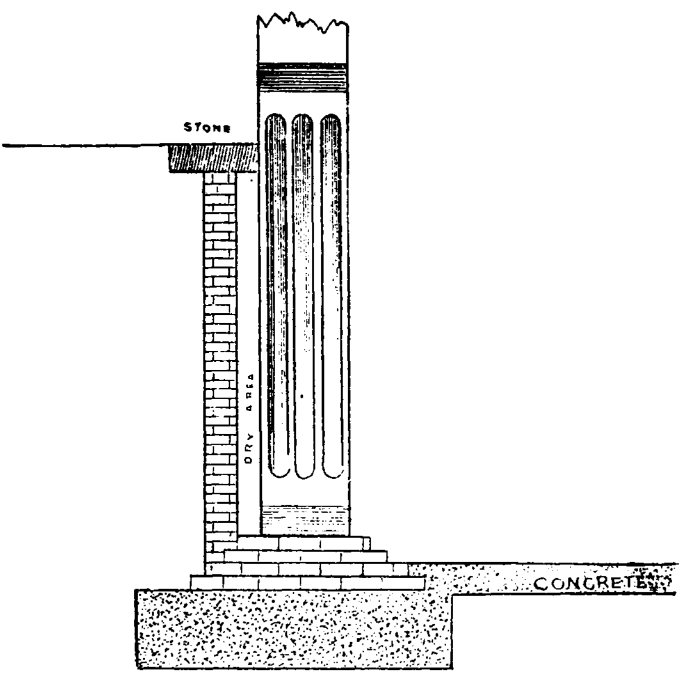



Fig. 9.—Damp-proof course.

each side. The house should have a plinth well raised above the ground-level so as to exclude damp and ground air. Raising the house on pillars and arches in addition affects this even more thoroughly by allowing free ventilation underneath.

**Walls.**—The walls are ordinarily constructed of bricks, stone or wood. Bricks are porous and absorb water very freely, and also allow air to pass through. It is, therefore, better to cover the bricks on either side with plaster which should be limewashed at least once a year. Again, a short distance above the ground-level, a layer of impervious material should be interposed into the structure of the wall so as to prevent moisture arising from the ground by capillary attraction and thus saturating the walls. This layer is known as the *damp-proof course*, and it may consist of stone slabs laid in cement and pointed with cement, asphalt, glazed bricks laid in cement, slates in cement or sheet lead.

The walls in India are generally two or three times thicker than in England. In the case of single-storeyed buildings they are usually 2 bricks thick, and those of double-storeyed buildings are 2½ or 3 bricks thick at the ground floor, and 1½ or 2 bricks thick at the first floor.

Hygienically they should have two layers with an intervening space to prevent their becoming too hot or too cold according to the season of the year. The top of this air space should always be covered by glazed tiles or stone to make it thoroughly non-conducting.

**Doors and Windows.**—Every living room should have at least a door and a window. The door should not be less than 6 feet by 3 feet. The window must open on to the external air, and must have an area equal to one-tenth of the superficial area of the room.

**Floors.**—The floors of dwelling houses should be made of an impervious material, which can be easily kept clean. The materials that are ordinarily used in India are rammed concrete plastered with cement, stone, bricks, tiles and marble. Seasoned teak boards closely jointed together are rarely used in India.

**Roofs.**—Roofs are either made flat or sloping, but in the case of flat roofs they should, however, be sufficiently inclined for free downward flow of rain water. In the construction of sloping roofs, tiles, thatch or corrugated iron sheets are used. Even in constructing roofs, double layers with an intervening space should also be provided as for the supporting walls. Thatched roofs are cool and dry, but they have the disadvantage of commonly sheltering birds, snakes and insects, besides their being exposed to the serious danger of fire. Roofs constructed of corrugated iron sheets become very hot during the summer.

Roofs should be provided with narrow channels all round to receive collections of water and provided with rain pipes at intervals to allow of an immediate discharge of them down below. In placing the rain pipes care should be taken that they are not placed directly against the walls, to prevent their absorbing moisture in the event of a breakage or leak occurring.

# CHAPTER VIII.

## HOSPITALS.

### GENERAL HOSPITALS.

**Site.**—The grounds on which a general hospital has to be constructed should be elevated and well drained, and the site should be easily accessible to the population for whose benefit it is intended. It should, therefore, be on or near a main road and in a healthy situation. Its area should be sufficiently large so as to provide for the future extensions as well as for present requirements. Ordinarily one acre of land should be allowed for every twenty beds, but in no case should it be more than forty beds. It is preferable to have a one-storeyed hospital, but from a point of economy of space a double-storeyed hospital may be erected, in which case, the clinical room, the X-ray department, offices, etc., should be on the ground floor, and the wards on the second story.

The hospital building should ordinarily be divided into an administrative block, an out-patient department and an in-patient department.

**Administrative Block.**—This is meant for housing the medical officer, the subordinate staff and accommodating the kitchen, store-room, etc. The nurses' quarters are usually built separately. Raised paths from one building to another should be provided. The block should be larger than is necessary at the time, in view of the probable extension of the hospital in the future. The laundry should be situated at some distance from this block. It should be provided with tanks for soaking soiled clothes, and sloping slabs or stones for washing purposes. There should be two small rooms made of corrugated iron and provided with doors, one of which will be used for temporarily storing soiled clothes, and the other for keeping clean clothes. An open corrugated iron or other shed is also necessary for drying clothes during the rains and for ironing them.

**Out-Patient Department.**—This should consist of a prescribing room, a dispensary and separate waiting places for males and females. A table should be placed in a side room behind a screen in a well-lighted place for the examination of patients. The dressing places for males and females should also be separate and screened off. In large towns it is also necessary to provide an operation room for performing minor operations requiring the patients to be anæsthetised. The steps of the out-patient building should be constructed of brick in lime mortar and the treads should be paved with stone slabs pointed with Portland cement, or they may be made of clinker brick on edge, or of brick rendered with Portland cement or 6 in. by 6 in. tiles laid in Portland cement. The floor should be paved with any suitable class of patent stone on 4 inches of concrete. The interior of all rooms should be painted with Paripan or other suitable, white, glossy, washable paint or a coat of Portland cement, ½ inch thick, but the operation room should be faced with white glazed tiled dado for a height of at least 5 feet from the floor and above this plastered with cement, ½ inch thick, and painted with Paripan. The exterior of all rooms should be plastered throughout with two coats of lime mortar.

**In-Patient Department.**—The wards of a general hospital should be built on the pavilion system with a small verandah on each side. The verandah on both sides keeps them cool and shady. They should be oblong, and should have their long axis directed from north to south, and should be separated from each other by a distance not less than twice their height. There should be separate wards for males and females, and for medical and surgical cases.

Each ward should be from 24 to 30 feet wide, and 12 to 15 feet high, and the length should be such as would allow 120 square feet of floor space to each patient and 1,200 cubic feet of air space especially where students and nurses are required to work in the wards. The minimum floor space approved by the Inspector-General of Civil Hospitals of the United Provinces of Agra and Oudh is 60 square feet and 810 cubic feet of space per patient. The windows should be opposite to each other, should have an area of one square foot for every 70 cubic feet of ward space and should reach within one foot of the ceiling. When within reach all windows should be pivoted at top and bottom. They must be covered by fine mesh wire gauze netting to keep away flies and mosquitoes.

The wards are ordinarily ventilated by keeping the windows open so as to allow cross-ventilation, but an arrangement should be made to bring in fresh air by means of tubes and to remove the foul air by constructing clerestory windows or openings in the ceiling especially for the cold and rainy seasons, when the windows are kept closed. The inlets in the form of tubes should be placed under the beds to prevent draughts.

The number of beds should be from 24 to 32 in one ward, but the main ward may contain 40 beds. The beds should be arranged with their heads to the wall facing into the ward, so that there should be a wide passage of about 11 feet between the two rows of beds. Each bed should be placed in an intervening space between two neighbouring windows, which should be at least a foot wider than the bed. Two beds may be placed in one space, if they can be so arranged as to have a distance of at least 3 feet between them.

In northern India it would be necessary to provide for the heating of wards during winter. This can be carried out by open fireplaces, ventilating stoves, or hot-water pipes. The cooling of the wards during summer can be best carried out by electric fans.

Separate bath-rooms and water closets or latrines for males and females should be provided in a corner away from the main ward, but connected to it by means of a covered passage, 10 feet in length.

The nurses' room, or what is commonly known as the duty room, should be at the near corner of the main ward, and should have a window overlooking it.

An operation theatre must be at such a place, where there is sufficient light and the least danger of dust. Big windows with ground glass panes should be placed in the northern and southern walls, so that, there would be enough light in the room, but no direct sunshine on the patient or the operator. No one should be allowed to enter the operation theatre without wearing an overall. There should be a gallery with a staircase leading on to the outside verandah, by which the students, not on duty, can enter and watch the operations.

A site for constructing a mortuary and a post-mortem room should be chosen, which is not objectionably in close proximity to the wards.

An observation ward should be constructed quite separate from the general hospital, and should be treated as a contagious diseases hospital. Doubtful cases as well as cases of cholera, tetanus, etc., should be treated in this ward.

It is desirable to have private wards for the convenience of middle-class people, who observe the *pardah* system, and who still want to be treated in the hospital. Each ward should be a perfect unit by itself, inasmuch as it should have a kitchen, a bath-room, a latrine and one more room, besides the ward itself. These wards may be constructed in one block, but separated by a partition wall, and removed from the general wards.

**Floors.**—The floors should, wherever possible, be laid with a gentle slope in one direction towards channels along one wall of the wards, or in the case of verandahs, towards the outside of the verandah to facilitate washing with water and disinfectants. The surfaces of all the floors must be continuous and not interrupted by the projecting door sills or thresholds. For flooring surfaces in wards, operation theatres and mortuaries, where an impervious unjointed floor surface is desirable, Bird's Indian patent stone, marble or the Bombay Co.'s Truscan floor enamel over ½ inch Portland cement are recommended by the Madras Sanitary Board. These materials readily lend themselves to the formation of channels along the walls.

**Walls.**—The internal walls of the wards, operation theatre, dispensary and mortuary should be rendered smooth with Portland cement from floor to ceiling and painted with Paripan "glossy," or other "glossy" white washable paint. They can also be made of an impermeable material, such as tiles or glazed bricks. All the internal corners should be rounded, and there should be no crevices or ledges which will allow the collection of dust. The external wall surfaces, if built of stone, should preferably be painted with cement, and if of brick, should be plastered and white-washed.

**Ceiling.**—The ceiling should be cemented or white-washed. Where jack arches are used, the tie bars should be embedded in the masonry of the arches.

**Doors.**—The door sills must not project above the floor level. Wherever possible, wooden door sills should be avoided. Flat panels should be used, as the raised panel doors catch dust. The doors in wards, operation theatres, dispensaries and mortuaries should not be less than 4 feet 6 inches between masonry jambs, so that there should be no difficulty for the stretchers to pass in and out.

**Furniture.**—The furniture in the wards should be as little as is compatible with the comfort of the patients and attendants. There should be no curtains, hangings or drapery of any kind. The bedsteads should be made of iron with spring wire mattresses, and should be 6½ feet long and 3 feet wide. The ordinary iron bedsteads with a durrie stretched across the poles by means of a string are very good, but they harbour bugs and lice. In the surgical wards, fracture beds with movable boards should be provided. The other furniture should be simple and strong, made of iron, where possible. It should be so constructed as not to harbour vermin, and made to be easily cleansed.

## MATERNITY HOSPITALS.

In India it is desirable that the maternity hospital should be quite separate from the general hospital, and there should be a separate establishment. It should be located near the centre of the population for whose benefit it is intended.

One unit should consist of two wards, and each ward should contain only four beds. There should be two separate delivery wards for each unit, one to be under cleaning, while the other is in use. Each unit should have a separate bath-room or scullery with plenty of water and means for disinfecting soiled clothing. The scullery and the latrine for the use of patients should be under a separate roof, but joined to the wards by a covered lobby open at both sides.

The floor space in the delivery wards should not be less than 150 square feet. It is a good plan to have a by-ward in connection with the delivery ward for the temporary care of specially exhausted cases.

The attendant's room and the store-room may be conveniently constructed at the corners of the verandah.

It is also necessary to have a waiting room for patients, and a well-lighted room for their examination.

## ISOLATION HOSPITALS.

These are ordinarily known as fever hospitals in Europe, and are used for the isolation and treatment of patients suffering from small-pox, scarlet fever, diphtheria, enteric fever, cerebro-spinal fever, infantile paralysis and typhus fever. These are of great value in combating the spread of infectious diseases and, must, therefore, be provided in all large towns and cities.

**Site.**—The site selected for building an isolation hospital should be far away from inhabited buildings, but should be easy of access. If the site is selected on the outskirts of a town or city, it should be sufficiently commodious as to provide a space of one acre for every twenty to thirty patients.

**Building.**—To ensure thorough isolation the hospital building should be at a distance of 40 feet from the boundary wall 6½ feet high, and should be of such a size as to roughly provide one bed for every thousand of the population, but this cannot be arbitrarily laid down as a standard, for it will depend more or less upon the characters and habits of the population, the incidence of infectious diseases and the number of diseases for which isolation is made compulsory. In

India cases of plague, cholera and small-pox are generally isolated in these hospitals, but there is no compulsory isolation of even these patients.

A large infectious hospital should consist of an administrative block for the medical officer, nurses, dispensary, kitchens, etc., wards for the accommodation of the sick and the accessory buildings, such as a mortuary, ambulance shed, laundry and quarters for the menial staff.

The administrative block need not be at a distance of 40 feet from the boundary wall, but should be at least this distance from the hospital wards.

**Wards.**—There should be separate blocks for the treatment of each disease, and each block should have two principal wards, one for males and the other for females. There should also be a special block containing at least two or three small wards to receive doubtful cases, before they are diagnosed and admitted into the principal wards. Bath-rooms and latrines should be placed in a block outside the ward, but connected with it by a cross-ventilated lobby. These blocks should be at least 40 feet apart from each other, and the same distance from the boundary wall. It is much better not to have any communication between the different blocks; however, they might be connected at right angles to their length by a covered corridor but open on both sides.

All the wards should, as far as possible, be on the ground floor, but if a double-storeyed building has to be used to economize space, the second storey must be reserved for the treatment of convalescent patients.

The wards should be rectangular in shape, and should contain ten or twelve beds, allowing 150 to 200 square feet of floor space, and at least 12 feet of wall space per bed, and 2,000 to 2,500 cubic feet of air space per patient. The windows should be situated on both sides, and should have an area of at least 1 square foot to every 40 cubic feet of ward space.

The wards are usually built on the pavilion system, but the cubicle system has lately come into vogue. This system is more favourable to the patients' recovery, and to reduce the risk of secondary infections and is more suited to Indian requirements. In this system a large ward is divided into a number of small rooms by means of partitions made of glass to a height of 7 feet. Each room is well lighted, and opens on to a verandah. It contains a bed and other necessary furniture, and is large enough to allow the patient between 2,000 and 3,000 cubic feet of air space. The nurse's room is situated near the centre of the block, so that she can supervise each of the cubicles while sitting in her own room. When a bath is to be given to the patient, a portable bath is brought into the cubicle.

The floors, ceilings and the internal surfaces of the walls should be made of impermeable material so as not to hold or absorb organic effluvia. The floors should be cleansed morning and evening with a 10 per cent. solution of hypochlorite of soda.

All soiled linen and dirty dressings must at once be placed in a disinfecting solution or in air-tight boxes, and carried to the laundry. Excreta and sputa must be mixed with a disinfecting solution, and removed from the wards at frequent intervals. They should then be mixed with solid refuse matters and burned.

Dishes, cups, spoons, etc., used by the patient should be collected and picked up by a nurse on duty with an antiseptic towel, and placed in a metal receptacle. This should then be carried to a special room, where they should be boiled and disinfected.

Basins containing disinfecting solutions should be kept on the verandah in which the doctor and the nurses should wash their hands on coming out of the ward.

The following are the regulations which must be observed in isolation hospitals:—

1. The medical officers and students should wear overalls on entering the wards, and should wash their hands on leaving.

2. The nurses must not leave the hospital premises without changing their outer clothing, which should consist of cotton material.

3. The relatives visiting the patients should wear overalls on entering the wards, and should wash their hands and faces on leaving. They should be warned not to enter any public conveyance immediately on leaving the hospital.

4. Tradesmen must not be permitted to pass beyond the boundary wall.

5. Convalescents should be given a hot bath, and their clothes disinfected before they are discharged from the hospital.

**Temporary Hospitals.**—Where the construction of permanent hospitals is not possible owing to the cost, necessary materials should be kept ready for erecting temporary hospitals, so that there should be no difficulty in isolating the first case, as soon as an epidemic breaks out. In India most of the infectious diseases occur at regular periods of the year, and hence there should be no difficulty in erecting such a hospital a week or two before the actual outbreak of the disease.

The floors of the temporary wards should be raised at least a foot from the ground and made of concrete and cement. The roof should be made of corrugated galvanized iron sheets, and its ridge should be used for ventilation as well as the windows. It may also be thatched with grass as a temporary measure. The walls should be made of *jhamps* or matting, which should be so arranged that they can be lifted up at the sides of the ward, so that the patients may practically live in the open air with only a roof over them. The thatched roof and the walls can be easily burnt, when the epidemic is over. Instead of matting tents can be used, but the best tents are those, in which the four sides can be well raised during the day.

## SMALL-POX HOSPITALS.

In India there are no separate hospitals for the isolation and treatment of patients suffering from small-pox. They are generally removed to the isolation hospital, if one exists. But in England and other countries separate hospitals for small-pox are constructed, because small-pox cases, if admitted into a ward of the general isolation hospital, might convey the disease to other patients admitted into the hospital.

If it is necessary to erect a separate small-pox hospital, the following rules laid down by the Local Government Board of England should be observed in order to avoid all possible risk from aerial convection of infection :—

1. The site should be such as would not have within a quarter of a mile of it as a centre, either a hospital, whether for infectious diseases or not, or a work house or any similar establishment, or a population of 150 to 200 persons.

2. The site should be such as would not have within half a mile of it as a centre, a population of 500 to 600 persons, whether in one or more institutions, or in dwelling houses.

But this view is not shared by all medical men. Some are of opinion that the small-pox hospital is no danger to its next-door neighbours, if it is well screened and properly managed.

## CHAPTER IX.

### SCHOOL HYGIENE.

THE impressions of childhood are deep and lasting. Hence it is necessary that they should in all respects be sound. Neatness, tidiness, cleanliness, freshness of atmosphere, punctuality, and orderliness in school, leave impressions on scholars, which are likely to have lasting effects in their after-life. The hygienic conditions of the schools should, therefore, in all cases be of a vastly higher standard than those to which the scholar is accustomed in his own home.

**The School Site.**—The site selected for a school should be elevated to provide for suitable drainage, and sufficiently large and open to allow the free access of pure air and light. The area of the site should, on an average, be one-fourth acre for every two hundred and fifty scholars. In its immediate vicinity there should be no depressions, hollows, tanks, rivers or water-courses, large open drains, or premises in which insanitary trades likely to affect adversely the health of scholars are carried on. To afford an easy means of access to the scholars the site should be central but removed from the noise of traffic. In large towns and cities, where a quiet site cannot be obtained, the building should be set back at least sixty feet from the main street.

**The School Building.**—The school building should be constructed on a plinth at least one foot above the ground, to be increased in proportion to the humidity of the soil in the area selected. If an elevated site be not available, the plinth should be raised at least two feet. The immediate surroundings to a distance of half the breadth of the building, should be properly sloped. To ensure a dry and healthy site it is necessary to have a *pacca* drain surrounding the plinth and connected with properly sloped effluent drains, so as to lead away storm water to the general drainage of the neighbourhood.

Where the school building has to be divided into a number of class rooms, the modern tendency is to group them round a large central or assembly hall, but a better system is that in which the class rooms are placed end to end in one line and connected by means of a corridor, eight to ten feet wide, which runs along one side of the rooms. However, if it is considered necessary to have a central hall, in which all scholars can congregate together, it should be completely isolated from the class rooms, or at any rate it should be separated from them by ventilated corridors or verandahs.

The class rooms of primary schools should be on the ground floor but, if this is not practicable owing to the paucity of ground in large cities, upper storeys must be provided, but should not be more than two storeys. The stairs should, in that case, be fire proof, at least five feet wide and the doors at their foot must open outwards.

The Educational Board of England allows ten square feet of area per scholar, but in India the class rooms should be so constructed as to provide at least twelve square feet of floor area per scholar. The rooms should be more or less oblong since lighting and supervision can be more satisfactorily carried out than in a square room. Such a class room should be thirty feet long, twenty feet broad and at least fifteen feet high.

The floor of the class room should be made of concrete, tiles or stone flagging, or it may be of brick on flat, laid on *kankar*. It is preferable to have the floor made of hard wood and polished with beeswax, but it cannot be universally adopted on account of cost.

There should be no crevices in the floor, in which dust can lodge.

The interior walls of the class room should be painted or distempered to permit of regular washing, and should be of a greenish grey colour, since this increases the brightness of the room by reflecting light rays to a greater extent than other colours. The corners formed by the junction of the walls with the floor and the ceiling should be rounded off to facilitate cleaning. Unnecessary cornices or beams, or places, on which dust can settle, should be avoided.

The cleanest and most hygienic type of a roof is that of the jack-arch type, of *pacca* brick.

If, however, owing to the financial difficulties it is not possible to erect an ideal school building especially in small towns or villages, open air classes under shady trees should be held on a *pacca* platform raised at least one foot above the ground.

**Cloak Rooms.**—Cloak rooms are not considered to be so necessary in Indian schools as in European schools; but it is better to provide a distinct and separate room to place umbrellas and waterproofs used in the rainy season. These rooms should be well ventilated and capacious so as to allow a space of at least 150 square feet for every fifty scholars, and should be fitted with numbered pegs at a convenient height and at intervals of 12 to 15 inches, so that scholars may not exchange their caps, as ringworm of the scalp is often spread by their caps. It is desirable to have separate umbrella racks with proper drip channels.

**Orientation.**—The school building, if provided with only one corridor, should face north-west and south-east, and should have the corridor on the side which faces south-east so as to afford a maximum amount of sunshine and ample lighting. However, in the United Provinces of Agra and Oudh it is desirable that the school buildings especially of the high schools should face north and south so as to protect the majority of the class rooms from the hot westerly winds. Again those class rooms which are situated in the wings and whose doors face west can, if necessary, be cooled, with *khas tatties*, if used during the hotter part of the day.

**Lighting.**—Light should come directly from the sky, and should be sufficient to enable a scholar with normal eye-sight to read in any part of the class room with ease small print at 12 to 16 inches from the eye. The windows should be placed on both sides of the class room, so that the angle of incidence made by the falling of the sun's rays into the room should not be less than 25°, and the angle of aperture or arc of the sky should never be less than 5° of an arc in any part of the room. But the windows giving the chief light should be on that side of the room which is to be to the left of the scholars so as to avoid shadows being thrown on the paper when the scholar is writing. Windows in front of the scholars are apt to dazzle their eyes, while those situated on their back are likely to cast a shadow on their work. Both these should, therefore, be avoided. Skylights are also unsatisfactory, and should not be used to illuminate the class room.

The windows should be wide, and not too far apart. They should reach as high as the ceiling of the room and should open directly into the external air. The glass panes should not be too much broken up by wood work. The window sills should be four feet high from the floor, and the window area should be from one-fourth to one-sixth of the superficial floor area.

**Ventilation.**—Natural ventilation by means of the windows is usually sufficient to maintain the purity of the air in class rooms, but artificial means may be necessary for seasons when the windows are closed. For this purpose inlets and outlets should be provided on the pattern of louvres made of stone and built into the walls like a venetian blind. The inlets should be directed obliquely upwards and from without inwards, and placed at such a level that the lowest part of the louvred area is at least two feet from the floor, to allow of the ingress of pure air. These should be protected by wire netting on the inside to prevent their being tampered with by the scholars. The outlets should be placed higher up within one foot of the ceiling, should be directed from within outwards and upwards, and should be protected by wire netting on the outside to prevent the birds from entering and building their nests. They should also be provided with rain-protectors. To ensure thorough ventilation of the class rooms all the doors and windows should be thrown open during an interval of five minutes allowed after every period of school work. No one should be allowed to remain in the class rooms during this interval. The scholars would also be benefited by this interval, as they will have a brief but sufficient mental and physical relaxation, and will be better fitted to put their mind to the next class work.

**School Furniture.**—The most important articles of furniture in the class room are the seats and desks. These should be provided for each scholar separately. This plan is preferable to combined seats and desks for several scholars. The seats and desks should be of an adjustable pattern to suit the convenience of the scholars of all ages. They should be placed at a distance of 24 inches from the wall, and there should be an interval of 10 inches between the rows of seats. They should also be arranged parallel to one another and at right angles to the windows in the side wall on the left of the pupils occupying them.

The desks should not be of the box pattern as this leads to slovenly habits and the collection of undesirable odds and ends. An open shelf may, however, be provided, if desired. The desks should be from 15 inches to 18 inches broad, and should be inclined at an angle of 15 degrees for writing and 45 degrees for reading. The desk should overhang the seat by one or two inches so as to avoid stooping while writing. The height of the desk above the seat should be one-sixth of the scholar's height, *i.e.*, it should be such that when the scholar is sitting down, he can place both his forearms comfortably on the desk without raising or depressing the shoulders.

The seats should have a rounded front, should be 10 to 12 inches wide so as to give enough support to the upper parts of the thighs and should be so high that the feet of the scholars occupying them should rest square upon the floor. They should also be provided with a back, which should be hollowed out in such a way that the upper part of it may fit the concavity of the back and thus support the body in an erect posture.

Matting should not be allowed on the floor, if the seats and desks are used in the class. It simply harbours dirt.

In village primary schools, where money is the chief question, it is not necessary to provide the seats and desks, but the scholars can sit on the floor. In that case the teachers should insist that the scholars raise one knee and use it as a desk while reading and writing so that by adopting this posture the spinal curvature and undue compression of the thoracic and abdominal organs may not be produced. Moreover, in these schools, each scholar should be separately supplied with a piece of *moonj* matting or other material of this nature, and should be responsible for keeping his own mat clean. It should be renewed, when necessary.

Black boards should be dull black, not glossy, and should be provided with chalk-troughs to prevent dissemination of the chalk-dust. They must not be placed in good light. Maps should not be too glazed to be injurious to the eyesight of the scholars by looking at them for long periods.

All almirahs for books and school materials should be built into the walls to avoid the collection of dust. If this is not possible, the tops of the almirahs should be sloped to allow of easy cleaning; they should also be raised on legs at least 12 inches in height to facilitate cleaning underneath.

**Cleaning of Schools.**—At the end of every day's work the doors and windows of each class room should be opened wide, and the floor swept with a wet duster or with a broom after being wetted to keep down dust. Once a week the furniture should be removed from each room, the floors and window sills should be well scrubbed with hot water and soap, and the furniture should be replaced after cleaning it thoroughly. Once in a fortnight the rooms should be thoroughly sprayed with a disinfectant, such as izal or cyllin. All waste matters should be collected and burnt, or deposited in metallic dust-bins covered with closely fitting lids, and placed out of reach of the scholars.

**Water-supply.**—Every school should be provided with an adequate supply of pure drinking water. In cities where there is a municipal water-supply, the school should be connected with this, and taps provided in the compound in such number as is considered necessary. In other towns water should be obtained from a *pacca* deep and closed well, provided with a pump. If a pump is not provided, the well should have round its mouth, and sloping away from it, a platform with a marginal gutter opening into a *pacca* effluent drain, connected with the surface drainage of the locality, to carry off all surplus water. The well should be disinfected periodically.

Owing to the climatic conditions of the country it is necessary to store water in earthenware *chatties* to keep it cool, especially in summer. These *chatties* should be well covered with closely fitting lids, and should, under no circumstances, be placed under a staircase, or in an ill-ventilated dark room near a drain. They should be kept in double sets, so that one set might be used and the other kept exposed to the sun on alternate days. They should have a broad mouth to allow of a thorough scrubbing and washing every day. They should also be disinfected with potassium permanganate once a week. The drinking cups should be made of metal, and should be well rinsed each time before and after use in order to avoid the spread of infective diseases, such as diphtheria. The scholars should be taught to dip the lips into the water rather than grip the edges of the cup between the lips. The cups should never be dipped into the *chatty*, but a special man, preferably a Brahmin, should be employed to pour out water into the cups.

"Crystal stream" drinking fountains, which deliver a fine upward jet of water that can be received directly into the scholar's mouth without the use of a cup, have been recommended in England, but are unsuitable for the hot climate of India.

**Meals.**—A separate room should be reserved for taking mid-day meals. These should be either supplied by the school, or should come from the scholars' home, but the scholars should never be permitted to purchase eatables from ordinary food hawkers, who should not be allowed to enter the premises of the school except those who are licensed vendors allowed by the school authorities. They should keep their articles for sale in clean and covered utensils and in almirahs with wire-netting or glass cases, and should supply nothing but wholesome food and, if possible, quite hot.

**Play-grounds.**—Play-grounds must be provided for all schools for organized games, such as football, cricket, hockey, tennis, as also for physical drill and gymnastics, but these are not very essential for village schools, as a piece of waste land is generally available in the village, which may be used for play. However, it is necessary that the school should have a small compound enclosed by a boundary wall to afford a certain amount of seclusion to the school, and to prevent the straying of cattle into the premises.

All play-grounds should be square or oblong, not cut up by buildings, should be free from dust and well-drained. Their surface should be levelled, and covered with lawns or made of material such as asphalt or granolithic cement. The size of the play-ground should vary with the number of the scholars. The space should be at least 30 square feet per scholar. The whole play-ground should be open to the sun, but it is desirable that a portion should be covered in for use during rains. It is also desirable that a portion might be converted into a garden, if more space is available ; inasmuch as gardens have an educative value and, if well kept, improve the appearance of the school. Since all the scholars cannot take part in hockey, football, etc., it is very necessary that half an hour on each school day should be devoted to physical training in drill exercises in each class, so that their physical powers and mental faculties may be developed. This should be carried out in the open air or in a large room available with doors and windows open.

## HOSTELS.

The present tendency of building hostels for separate castes or communities should be discouraged. The scholars of all castes and creeds must live together, so that they may have a sort of fellow-feeling among themselves and have a wider outlook in life. The hostel building should have the front facing the north or south, but not the east or west. Each room of the hostel should be so constructed as to allow at least 50 square feet of floor area per scholar, and should accommodate two scholars. The height of the room should not be less than 15 feet. Each scholar should be supplied with a table, a chair and an iron bed with a galvanized iron or copper wire mattress. Wooden beds strung with *newar* or *moonj* should be condemned, as they harbour bugs and other vermin in large numbers. There should be a closed almirah fixed in the wall, one for each scholar, to keep his books and clothes. For the purpose of ventilation direct openings of an area of at least two square feet should be provided both in the front and back walls over the doors and windows. These should communicate directly with the outer air, be rain-protected and provided with small mesh wire-netting. A common reading room must be provided with a sufficient number of tables and chairs.

The illumination of the rooms should not be left in the hands of the scholars, as they are in the habit of using the inferior qualities of lamps, which are injurious to their eyes.

Each room should either be illuminated at night by a hanging lamp suspended in its middle at a height of 6 feet from the floor, which should be equal in candle power units to one-sixth of the floor area in feet, or each scholar should be supplied with a lamp having candle power of 8 or 10 units, and provided with a green shade to cut off direct light from falling on his eyes. The lights must be extinguished by 10 o'clock at night. Where electric light is available, inverted lamps should be hung up at a height of 6 feet from the floor in each room, and at intervals of 6 feet in a common reading room.

Separate dining-halls should be provided for Mahomedans, Christians and Hindus. Hindus, as a rule, do not use a dining-hall, but they must be encouraged to do so at least on festivals. These halls should be furnished with a large dining table, a sufficient number of chairs, and one or two hanging lamps according to the requirements.

Kitchens should have a *pacca* floor, should be provided with chimneys to obviate the soot and smoke nuisance, and should have proper drainage to carry away the sullage. These drains should be well flushed and properly cleansed twice daily. Proper iron receptacles having well-fitting lids to prevent the accumulation of flies, should be provided for collecting dry refuse. These should be emptied and cleaned twice daily after use. The doors and windows of the kitchen should be provided with fine mesh wire-netting to keep away flies. The doors should also be self-closing ones.

A bathing platform should be provided for bathing and washing purposes. This should have a marginal drain to carry away effluent water, and should be divided into compartments by erecting partition walls. Each compartment should be provided with a tap, if there is a pipe water-supply. When water has to be taken from a well, the platform should be constructed at some distance from it, and a reservoir of suitable size should be made to supply water to the taps. In addition to these, it is desirable to introduce one or more plunge or shower baths. If possible, each hostel should be provided with a swimming bath with clean water, where the scholars can learn the art of swimming, and enjoy their bath, especially in summer.

## SANITARY CONVENIENCES.

In towns where a sewerage system exists and a suitable water-supply is available, closets of the most approved type should be provided and connected with the properly made sewers. These closets should be of the wash-down, pattern connected with the flushing cistern. Trough closets should not be used. In all mixed schools separate closet accommodation should be provided for both the sexes. The number of closets depends upon the size of the school or the hostel, but the minimum should be one for every fifteen girls and one for every twenty boys. In addition to the closets, urinal accommodation is required for boys, and white glazed stalls, not slate slabs, should be introduced.

In towns and villages, where there is no system of a pipe water-supply and sewers, latrines of a separate system pattern should be provided with non-absorbent seats and walls. These should have an enclosure wall of fenestrated brick work. The provision of one latrine seat for every fifty scholars for day schools and two latrine seats for every twenty boarders for hostels is considered sufficient. In addition to these, a separate night latrine should be provided for each hostel.

Urinals having a surface of non-absorbent and smooth material, such as Indian patent stone, should be provided, so that the *moris* (drains) may not be used as urinals, or the scholars will commit nuisance anywhere in the compound of the school. Two urinals for every fifty scholars for a day school and one for every twenty scholars living in a hostel must be provided. In addition to these, removable urinals of the Donaldson iron bucket pattern filled with saw-dust or dry earth at the rate of at least one for every twenty-five boarders should be placed at convenient places in the courtyard of the hostel for night use. These should be removed altogether in the day-time, and cleaned and replaced at night. The latrines and urinals should never be included in the main school buildings, but should be built separately and at a distance of not less than 20 feet from the main building to which they may be connected by a covered way allowing of cross-ventilation. It is also necessary that the latrines and urinals as well as the school and hostel compound should be kept in a clean and trim condition not only for the sake of the health of the scholars, but also as an object lesson in cleanliness. For this purpose it is necessary to employ one or two sweepers whose work should be supervised by the head master of the school.

## PERSONAL HYGIENE OF SCHOLARS.

The age at which children attend school is very impressive, and it is, therefore, incumbent on their teachers to inculcate on the minds of their scholars the principles of personal cleanliness and the formation of regular and good habits by precept and example. They must, therefore, be tidy and clean in their person and clothing, punctual and orderly in their work, and of good moral character. They must also be trained in elementary physiology and domestic hygiene, so that they can teach elementary hygiene in schools.

Smoking, which is a very injurious habit, is now-a-days very prevalent among school-boys. Hence it should be strictly forbidden, and any scholar found in possession of a cigarette must be severely dealt with. The teachers themselves should make it a point not to smoke in the presence of their scholars. They should also explain to them the injurious effects of intoxicating drugs, such as alcohol, cocaine, cannabis indica and opium. Scholars coming to school in a dirty condition should be excluded therefrom, and not readmitted until they are clean. They should not be allowed to spit promiscuously anywhere on the premises of the school or hostel, and a notice prohibiting spitting should be put up in every class room, and in every room in the hostel.

The system of early marriage should be discouraged, as far as possible, by gradually excluding married boys from all schools below the 9th and 10th classes. At any rate married and unmarried boys should not be allowed to mix together.

The practice of self-abuse is unfortunately prevalent in schools. This is detrimental to the physical, mental and moral well-being of the scholars. It is, therefore, very essential that teachers should take every necessary step to eradicate this evil. Every scholar must take part in physical exercises or some game, so that he may have sound sleep. No scholar should be allowed to read pamphlets dealing with pornographic literature. Any one found in possession of such literature should at once be expelled from the school.

## MEDICAL INSPECTION OF SCHOLARS.

In 1907 the British Parliament passed an Act which provided for the medical inspection of school-children, and came into force in January 1908. In India no such law has been passed, but the Local Governments have made some provision for the inspection of school children by giving some special allowance to sub-assistant surgeons and assistant surgeons in their service, but this cannot be satisfactory. The Government of India should pass an Act which should compel the educational authorities to employ whole-time medical officers with registrable qualifications, whose duty should be to inspect and report periodically about the sanitary conditions of the school and the hostel as regards the site, drainage, lighting, ventilation, superficial and cubic space, furniture, equipment, play-ground, water-supply, kitchens, pantries and latrine and urinal accommodation, and to medically examine the school-children. In schools children are brought into intimate association with each other, so that there are ample opportunities for the spread of infectious and contagious diseases, but the institution of medical inspection would be very valuable in preventing the spread of these diseases, and would frequently lead to the timely treatment of minor ailments and defects by bringing them to their parents' notice. The medical officer should have the power to exclude scholars from school: (1) on the ground that their exclusion is desirable to prevent the spread of disease ; (2) on the ground that their uncleanly or verminous condition is detrimental to other scholars ; (3) on the ground that, owing to their state of health or their physical or mental defects they are incapable of receiving proper benefit from the instruction in the school. He should also be authorized to order the immediate closure of the school on the outbreak of an infectious disease, such as plague, influenza, diphtheria, measles, small-pox, or pneumonia. This extreme measure should, however, be adopted under very exceptional circumstances. In country districts where the children meet only at school, such a measure may be justified ; but in towns the children will frequently meet for play when the school is closed. The usual measure to be adopted would be to exclude from school the children from affected households. They should be allowed to return only when their house and clothing have been thoroughly disinfected, and they themselves are declared by a certificate from a medical practitioner that they are no longer infectious.

The following table gives the summary of rules regarding the exclusion of children from school on account of infectious diseases.

| Disease. | Period of exclusion of children suffering from disease. | Period of exclusion of children living in infected houses. |
|---|---|---|
| **Small-pox.**<br>**Cholera** | 1. Until the medical attendant certifies, if the case is treated at home.<br>2. Until after discharge from hospital. | Until seven days shall have passed after the date of the certificate from the Health Officer that the house is free from infection. |
| **Diphtheria.**<br>**Membranous Croup.** | 1. If the case is treated at home, until a medical certificate, based on three successive bacteriological examinations, is furnished.<br>2. Until a fortnight after the date of discharge from the hospital. | |
| **Scarlet Fever or Scarlatina.** | 1. Until the medical certificate is forthcoming, if treated at home.<br>2. Until a fortnight after date of discharge. | |
| **Erysipelas.**<br>**Enteric Fever.** | 1. Until the medical attendant certifies, if the case is treated at home.<br>2. Until after discharge from hospital. | Not to be excluded. |
| **Measles.** | At least one month. | All infants for 15 days from occurrence of the last case. |

| Disease. | Period of exclusion of children suffering from disease. | Period of exclusion of children living in infected houses. |
| --- | --- | --- |
| **Measles**—contd. | | Seniors not to be excluded if they have had the disease, or 15 days from occurrence of first case. |
| **Mumps.** | One month. | Infants for 3 weeks, or for such time as is considered necessary by the medical attendant.<br>Seniors for the same period as infants, if they have not had the disease; otherwise not to be excluded. |
| **Whooping Cough.** | As long as cough continues, but not to be re-admitted until at least 5 weeks from commencement of whoop. | Infants for two weeks.<br>Seniors for two weeks if they have not had the disease, otherwise not to be excluded. |
| **Chicken-pox.** | Two weeks or until every scale is off scalp or body. | Infants for two weeks.<br>Seniors for two weeks, if they have not had the disease; otherwise not to be excluded. |
| **Ringworm.**<br>**Favus.**<br>**Scabies.**<br>**Ophthalmia.**<br>**Trachoma.** | Until medical certificate is obtained that the child is cured. | Not to be excluded. |

| **Disease.** | Period of exclusion of children suffering from disease. | Period of exclusion of children living in infected houses. |
|---|---|---|
| **Consumption.** | Exclude if the disease is accompanied by coughing or spitting. | Not to be excluded. |
| **Leprosy.** | Exclude from school. | Children, if not affected, should not be allowed to live in the same house with a leprous patient. |

When primary education becomes compulsory, each child should be medically examined three times during his school course, *viz.*, once at the time of entry, once just before leaving and once at some intermediate period. At each inspection the height and weight should be taken and notes made with regard to sight, hearing, cleanliness, clothing, nutrition and the presence or absence of lesions in the heart and other organs. To keep a permanent record of these inspections it is better to have a medical history card for each scholar, to be kept in the custody of the head master. On transfer of the scholar from one school to another, this history card should be sent to the head master of that school along with his transfer certificate.

The history card should contain the following headings :—

Register No..........................................................
Scholar's name..........................................................
Father's name..........................................................
Surname, if any..........................................................
Caste..........................................................
Residence..........................................................

Date of birth..............................................................
Date of admission to school...........................................
Date of primary vaccination ......................................
Date of revaccination (1)............................................
(2)............................................

| | | | |
|---|---|---|---|
| Name of school. | | | |
| Date of Inspection. | | | |
| Physical development and state of nutrition. | | | |
| Cleanliness and condition of clothing. | | | |
| Cleanliness and condition of scalp. | | | |
| Eye diseases. | | | |
| Vision. | | | |
| Ear diseases. | | | |
| Hearing. | | | |
| Speech. | | | |
| Heart and circulation. | | | |
| Tuberculosis. | | | |
| Infectious and contagious diseases. | | | |
| Malaria, Acute. | | | |
| „ Chronic. | | | |
| Other diseases. | | | |
| General Remarks. | | | |
| Medical Officer's signature. | | | |

**Special Schools.**—Separate special schools should be provided for mentally defective children; but it should be remembered that many of the children who are regarded dull and backward by their teachers are proved to be so only because they are suffering from defective vision or defective hearing probably due to the adenoids and enlarged tonsils. Others are so called because they are word blind as a result of some defect in the conditions between the receptive and perspective centres in the brain.

Special schools should also be opened for the blind, deaf and dumb.

# CHAPTER X.

## CLIMATOLOGY AND METEOROLOGY.

### CLIMATOLOGY.

**Climatology.**—Climatology deals with the combined effects of the atmospheric and earthly conditions with reference to their suitability to animal and vegetable life.

The principal factors determining the climate of a locality are:—(1) The latitude with reference to the terrestrial equator; (2) The distance from the sea-side; (3) The altitude; and (4) The prevailing winds. Besides these, there are a few other local conditions that are likely to modify it, *viz.*, proximity to cultivated lands, sub-soil drainage, presence of vegetation, neighbourhood of forests, congestion of dwelling houses and manufactories, if any, situated in the locality.

**Classification of Climate.**—Climate is classified on the principle of the latitude as follows:—

(1) **Warm Climate.**—This comprehends the sub-varieties, equatorial, tropical and sub-tropical, and prevails within an area of 35° on either side of the equator, within which, geographically speaking, are comprised Asia including India and China, Polynesia including all Australia excepting Victoria, Africa, North America south of California and South America north of Uruguay with the West Indies. Its characteristic features are prevalence of more or less high temperature, heavy rainfall and well-defined dry and wet seasons. In the equatorial region the temperature varies within a wide range of 54° F., and 118° F., the mean being about 84° F.; but the warmth is considerably lessened on account of heavy rainfall amounting, on an average, to about 40 inches in the year. The commoner affections that are attributable to warm climates are heat stroke, yellow fever, cholera, dengue, liver abscess,

dysentery, diarrhœa, small-pox, malarial fever and kala-azar.

(2) **Desert Climate.**—This is to some extent allied to warm climate, and is characterized by heat, dryness and greater purity of air. Pathogenic micro-organisms, specially those derived through a process of fermentation, are unable to thrive in such a climate as is evidenced by the comparative scarcity of cases of pulmonary consumption and the rapidity of healing of surgical wounds. An extreme variation of day and night temperatures is, however, commonly met with owing to a rapid radiation of heat from the sandy soils.

(3) **Temperate Climate.**—This prevails within the latitudes of 35° and 55°, which includes Central and Southern Europe with its islands, the part of Asia between the Mediterranean, the Black Sea and Japan, a large part of North and South America, South Uruguay, Victoria in Australia, New Zealand, Tasmania and numerous isles in their vicinity. It has four well-defined seasons with a greater rainfall in autumn and winter, and has a mean temperature varying between 50° and 60°F. The races inhabiting these localities with its influence are, therefore, naturally found to possess a more vigorous physique, but kidney and lung troubles as well as rheumatism, diphtheria and influenza are more prevalent in these regions.

(4) **Cold Climate.**—This prevails in regions lying within 55° from the poles. Here winter is severe and long, lasting for ten months and summer is short, often lasting a few weeks. Rainfall is scarce, while the fall of snow is abundant. Owing to a lack of vegetables and fruits, people suffer from scurvy, and they suffer from scrofula or tuberculosis owing to overcrowding and poverty prevailing there. However, dry and severe cold makes the inhabitants hardy and muscular.

(5) **Mountain Climate.**—This is to be found chiefly in places about 3,000 feet above sea-level, and is characterized by diminished atmospheric pressure, rarefaction and purity of air, and extremes of heat and cold. Besides, less moisture, a greater amount of ozone and the prevalence of strong winds are met with in the mountain climate. This climate is very beneficial to persons suffering from phthisis in an early stage without much congestion and bronchitis. Spots selected for them should be those which are sheltered from cold winds. It is no good for these persons to go and live in crowded houses or in the bazars without taking any precautions. It is also good for persons suffering from anæmia, spasmodic asthma without emphysema, and chronic pleurisy, but is bad for persons suffering from chronic bronchitis and emphysema, bronchiectasis, diseases of the heart and great vessels, affections of the kidneys and liver, and those of the brain and spinal cord. No patient should be allowed to go to the hills, who cannot take abundant exercise. The aged and very feeble persons should, therefore, be debarred from going there.

(6) **Marine or Ocean Climate.**—This denotes what prevails in islands, capes and at sea-side places, and is characterized by an equable temperature, greater humidity and a copious rainfall. The atmopshere in these regions is rich in ozone, and free from dust and germs. Rheumatism is, however, common in such a climate but, on the other hand, lung diseases, such as bronchitis, emphysema and congestive phthisis are often cured by a change to such a climate.

**Climate in relation to Health.**—The human body has got wonderful powers of adaptability which enable it to accommodate itself with varying climatic conditions; yet the various races have also well-defined limits of endurance; and, if placed under conditions which would tax them beyond such limits, their health is liable to deteriorate considerably. For instance, the health of Europeans has been known to suffer largely when they come to reside for long in tropical countries. On the contrary the dark races of the African tropics, in migrating to temperate climates, become markedly predisposed to pulmonary complaints, especially phthisis.

Apart from the injurious influences of extreme climatic conditions there are certain affections met with amongst Europeans in India that are directly attributable to improper and unsuitable diet.

## EFFECTS OF TEMPERATURE.

(*a*) **Cold.**—Prolonged exposure to cold causes contraction of the surperficial blood vessels, and specially the terminal arterioles of the extremities resulting in frostbite and gangrene of the fingers and toes. It further causes lassitude, torpor followed by deep sleep, insensibility and coma. Sometimes such attacks of torpidity are varied by those of delirium.

(*b*) **Heat.**—The effects of the direct rays of the sun on the body are, when not very powerful, highly beneficial, as is evident by comparing the pale faces of the people living in insanitary buildings of the cities into which they do not have access, with the ruddy cheeks and vigorous appearances of those living in the open localities in villages and towns ; and it is truly said that "Where the sun does not enter, the physician will." But prolonged exposure to heat whether in the sun or in the shade produces marked physiological disturbances.

Heat diminishes the number of respirations from 16.5 (England) to 13.74 and even to 12.74 in the tropics. Water exhaled from the lungs is diminished, and so is the amount of urine and urea. On the other hand there is a great increase of perspiration. This may lead to an irritation of the sweat-glands known as prickly-heat.

As successful remedies for prickly-heat all contain antiseptics, there can be no doubt that the disorder is due to a microbe whose growth is favoured by the abnormal activity of the sweat-glands. The process of metabolism suffers largely, resulting in a loss of appetite, and the liver becomes congested and indurated. Apart from malarial and other parasitic diseases peculiar to tropical countries, continued residence in them may also bring about a sort of languor, both mental and physical, premature senility and a general lowering of the expectation of life.

The human body can adapt itself to large variations of temperature with the perspiration invoked by its excess, but directly this process happens to be in abeyance, this heat-regulating state of equilibrium comes to be disturbed, and as a consequence injurious effects of heat-stroke manifest themselves. The most enervating effects of heat are experienced, when it is continuous and associated with considerable humidity. Heat can be better tolerated, when the air is in motion than when it is still.

(*c*) **Humidity.**—A large amount of humidity in the surrounding air offers an injurious check to a process of free cutaneous perspiration and respiratory evaporation; besides, it is liable to foster attacks of coryza and respiratory catarrh. It also prevents the free radiation of heat from the earth, and favours putrefaction. Malarial fevers, plague and small-pox are said to flourish in a humid atmosphere.

(*d*) **Rainfall.**—This exerts a beneficial influence by reducing the atmospheric moisture and by washing down impurities and microbes contained in the air, but in excess it becomes a source of serious danger on account of its carrying down a very large number of disease-bearing germs into tanks and wells, the stagnant water of which eventually aids their considerable proliferation. A considerable amount of rain also exerts a sort of relaxing effect on the climate of a locality.

(*e*) **Atmospheric Pressure.**—The effects of diminished atmospheric pressure are felt at an altitude of 5,000 or 6,000 feet and over. They consist in an increase in the pulse rate and in the number of respirations, as also in mountain sickness with giddiness, vomiting and possibly bleeding from the nose and ears. Persons migrating to high altitudes first complain of shortness of breath. Owing to the rarefaction of the atmosphere, the respirations become fuller and deeper with a view to obtain the required amount of oxygen. The mountain races are, therefore, found to possess broad, deep chests, and well-developed muscles with a vigorous heart and vascular system; they are thus capable of enduring a considerable amount of exertion as is needed in walking uphill.

The effects of increased air pressure are specially observed amongst divers, miners and workmen in tunnels and caissons. The circulation of blood amongst them is slower the number of respirations lesser and they also complain of ringing and deafness of the ears as well as a feeling of giddiness, and suffer from attacks of epistaxis, hæmoptysis, nausea and vomiting. These conditions may sometimes culminate into one of unconsciousness.

## METEOROLOGY.

Meteorology is the science which treats of atmospheric phenomena in relation to weather and climate. The principal factors requiring systematic observations and records are the atmospheric pressure, temperature, humidity, the force and the direction of winds, sunshine, the presence or the absence of clouds, mists, fog, storms and rainfall.

**Atmospheric Pressure.**—The atmospheric pressure is

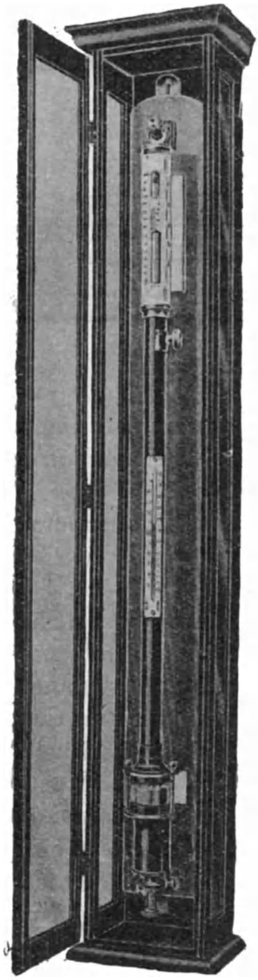


Fig. 10—The Barometer.

measured by an instrument known as "barometer," consisting of a cistern of mercury mounted by a scaled glass tube about 34 to 36 inches long, and in addition provided with arrangements enabling the correct reading of the mercury column even to a variation of one-thousandth of an inch. A vernier and a thermometer are attached to it.

The location of a barometer is, however, important. It should be suspended in a correctly vertical position in good light, but away from direct sunlight and sources of a tropical heat.

**Temperature.**—Several kinds of thermometers are used in the observatories in India for recording the temperature. The following are a few in common use:—

(1) The standard or dry bulb thermometer for taking temperature at the moment of observation.

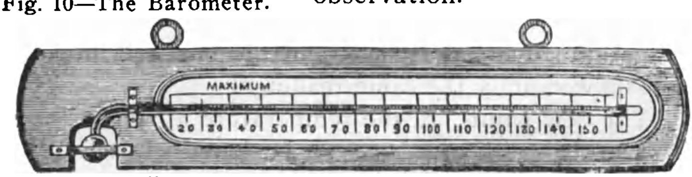



Fig. 11—The Maximum Thermometer.

(2) The maximum thermometer for registering the highest temperature attained in the day or in any other period. Mercury is used in this thermometer.


Fig. 12—The Minimum Thermometer.

(3) The minimum thermometer for registering the lowest temperature during the night or early morning. Coloured alcohol is used as an indicator.

Besides these, the following varieties of thermometers are also used for determining the humidity (*i.e.*, the dryness or dampness) of the air:—

(4) The wet and dry bulb thermometer, by which the humidity of the air at the time of observation is ascertained. This consists of two thermometers mounted side by side. One, the dry bulb, gives the temperature of the air. The other, the wet bulb, is covered with loose muslin or cotton wool, which dips into a small receptacle of water placed immediately below. Owing to evaporation from the muslin the temperature of the wet bulb is lower than that of the dry bulb. This difference in the temperature is connected with the humidity of the atmosphere, for if the air is dry, the evaporation will be rapid, and the difference in the temperature will be great. If, however, the atmosphere is saturated with moisture no evaporation will take place, and the two thermometers will show exactly the same readings.

The dew point, *i.e.*, the temperature at which the air is saturated with moisture can be found when the temperatures of the two thermometers are known. The following formula may be used for the purpose :—Dew point=Td—F (Td—Tw), where Td and Tw represent the temperatures of the dry and wet bulbs, and F the factor opposite the dry-bulb temperature found in Glaisher's tables.

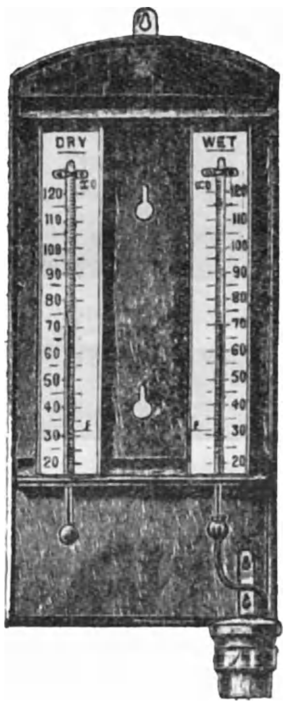



Fig. 13—The Wet and Dry Bulb Thermometer.

(5) The wet minimum thermometer by which humidity at the coolest time of the night is ascertained.

These thermometers must be freely exposed to currents of atmospheric air. In Indian observatories they are placed within a wire enclosure under a thatched shed. thus well secured against the inclemencies of the weather.

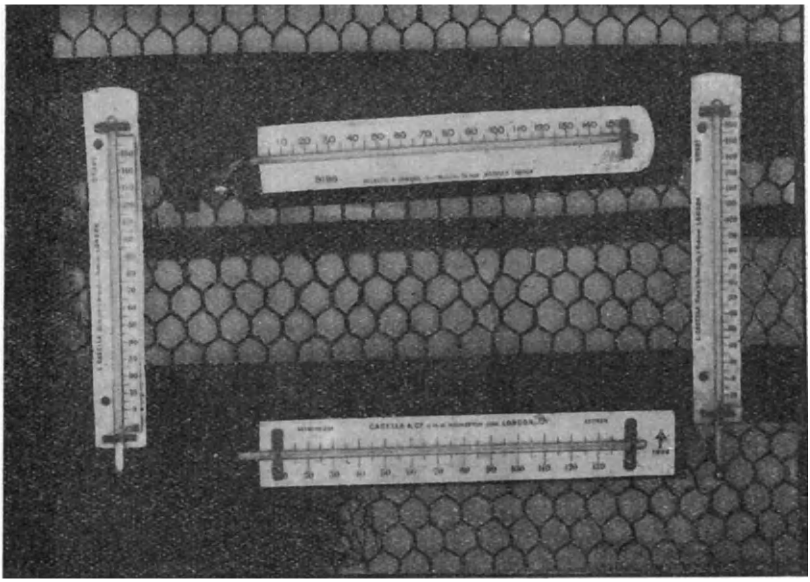


Fig. 14—Arrangement of Thermometers in an Indian Observatory.

**Winds.**—The direction of the wind is indicated by a vane commonly known as " weather-cock." An ordinary form of it consists of a balanced lever turning freely on a vertical axis, the broad end of which comes to be exposed to the prevailing current, while the narrower end points to the direction from which the wind may be blowing. It should be fixed on the highest accessible point. If on a building it should be fixed on its highest point and at least four feet above it. Large trees and buildings in the neighbourhood are always objectionable.

The velocity of the wind can be estimated by Robinson's anemometer, which consists of four small cups fixed at the ends of horizontal iron spikes of such a

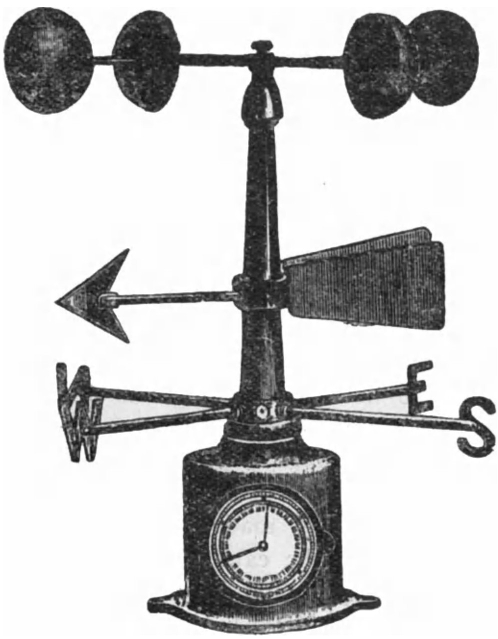


Fig. 15—Robinson's Anemometer with a Vane.

length as will enable it to measure a mile by 500 of its revolutions. By means of an additional contrivance consisting of clock-work and a dial, the number of miles traversed by the wind in a given time can be roughly determined. The anemometer should be placed at least 20 feet above the ground, and fixed as rigidly as possible to its supports so as to be free from all oscillating movements even in the strongest winds.

Winds are produced by differences in atmospheric pressure, which in turn are caused by changes in temperature and moisture. Whenever the ground is heated, the air in contact with it expands, rises, and so lessens the pressure, thus allowing the air from colder regions to flow in as wind. Winds are classified as permanent and periodic. The trade and anti-trade winds are permanent, and periodic are those which occur only at certain seasons, *e.g.*, the monsoon of the Indian seas. The land and sea breezes depend on the same principle.

**Sunshine.**—The hours of bright sunshine are recorded by instruments, called sunshine recorders. There are two varieties of them. One is called Campbell Stoke's sunshine recorder. It consists of a glass sphere, which focuses the sun's rays on a strip of graduated mill-board, making a burnt track, when the sun shines. The Millboard is so placed that the definite sections of it correspond to hours. The other is Jordan's photographic recorder, by which a straight line of sunlight is recorded on sensitized paper placed in two semi-circular dark chambers. A ray of sunlight is admitted through small slits made in the sides of these chambers. Owing to the earth's rotation the sunlight travels over the paper, and leaves behind a mark of its duration and intensity.

**Clouds.**—These consist of collections of condensed aqueous vapour, and are meteorologically classified into the four following principal types:—

1. Cirrus, or white and feathery-looking streaks, which are associated with south-westerly winds. They are the loftiest in elevation of all clouds, and are 20,000 to 30,000 feet above the earth.

2. Cumulus, or heaped-up masses, occurring at elevations of from 4,000 to 6,000 feet.

3. Stratus, or horizontal bands of cloud. These are usually seen at sunset, and foretell fine weather. They are the lowest in elevation of all clouds.

4. Nimbus, or dark masses discharging rain or snow.

Combinations of these varieties are commonly seen. They exercise a great influence on the temperature, preventing radiation from the earth's surface, and absorbing much of the heat radiating from the sun. The amount of cloud present in the visible sky is estimated by a scale 0—10, the former representing a cloudless sky, and the latter one wholly overcast.

Fig. 16—The Sunshine Recorder.

**Rainfall.**—The quantity of rain that falls is measured by an instrument called a rain gauge, which consists essentially of a copper circular funnel and a receptacle made of glass. The funnel is usually five inches in diameter. The water received is measured in a small graduated measure, the capacity of which is designed to indicate half an inch of rain. An inch of rain

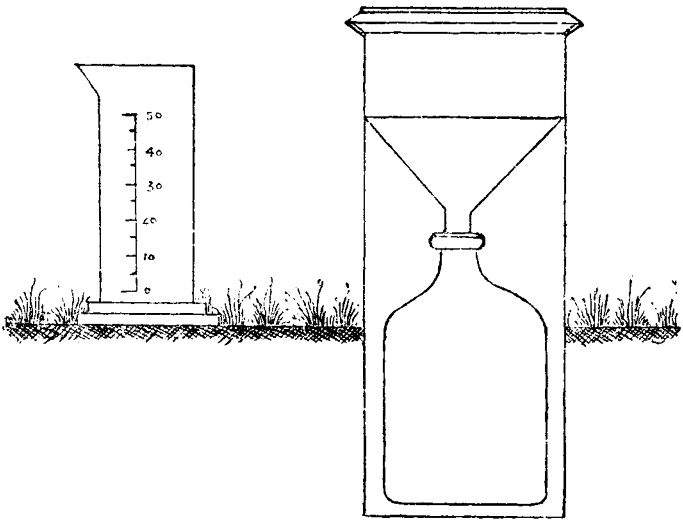



Fig. 17.—The Rain Gauge.

represents about 101 tons of water per acre, *i.e.*, 4.67 gallons per square yard. To measure hail or snow it is necessary to melt it by means of heat or by adding a known quantity of hot water. The rain gauge should be fixed in the ground to such a depth that the edge of the rim is at least 12 inches above the surface and perfectly level. It should be in an open place, as far from trees, houses and other obstructions as possible.

**Weather Forecasts.**—These are issued from the central meteorological offices, and depend to a large extent upon a knowledge of the barometric pressure and cyclonic and anti-cyclonic disturbances prevailing at various points over a very extensive area. The readings of the barometer taken daily at the same time (8 A.M.) at several places in India are telegraphed to Poona, where they are laid down upon a map or chart. On this chart lines called "isobars" are drawn connecting the places showing the same barometric pressure. These lines form circles or ellipses with, in some cases, the lowest, and in other cases, the highest pressure in the centre. A cyclone is formed, when the lowest pressure is in the centre. The anti-cyclone is formed in those cases, in which the pressure is highest in the centre.

# CHAPTER XI.

## FOOD.

FOOD, as ordinarily defined, consists of substances ingested through the digestive tract, where they, as a rule, undergo certain changes to befit them for assimilation. Food is a necessity of life, as it supplies nutrition to the body, repairs the body tissues and also constitutes a source of its heat and energy for the performance of work.

### CLASSIFICATION OF FOOD STUFFS.

These food substances are classified into organic, inorganic and food auxiliaries. The organic are again subdivided into nitrogenous, such as proteins or albuminates and non-nitrogenous, such as (*a*) hydrocarbons or fats, (*b*) carbohydrates, *e.g.*, starch and sugar, (*c*) vitamines, and (*d*) vegetable acids. The inorganic are mineral salts and water, and food auxiliaries consist of condiments, such as various sorts of Indian "masala's" and beverages, such as tea, coffee, cocoa, alcohol, etc.

**Proteins or Albuminates.**—Chemically proteins contain 16 parts of nitrogen, 54 parts of carbon, 22 parts of oxygen, 7 parts of hydrogen and 1 part of sulphur. They are derived from both classes of food—animal and vegetable.

Animal proteins are said to have the advantage of easy assimilation, but their metabolic products not being easily eliminated tend to accumulate into the system giving rise to various toxic and diathetic conditions; for instance, gout and certain derangements of the liver and kidneys.

Proteins may be divided into two groups. The first group consists of proteins, such as fibrin, myosin, glutin, casein and legumin, constituting true albumins. They are easily converted into soluble peptones and albumoses by the action of gastric juice in the process of digestion, and are thus more diffusible and easier of absorption into the blood and lymph streams. The proportion of nitrogen to carbon in them is nearly 2 to 7.

The second is known as the albuminoid group, which comprises substances derived mainly from animal tissues, such as gelatin, chondrin and keratin. Their nutritive value is very small, but they are largely used in the form of vehicles, such as jellies. The proportion of nitrogen to carbon in these is 2 to 5.5.

The nutritive functions of nitrogenous foods, therefore, lie principally in the formation and repair of tissues and in supplying the digestive and other fluids of the body. A certain proportion of them, by being decomposed directly in the blood, helps in the maintenance of animal heat and the development of energy.

**Hydrocarbons or Fats.**—These are compounds of glycerine and fatty acids, such as oleic, stearic and palmitic. They do not contain any nitrogen but only carbon, hydrogen and oxygen. In the process of digestion they are broken up, and emulsified by the pancreatic juice and bile, and are thus readily absorbed by the lacteal vessels; but a small portion of them is saponified. The chief function of fats is to repair and renew the fatty tissues, to supply energy and to maintain the body heat, derived through a process of their oxidation and decomposition into carbon dioxide and water. They also help in removing the effete products of the system. Animal fats are more easily digested than vegetable fats. If, however, there is an excess of fat in a particular dietary, it is liable to pass unchanged through the digestive tract and in its course to set up decomposition. The examples of fats are *ghee* or butter, olive and mustard oils, beef fat, etc.

**Carbohydrates.**—These are derived chiefly from vegetable food, and are taken mostly in the form of starch. They all contain carbon, hydrogen and oxygen, the two latter in proportion almost similar to that of water. By the action of saliva and the pancreatic juice the starch is converted into grape sugar; this is absorbed into the blood, and carried mainly to the liver, where it is stored up as glycogen to be given out to the system again as a source of maintaining the body heat by its eventual breaking up into carbon dioxide and water. As a result of their incomplete combustion adipose tissue may also be formed. They are also responsible for helping largely the digestion of proteins and maintaining reactions of various bodily secretions and excretions.

**Vitamines.**—These are organic accessory substances, existing in minute but sufficient quantities in most natural foods, and are necessary to the normal growth and nutrition of the body. They are, however, liable to be removed in the process of manufacture, or destroyed in the preparation of foods. Hence it is desirable that some raw food, such as salad or fruit, should be included in the daily dietary.

The nature of these vitamines is not yet known, but Funk is of opinion that they are crystalline and related to the *pyrimidins*. They are soluble in water, and alcoholic acids may be prepared containing them.

**Vegetable Acids.**—These are organic acids, the chief of which are tartaric, citric, malic, oxalic and acetic. They exist in fresh vegetables and fruits either as free acids, or combined with alkalies as alkaline salts; and form carbonates in the process of digestion which help greatly in maintaining the alkalinity of the blood and other fluids. If they are withdrawn from food, the blood becomes impoverished and scurvy usually results.

**Mineral Salts.**—The mineral salts, namely, chlorides, phosphates and sulphates of lime, soda, potash and magnesium, as also some iron salts must be included in the diet, as they help in building up and repairing the tissues of the body. The chlorides as represented by common salt keep in solution the cells of the blood and other fluids, and the hydrochloric acid of the gastric juice is also derived from them. The phosphates of calcium, potassium and magnesium contribute largely to the formation of bone, and iron forms an important part of the colouring matter of the red blood corpuscles.

**Water.**—Water happens to be the medium through which all chemical changes with regard to the nutrition and repair of body tissues take place. It helps to eliminate the effete products, to maintain the body heat by evaporation and acts as a solvent and diluent of solid foods, so that they may be easily digested and assimilated in the system.

## NUTRITIVE VALUE OF FOOD STUFFS.

The energy value of the food stuffs may be expressed as the heat produced during its combustion. The standard of this measure is the heat-unit or calorie. A calorie is the amount of heat required to raise 1 kilogramme or 1 litre of water 1° C. or 1 lb. of water 4° F. The calories may also be expressed in terms of work, as heat is also a mode of motion. The heat-unit may be transformed into the metric work unit by multiplying it by 425, and into the foot-pound unit by multiplying it by 3,060.

In the body the combustion of carbohydrates and fat is complete, but protein is not completely oxidized, being largely excreted as urea from the body. Rubner after careful investigation estimates that during digestion 1 gramme of protein yields 4.1 calories, 1 gramme of fat 9.3, and 1 gramme of carbohydrate 4.1. The amount of energy expended by a man at rest in the form of heat and of the internal work of the various systems is 2,500 calories per day. According to Voit a diet yielding 3,000 calories is regarded sufficient for a man doing hard muscular work, but according to the investigations carried on during the late War 4,500 calories were supposed to be necessary for the maintenance of good health of the soldiers. Hence the field service ration was raised to 3 lbs.

## STANDARD DIET.

While constructing ideal standard diets the daily loss of carbon and nitrogen has to be taken into consideration. A man weighing 70 kilogrammes or 11 stone excretes 20 grammes of nitrogen and 300 grammes of carbon in 24 hours. Assuming that proteins contain 16 per cent. of nitrogen, 125 grammes of proteins are required to supply 20 grammes of nitrogen. But according to Chittenden a little more than half the amount of proteins is advantageous both on the ground of health and economy. In the best diets the proportion of proteins to carbohydrates should be 1 to 5 and of fats to carbohydrates 1 to 8. The following is a table for the standard diet required for a European weighing 150 lbs. :—

| | Subsistence | Ordinary work. | Hard laborious work. |
|---|---|---|---|
| | oz. | oz. | oz. |
| Proteins .. .. | 2.0 | 4.5 | 6.5 |
| Fats .. .. | 0.5 | 3.5 | 4.0 |
| Carbohydrates .. | 12.0 | 14.0 | 17.0 |
| Salts .. .. | 0.5 | 1.0 | 1.3 |

According to Church the following table is for the standard diet for an Indian weighing 105 lbs.:—

| | Subsistence | Ordinary work. | Hard, laborious work. |
|---|---|---|---|
| | oz. | oz. | oz. |
| Proteins .. .. | 2.123 | 2.954 | 3.635 |
| Fats .. .. | 0.752 | 1.412 | 2.506 |
| Carbohydrates .. | 7.520 | 12.531 | 11.190 |

The above quantities are supposed to be dry or water-free food. Ordinarily solid food contains, on an average, 50 or 60 per cent. of water, so that in actual practice the quantities shall have to be doubled. Thus, the daily quantity of dry food required by a man doing no work is about one-tenth ounce for each pound of his body weight, and one-seventh ounce by a man doing ordinary work. Women require about 10 per cent. less than men, and children under ten years of age need one-half of a woman's allowance, but require more food per unit of body weight and a higher proportion of proteins. At 14 years they require as much as a woman. Brain workers need easily digestible food, in sufficient but not in large quantities, and preferably of animal origin. Again, habit, race and climate should be taken into consideration in selecting both the quality and quantity of a dietary. For instance, a largely vegetable dietary suits the constitution of an Indian and other tropical races better than an exclusively meat one ; while the contrary holds good in the case of Europeans and other races inhabiting the temperate and cooler climates.

**Calculation of a Diet.**—To calculate a diet the first essential point is to know the percentage composition of common foodstuffs, and then to employ the rule-of-three to determine the quantities of the proximate principles according to the standard diet. The following is a table showing the composition of the various articles of food:—

| Articles of food. | In 100 Parts. | | | |
|---|---|---|---|---|
| | Proteins. | Fats. | Carbohydrates. | Salts. |
| Raw Meat | 20.5 | 8.5 | .. | 1.5 |
| Cooked Meat | 27.5 | 15.5 | .. | 3.0 |
| Salt Meat | 30.0 | 2.0 | .. | 20.0 |
| Pork | 10.0 | 50.0 | .. | 2.0 |
| Fish | 16.0 | 5.0 | .. | 1.0 |
| White Fish | 18.0 | 3.0 | .. | 1.0 |
| Eggs | 13.5 | 11.5 | .. | 1.0 |
| Milk (Sp. gr. 1030) | 4.0 | 3.7 | 4.8 | 0.7 |
| Butter | 4.0 | 81.0 | .. | 2.5 |
| Cheese | 28.2 | 31.6 | .. | 4.2 |
| Wheat | 13.5 | 1.2 | 68.4 | 1.7 |
| Wheat, Fine Flour | 7.9 | 1.4 | 76.4 | 0.5 |
| Bread (Wheaten) | 8.0 | 0.5 | 50.0 | 1.5 |
| *Juar* | 7.67 | 2.77 | 67.26 | .. |
| *Bajri* (*Bajra*) | 10.4 | 3.3 | 71.5 | 2.0 |
| Barley-meal | 10.5 | 2.2 | 72.8 | 2.6 |
| Maize | 9.5 | 3.6 | 70.7 | 1.7 |
| Oatmeal | 16.1 | 7.2 | 67.5 | 1.9 |
| Rice | 6.5 | 0.6 | 79.1 | 0.6 |
| Rye Flour | 6.8 | 0.9 | 78.8 | 0.7 |

| Articles of food. | In 100 Parts. | | | |
|---|---|---|---|---|
| | Proteins. | Fats. | Carbohydrates. | Salts. |
| Gram . . . . . . . . | 21.7 | 4.2 | 59.0 | 2.6 |
| *Mung* . . . . . . . . | 22.7 | 2.2 | 55.8 | 4.4 |
| *Arhar* . . . . . . . . | 21.70 | 54.06 | 2.50 | 5.50 |
| *Urd* . . . . . . . . | 22.33 | 55.22 | 1.95 | .. |
| *Masur* . . . . . . . . | 25.47 | 55.03 | 3.00 | 3.33 |
| Peas (*Mattar*, dried) . . | 24.6 | 1.0 | 62.0 | 2.9 |
| Peas (*Mattar*, green) . . | 7.0 | 0.5 | 16.9 | 1.0 |
| Soy Beans . . . . . . | 35.3 | 18.9 | 26.0 | 4.6 |
| Arrowroot . . . . | 0.8 | .. | 83.3 | 0.27 |
| Sugar . . . . . . . . | .. | .. | 96.5 | 0.5 |
| Potatoes . . . . . . . | 1.5 | 0.1 | 23.0 | 1.0 |
| Bananas (yellow) . . . | 1.3 | 0.6 | 22.0 | 0.8 |
| Cabbage . . . . . . . | 1.8 | 0.5 | 5.8 | 0.7 |
| Carrots (fresh) . . . . | 1.1 | 0.4 | 9.3 | 1.0 |
| Ground-nuts . . . . | 24.5 | 50.0 | 11.7 | 1.8 |
| Almonds . . . . . . . | 21.0 | 54.9 | 17.3 | 2.0 |
| Walnuts . . . . . . . | 18.4 | 64.4 | 13.0 | 1.7 |

In England a diet containing 9 ounces of meat, 18 ounces of bread, 16 ounces of potatoes, 16 ounces of milk, 2 ounces of butter, and 3 ounces of oatmeal is considered quite sufficient; while in India a diet consisting of 4 ounces of meat, 24 ounces of wheat, 16 ounces of vegetable, 16 ounces of milk, 2 ounces of butter, and 3 ounces of *dal* is regarded quite liberal, and is generally taken by Sikhs.

Indian Sepoys on field service are supplied with a ration as follows:—

| | |
|---|---|
| Atta (Wheat flour), or Rice .. | 1½ lb. |
| Fresh meat (Only for meat-eaters) .. | 4 oz. |
| Dal .. .. .. .. | 3 „ |
| Ghee .. .. .. .. | 2 „ |
| Goor .. .. .. .. | 2 „ |
| Potatoes .. .. .. | 2 „ |
| Salt .. .. .. .. | ½ „ |

Table showing the rate of digestion of different articles of food :—

| Articles. | Time. | Articles. | Time. |
|---|---|---|---|
| | H. M. | | H. M. |
| Apples (cooked) | 1 0 | Cucumber . . | 4 45 |
| Banana . . . | 1 45 | Custard (baked) | 2 45 |
| Beef, boiled . | 3 0 | Eggs, boiled and hard (fried) . | 3 to 3 30 |
| „ roasted . | 3 to 4 hrs. | Eggs, boiled and soft . . . . | 3 0 |
| „ salted . | 5 30 | | |
| Bread . . . . | 2 0 | Eggs, raw . . | 1 30 |
| „ Wheaten . | 3 to 4 hrs. | Fish, boiled . | 2 to 3 hrs. |
| Butter . . . . | 3 30 | Fowl, domestic | 4 0 |
| Cabbage . . . | 2 9 | „ wild . . | 4 30 |
| Carrots . . . | 3 30 | Goose . . . | 2 30 |
| Cauliflower . . | 2 0 | Lamb . . . . | 4 0 |
| Cheese . . . | 3 30 | Lobster . . . | 2 30 |
| Crabs . . . | 4 0 | Mackerel . . . | 4 0 |

| Articles. | Time. | Articles. | Time. |
|---|---|---|---|
| | H. M. | | H. M. |
| Melons . . . | 3 0 | Pork, roasted . | 5 30 |
| Milk, boiled . | 2 0 | Potatoes, fried . | 3 30 |
| „ raw . . | 2 30 | „ roasted | 2 30 |
| Mutton, boiled . | 2 30 | Poultry . . . | 2 30 to 4 hrs. |
| „ roasted | 3 0 | Radishes . . . | 4 0 |
| Nuts . . . . | 4 0 | Rice, cooked . | 1 to 2 hrs. |
| Oranges . . . | 2 45 | Sago . . . . | 1 to 2 hrs. |
| Oysters, raw . | 2 3 | Sardines . . . | 3 15 |
| „ stewed | 3 30 | Shrimps . . . | 3 45 |
| Parsnips, cooked | 2 30 | Soles . . . . | 1 30 |
| Peas, green . . | 2 30 | Spinach . . . | 2 0 |
| Pears, ripe . . | 2 0 | Tapioca . . . | 1 to 2 hrs. |
| Pineapples . . | 2 45 | Tomatoes . . | 2 15 |
| Pork, boiled . | 3 30 | Turnips . . . | 3 30 to 4 hrs. |

## CONDITIONS REGARDING DIETS TO MAINTAIN HEALTH.

Even though food may be taken in due proportion of its necessary constituents it may fail to nourish the body sufficiently, unless the following conditions are also complied with :—

(*a*) **Digestibility.**—The digestibility of any kind of food depends upon its quality and its mode of cooking. Vegetable foods are ordinarily less digestible than animal owing to their containing a very large amount of indigestible cellulose.

(*b*) **Flavouring.**—Flavouring of food, if deficient or if not varied from time to time, may fail to invite a good appetite. Experience regarding prison and asylum dietary has shown that attention to varieties of flavouring improves noticeably the health of the inmates.

(*c*) **Uniform Quality of Food.**—Continued ingestion of a similar kind of food has commonly been known to impair the digestion. Hence perhaps the custom among Hindus of eating particular articles of diet on certain days of a week. The sameness cloys, and with variety more food is taken and a larger amount of nutriment is introduced.

Besides, there are a few other points equally important in reference to ingestion of food, which should also be taken into consideration.

1. **Time.**—The hours of meals should be fixed at due intervals and kept regularly. There must be an interval of from 5 to 6 hours between any two of them, so that the stomach may have at least an hour's rest after the products of gastric digestion have left it after physiologically fixed periods of four hours for active digestion. The hours observed by Indians generally with reference to their meals (midday and an earlier part of the evening) happen to be placed at injuriously long and unequal intervals. For men at work it is injurious to start their daily labour with an empty stomach ; they should, therefore, have some sort of a light meal before commencing it. An empty stomach also will predispose to attacks of chill and fever.

2. **Mastication.**—Food must be properly masticated, and for the purpose must be taken in small mouthfuls.

3. **Ingestion of Water.**—Water should not be taken in large quantities either before or during a meal, as it dilutes the gastric juice, and thus harms its digestive properties and predisposes to attacks of dyspepsia and indigestion.

4. **Cooking of Food.**—A proper mode of cooking is also an essential factor, inasmuch as it makes the articles of food not only tender, digestible and palatable, but also inviting to the eyes. The process of cooking specially at a high temperature kills almost all the germs of disease, and thus obviates a very common source of infection. The chief methods of cooking adopted are boiling, roasting, frying, and steaming.

Boiling helps the decortication of an indigestible coating of food materials. Boiled food is less tasty, but more digestible than when cooked in any other way. Meat should be plunged into boiling water, if it is desired to retain its nourishing substances within the mass. This makes it harden on the surface. This hard portion acts as a skin, and prevents juices of the meat escaping. If a rich broth is desired, the meat should be placed in cold water, and boiled slowly. Roasting causes considerable shrinking due mainly to loss of water. The principle in roasting is the retention of nutritive juices by the formation of a coagulated layer on the surface. Roasted meat is much more tasty than boiled meat, but does not digest so easily.

Frying consists in boiling the food in very hot fat or vegetable oil. Fried substances are often indigestible on account of the large amount of the oily matter, that penetrates into them.

Steaming is a good method of dealing with starchy foods. It is carried out by placing an article of food on a metal sieve which is then put in a pot of boiling water supported by pieces of a brick, so that only the steam reaches the article.

It may also be added that cooking utensils should be kept scrupulously clean and well tinned, especially if made of copper. As far as possible, boiling water should be used for washing them instead of dry earth which, though a potent source of infection, is commonly used in an Indian household. The floor and walls of a kitchen should be kept thoroughly clean, and washings and scraps of food should not be allowed to accumulate in it.

## DISEASES CAUSED BY FAULTY DIETING.

1. **Cooking of Food.**—Badly cooked food usually causes indigestion.

2. **Quantity of Food.**—An excess of it brought on through frequent feeding, or ingestion of an unusually large amount of it at a time, will bring on attacks of dyspepsia, constipation and irritative diarrhœa ; on the other hand, if its quantity be less than would be needed for proper nourishment, the health of an individual may generally fail on account of debility, prostration and anæmia.

3. **Quality of Food.**—Ingestion of food containing proteins, fat and carbohydrates in disproportionate quantities is liable to bring about serious digestive troubles. For instance, an excess of proteins will cause enlargement of the liver accompanied by dyspepsia, gout and albuminuria; the "banting" system of cure for obesity is, however, based on an almost exclusive use of protein dieting. An excess of consumption of starchy and, fatty foods, on the contrary, tends to produce corpulence, dyspepsia, flatulence and acidity, and delays nitrogenous metamorphosis. A sedentary habit largely abets an injurious accumulation of adipose tissue. In children an excess of starchy food predisposes to rickets.

Generally speaking, a deficiency of nitrogenous constituents leads to a loss of tissue proteins through oxidation causing loss of weight. A deficiency of carbohydrates or of fats can, however, be borne better for some time, but a simultaneous defect of both will very soon lead to a state of injurious malnutrition as will be evidenced by the onset of such debilitating diseases as scrofula and tuberculosis. The absence of vitamines from food brings about diseases (deficiency diseases), such as polyneuritis or beri-beri, scurvy and possibly rickets, sprue and pellagra. A deficiency of mineral salts also predisposes to rickets and scurvy, while a deficient quantity of water by preventing free elimination of waste products from the system is liable to bring on diathetic complaints like rheumatism and gout.

## ARTICLES OF FOOD.

### ANIMAL FOODS.

These contain much digestible matter, chiefly proteins, a considerable quantity of fat, in some foods carbohydrates, in addition to water and mineral salts. Being thoroughly digested they leave but little residue in the intestines. For convenience of description they are classified as meat, fish, eggs and milk.

### MEAT.

The flesh of many animals is eaten as an article of food by man in different parts of the world, but the animals from which it is derived in India are goats, sheep and buffaloes. The consumption of cow flesh is religiously forbidden to the Hindus, while pork is condemned similarly by the Musulmans and Jews. Meat contains proteins, fat and salts. The proteins contained in it are myosin, alkali and serum albumin, a globulin derived from the blood; and gelatin formed in the process of cooking from the connective tissue coat of the muscle fibres, vessels and nerves. About thirteen per cent. is duly assimilated. The amount of fat varies in different kinds of meat. It solidifies after death, and consists of stearin, palmitin and olein. The salts of meat are chiefly the chlorides and phosphates of potash. Besides these three principal constituents, some extractives are also contained in the composition of a meat dietary derived from the muscles, and are said to stimulate digestion.

Bones form about 25 per cent. by weight of the meat marketed ordinarily and contain albuminoids, fat and mineral salts. With them soup is largely made, and from their marrow a highly nutritive form of food is prepared and used largely in the treatment of anæmia.

**Diseases caused by Bad and Unsuitable Meat.**—Putrid meat produces symptoms of ptomaine poisoning consisting of those of acute gastro-intestinal irritation, such as nausea, vomiting, abdominal pain, diarrhœa, and general prostration. Other poisonous symptoms are manifested through consumption of the meat of animals that have fed themselves on poisonous plants, or have been drugged with irritants, such as arsenic and antimony prior to their slaughter. The use of the meat of animals that have suffered from infectious or acute inflammatory diseases must be entirely prohibited.

Microbes or parasites that ordinarily find access into the muscles of animals are destroyed in the process of cooking but the toxins, if present in large quantities, may yet give rise to symptoms of poisoning. The parasites that ordinarily infect the animals are tænia solium, tænia mediocanelata and bothriocephalus latus. When the meat of such animals is not properly cooked, the undestroyed cysticerci of the parasites are ingested, undergo certain changes and develop eventually into tapeworms in the small intestine of man. There is another parasite named trichina spiralis, infesting the muscles of pig, which causes a disease known as trichiniasis in man by eating partly cooked pork or sausages infested with this parasite. The symptoms are diarrhœa and loss of appetite followed by fever, severe muscular pains, contractions and coma. Death may occur in a few weeks. The early symptoms, sometimes, simulate enteric or rheumatic fever.

**Inspection of Animals and Meat.**—Animals, the flesh of which is ordinarily consumed by human beings, should be inspected before being slaughtered for the purpose. The animal should not be too young or too old. The age is ascertained from the teeth and the number of rings in the horns. The latter may be filed by the dealers. Signs of health like free and active locomotion and a well-nourished body, bright eyes and glossy skin should particularly be looked for. Besides, it should also be noted that the breath should not be offensive, the mouth and nostrils should not be discharging, and both circulation and respiration should be tranquil. A sick animal, on the contrary, moves slowly and has a rough skin, dry nostrils covered with foam, dull heavy eyes, a protruding tongue and evinces generally symptoms of laboured breathing. It should be specially noted that tuberculosis is commonly met with amongst cattle, pigs and poultry, and as it is easily transmissible to human beings, it is necessary to detect its presence. Its presence may be ascertained by an examination of cervical or abdominal glands likely to be found inflamed and enlarged, and the udders in the case of cows, which will be found similarly inflamed. In doubtful cases a definite diagnosis can be made by injecting Koch's "tuberculin," and by observing the resulting reaction.

Besides inspecting the animals, it is also necessary to inspect the meat. Good meat should be firm and elastic and of bright red colour (except in the case of pork and veal) and marbled with fat. It should not pit on pressure, nor should it crackle. There should be no hæmorrhages in its substance, as these are indicative of acute disease. The juice exuding from the muscle should be red in colour and acid in reaction. The odour should be fresh and pleasant. Putrid meat is pale and soft and later on greenish, giving off an offensive smell, and alkaline or neutral in reaction. It is always safe to thrust a long-bladed knife deep into the flesh, and to see if the blade emits an unpleasant smell. The fatty covering of healthy meat should be firm and pale yellow in colour and free from blood, while suet fat should be hard and white. The ribs, if found attached to meat, should always be examined for pleuritic adhesions, while the attached pleuritic membrane should also be examined for the presence of tuberculous nodules commonly known as "butcher's grapes or kernels." The lungs should be examined for the presence of inflammation and abscesses, the liver for the presence of distoma or liver fluke, the muscles for teniæ and trichinæ and the mouth, stomach and intestines for evidence of specific cattle diseases. Lastly, the mesenteric and pelvic glands should also be examined for the presence of caseating masses.

**Preservation of Meat.**—Meat is usually preserved by drying, salting, and by the application of cold or heat.

Meat can be dried by exposure to the sun or to fire. The flesh thus treated loses much of its water, becomes desiccated and inhibits the growth of putrefactive bacteria. Smoking is very often combined with drying in preserving meat. Salt is a very good chemical as a preservative of meat, though its nutritive value diminishes very much. The meat can be smeared over the surface with salt, or can be pickled in brine, which usually consists of 1 part of saltpetre, 32 parts of salt and 2 parts of sugar.

The fact that cold prevents the growth of bacteria is made use of in preserving meat, especially when it has to be shipped long distances. The meat may be kept frozen or may be kept in a chamber, the temperature of which is at or just below 0° C. Frozen meat does not keep long after it is once exposed to the ordinary temperature of the air.

Heat as a preservative is used when meat or any other article of food has to be canned. The meat is sealed in tins, which are then subjected to steam under pressure at 115° C. for an hour or two. The contents of the tins expand and cause bulging. A small opening is, therefore, made in the lid to permit of the escape of air, and then the opening is sealed with solder. The tin is then heated for another hour to complete the sterilization. Owing to the partial vacuum caused during sterilization, the ends of the tins are slightly depressed. The presence of gases resulting from putrefaction bulges out the ends of the tins. Such a tin will emit a hollow sound when struck with a mallet and a splashing sound will be heard, when it is shaken. On opening it the gelatin is found in a liquid state. Tinned foods may become poisonous from the absorption of metal; hence the tins should be condemned if on opening they show a blackened appearance due to the action of sulphuretted hydrogen formed prior or subsequent to sterilization. The tin. in which food is preserved, should never contain more than 1 per cent. of lead. The acid foods are more likely to be affected by lead or any other poisonous metal.

## FISH.

In India fish is extensively used as an article of diet by people inhabiting Bengal and the coastal towns. Fish must be eaten fresh, and as early as possible after being caught. Fish is at its highest state of perfection just before spawning, and is then said to be "in season." During spawning it loses its store of fatty matter, and becomes poor, thin, watery and flabby. It is then said to be "out of season," and takes time to recover its condition.

Fresh fish is firm, stiff and free from any disagreeable odour, and its tail does not droop if held up horizontally. The eyes are prominent and full, with dark pupils, the gills are bright and red and the scales are full, firm and not easily detachable or rubbed off. In warm climates it rapidly decomposes. There is also a well-known proverb that fish should not be eaten in those months in which there is no "r." Thus in the months of May, June, July and August it should not be eaten, as it is likely to get decomposed rapidly owing to heat.

A putrid fish has dull, grey and sunken eyes and grey slimy gills, is inelastic and emanates a disagreeable odour, and its skin peels off easily. If eaten, when decomposed, it produces symptoms of acute gastroenteritis, *viz.*, vomiting, diarrhœa and prostration. Fish is also liable to certain parasitic infection, for instance, the cysticercus of bothriocephalus latus. Mussels and Oysters growing in sewage-polluted water have been known to convey the germs of cholera and enteric fever. They are also sometimes responsible for giving rise to symptoms of gastro-intestinal irritation simulating a choleraic attack. However, fish forms an important article of diet, specially for the sick and invalid, owing to its being easily digestible and nutritious.

Fish was formerly considered to be a very valuable article of diet for brain-workers on the presumption that phosphorus was essential for such men and that it was largely present in the fish; but there is no justification in either of these beliefs. Fish can be preserved by various methods as drying, salting, smoking, pickling and canning, but these methods modify its flavour to a great extent.

Salted fish, which is known as "Bombay ducks" or *Bomblas*, is relished very much, and is generally eaten with rice.

## EGGS.

Hens' eggs are usually eaten as food, though ducks' eggs and those of sea-fowls are also used in certain places. The egg consists of two parts, the white and the yolk, in the proportion of 67 to 33. The white contains chiefly albumin (egg albumin), with a trace of fat and a small proportion of salts; while the yolk contains a globulin with a larger amount of fat and salts. An average-sized egg weighs about 2 oz. A fresh egg should have a translucent centre when looked through in front of a candle or light, but in a stale one translucency is more noticeable at its top when held vertically on account of the presence of gases of decomposition. A good fresh egg will sink in a ten per cent. solution of common salt, and a stale one will float. Eggs can be preserved by covering their shell with oil, gum or wax, or with insoluble lime compounds.

Eggs are said to be the safest of all animal foods, as they are not liable to convey disease or contain harmful properties. There is no known infection of the hen transmissible to man through its egg. Every child in weak health should get from one to two raw eggs per day, preferably mixed with milk. An adult, who has tuberculosis or is predisposed to get it should take from 4 to 6 raw or half-boiled eggs in 24 hours. Boiled eggs coagulate the albumin, and hence are difficult to digest. One egg is equal to 4½ ounces of milk in nourishing value.

# CHAPTER XII.

## FOOD—(*Continued.*)

## MILK.

MILK is a typical example of a whole perfect food, as it contains all the constituents of a standard dietary in their nutritive proportions. It constitutes the staple diet for children till about the age of two years, but practically it is unable to stand as the only article of diet for healthy adults, seeing that, to derive the requisite nourishment a very large quantity of it, approximately nine pints, will have to be consumed. But such a large quantity containing, as it will, an enormously injurious amount of water cannot be conducive to healthy digestion. It, however, forms a very suitable article of diet for sick persons, especially for those suffering from weak digestion. All forms of milk are emulsions of fat containing proteins, carbohydrates and salts in solution in water.

The chief sources of milk and the average composition of each of its variety are as follows :—

| Kind of Milk. | Sp. Gr. | Total Solids. | Proteins casein-albumin. | Fats. | Carbo-hydrates, lactose. | Salts. | Water. |
|---|---|---|---|---|---|---|---|
| Mare's Milk | 1027 | 12.60 | 1.03-1.26 | 3.81 | 6.20 | 0.30 | 87.40 |
| Cow's Milk | 1032 | 12.83 | 3.02-0.53 | 3.69 | 4.88 | 0.71 | 87.17 |
| Buffalo's Milk | 1032 | 18.59 | 5.85-0.25 | 7.47 | 4.15 | 0.87 | 81.41 |
| Goat's Milk | 1032 | 14.29 | 3.20-1.09 | 4.78 | 4.46 | 0.76 | 85.71 |
| Ass's Milk | 1023-35 | 10.36 | 0.67-1.55 | 1.64 | 5.99 | 0.51 | 89.64 |
| Human Milk | 1035 | 9.22 | 1.24-0.75 | 1.21 | 5.67 | 0.35 | 90.78 |

As a nutritious article of diet milk plays an important rôle in the dietary of vegetarian Hindus. The usual custom is to take it early in the morning and just before retiring to bed. It should not be taken as a drink at meals, because it retards the process of digestion, and favours fermentation. Taken by itself, milk is antiseptic, but when used as a drink with other foods, it becomes an autotoxin.

Ordinarily cow's milk is largely used by human beings, but it contains a larger amount of casein and salts as compared with human milk; while it contains a lesser amount of the carbohydrate as represented by the proportion of milk-sugar in it. Thus during the process of digestion owing to a larger quantity of casein, it is likely to curdle more easily and produce indigestion. If it is used for infants under 9 months of age, the addition to it of a little water, milk-sugar and fat is necessary. Barley or lime water may also be added to it to help the formation of loose flocculent curd that is more easily digestible. Cow's milk differs in composition according to the age and the race of the cow, the kind of fodder used and the period in relation to calving.

Besides cow's milk, buffalo-milk, which is richer in fat, is used for human consumption. Ass's milk is very akin to human milk in composition, and is, therefore, largely used as its substitute. Infants in India, when artificially fed, are given ass's or goat's milk, whichever is more easily procurable.

**Preservation of Milk.**—In order to preserve it from fermentation and decomposition milk is either subjected to a process of sterilization or pasteurization. Sterilization is accomplished by repeatedly boiling milk in a vessel, which is then hermetically sealed at the boiling temperature. Its disadvantages are that it alters the taste of the milk and renders it less easy of digestion by destroying its ferments. Pasteurization consists in rendering the milk more or less sterile by keeping it at a temperature of 150° to 167°F. for from twenty to thirty minutes, and then cooling it rapidly to 40° or 45°F. It should always be kept cold; it however does not keep well for more than three or four days, and it is not certain if the tubercle bacillus is destroyed by this process.

Antiseptics, such as salicylic acid, boracic acid, borax, boroglyceride, sulphurous acid and formaldehyde are largely used as preservatives in European countries, but their use must be prohibited as they are harmful to health. It may also be preserved in a desiccated state, after its watery portion is evaporated completely by slow boiling ; or after it is concentrated and mixed with sugar, as condensed milk.

**Adulteration of Milk.**—The adulteration of milk in India has become so proverbial that it is almost impossible to obtain pure and fresh milk. The most common adulterant is the addition of water varying from 20 to 60 per cent. Sweet substances, such as *batasas*, molasses, treacle or sugar are added to raise the specific gravity and thus disguise watering. A large part of the cream is very often removed, and water is then added to make up the normal specific gravity. The addition of skim milk to whole milk is also a form of adulteration difficult to detect. Thickening agents, such as starch, flour, gum, dextrine and arrowroot, are, sometimes, added to milk. Annato, a vegetable colouring matter, is occasionally added with the object of concealing skimming or watering or to make the milk look richer.

**Analysis of Milk.**—The milk of cows and buffaloes is largely used in India. It is difficult to give the standard composition of milk for the whole of India, as the breeds vary in different parts of the country and consequently the amount of milk given by them. Dr. Joshi, of Bombay, gives the following as the average percentage composition of cows' and buffaloes' milk:—

| | Specific Gravity. | Total Solids. | Fat. | Solids not Fat. |
|---|---|---|---|---|
| Cows' Milk | 1030.87 | 13.9 | 4.85 | 9.04 |
| Buffaloes' Milk | 1028.87 | 17.36 | 7.62 | 9.66 |

It would appear from the above figures that the amount of fat in the milk of Indian cows and buffaloes should not fall below 4 and 5 per cent., respectively. Thus it is also apparent that the percentage of fat in the milk of Indian cows is higher than in that of European cows.

**Physical Characteristics.**—Pure milk, when placed in a glass vessel, should be quite opaque, white in colour, and there should be no deposit at the bottom. It should have a sweetish taste but no smell. When boiled it should not change in appearance. After standing for a while, a layer of cream should form on its surface, which should yield from 8 to 12 per cent. of cream.

**Chemical Examination.**—The chemical examination of milk consists in ascertaining its reaction, specific gravity, total solids and fat contained in it.

**Reaction.**—In reaction fresh milk is generally amphoretic, turning red litmus blue and turmeric brown. The strongly acid reaction shows that lactic or butyric acids have developed owing to the action of micro-organisms. The milk is strongly alkaline, if the cow is ill, or if much colostrum, or sodium carbonate has been added to it.

**Specific Gravity.**—The specific gravity is usually estimated by the lactometer. At a temperature of 60°F. it varies, as a rule, between 1027 and 1034, being less as fat is greater. The specific gravity falls 1° for each rise of 10°F., above 60°F., and at 60°F. there is a loss of 3° of specific gravity for every ten per cent. of water added.

**Total Solids.**—These are estimated by taking 2 c.c. of the milk in a flat shallow dish of known weight, and evaporating it to dryness over the water-bath and then in the water-oven for half an hour. If the dish is now weighed with the residue, the increase in weight is the amount of total solids in 2 c.c.

**Fat.**—The determination of fat is very important. The chief methods that are adopted for estimating the amount of fat are Werner-Schmidt's method, Adam's process and Leffman-Beam process.

**Werner-Schmidt's Method.**—This is a wet extraction method. It consists in taking 10 c.c. of the milk in a graduated Stoke's tube, and adding strong hydrochloric acid to the 20 c.c. mark, and heating until the mixture turns a brown colour. The tube and its contents are cooled in water, and ether is added to the 50 c.c. mark. The tube is firmly corked, and the contents are well mixed by inverting slowly ten to twelve times, and the fat is extracted. The tube is set aside to allow the ether to separate and become clear. 10 c.c. of the ether is taken and evaporated in a weighed platinum dish. The dish is dried, cooled and weighed. The increase of weight is the weight of fat dissolved in ether.

**Adam's Process.**—This consists in the use of a strip of Adam's fat-free paper to absorb a definitely weighed quantity of milk. The paper is then rolled up into a coil, dried in the water-oven for two hours, and the fat is extracted by ether in Soxhlet apparatus.

**Leffmann-Beam Process.**—For this process a special set of graduated flasks and a special centrifugal machine are used. Into one of these flasks 15 c.c. of the milk are introduced by means of a pipette, and then 3 c.c. of a mixture containing equal parts of amyl alcohol and strong hydrochloric acid, and these are thoroughly mixed. Then 9 c.c. of strong sulphuric acid are poured in slowly, 1 c.c. at a time, shaking after each addition. The flask is then filled up to the zero mark with a hot and freshly-prepared mixture of one part of sulphuric acid to two parts of water. It is then placed in the centrifugal machine, and centrifugalized for at least two minutes. On stopping the machine, the fat will be seen to have separated out as a layer on the surface, and the percentage is read off, each graduation representing 0.1 per cent. of fat by weight.

**Cane Sugar.**—The presence of cane sugar is found by adding a few drops of hydrochloric acid and 0.1 grain of resorcin to 10 c.c. of the milk, when a rose-red colour is produced.

**Starch.**—The presence of starch can be detected by adding a small quantity of a solution of iodine in potassium iodide to the whey, when a blue colour is produced.

**Microscopic Examination.**—When seen under the microscope, the normal constituents of milk are round oil globules of various sizes in an envelope and a little epithelium. The abnormal constituents are pus cells, casts of the lacteal tubules and epithelium in large amount. The added matters may be dirt, starch grains, etc.

**Bacteriological Examination.**—This is carried out to ascertain the number and nature of bacteria in milk. The milk within the udder of a healthy animal is ordinarily sterile, but it may easily be infected by a certain number of bacteria which may have gained entrance through the lactiferous ducts and teats. Hence fresh milk collected in the pail always yields 100 to 500 bacteria per c.c., but millions of bacteria are found in 1 c.c. of milk in India on account of the insanitary conditions of stables and the dirty methods by which the animals are milked. The pathogenic bacteria found in the milk are derived from—

1. The animal, *e.g.*, streptococci, staphylococci, tubercle bacilli, anthrax bacilli, foot-and-mouth disease germs and actinomyces.
2. The skin of the udder soiled with dry and wet dung, *e.g.*, several fæcal organisms.
3. The infectious material of human origin during the act of milking, storing or transit, *e.g.*, typhoid, diphtheria and cholera.

## DISEASES CAUSED BY MILK (MILK-BORNE DISEASES).

Fermented or sour milk, if given to children, causes vomiting, flatulence and diarrhœa, and may also cause thrush or parasitic stomatitis, if it contains *Oidium albicans* besides the ordinary lactic acid bacillus. If it happens to contain purulent matter derived from abscesses or pustular eruptions on the udders of cattle, symptoms of severe gastric irritation may set in. Being also liable to absorb gases freely, it may become contaminated with offensive emanations and effluvia when kept in an open vessel and may thus cause diarrhœa.

The diseases, which are most commonly transmitted to man by contaminated milk, are tuberculosis, typhoid fever, cholera, diphtheria, scarlet fever, septic sore throat and foot-and-mouth disease. Malta fever is said to spread through goat's milk. Very often the epidemic outbreaks of these diseases have been traced to a particular source of milk-supply from the following characteristics :—

1. The onset of the outbreak is usually sudden, and it declines rapidly, if the milk-supply is stopped. This is generally not the case in an ordinary outbreak of epidemics.

2. The cases occur among those families, where the source of milk-supply is the same.

3. Those who take the largest quantity of milk in the family suffer most, as they absorb a larger amount of the poison.

4. Rich families suffer more than the poor, as the latter, as a rule, do not use milk.

5. The incubation period in such cases is generally shortened.

As lactiferous ducts form an important excretory channel, foreign matters of a vegetable nature taken along with the ordinary fodder may affect the quality of the milk or may impart merely a disagreeable odour, during the process of their elimination. For instance, admixture of euphorbeous plants will cause diarrhœa, and of *rhus toxicodendron* weakness, vomiting and diarrhœa. But ingestion of turnips and diseased potatoes along with the fodder merely gives a disagreeable odour without affecting the quality of the milk.

## PRECAUTIONS AGAINST TRANSMISSION OF DISEASES THROUGH MILK.

1. Milk from a diseased cow, with sores on its udders or teats, must be condemned.

2. The udders and teats of the cow should be thoroughly washed before milking.

3. The fingers and hands of persons employed in milking should also be washed and cleaned scrupulously. Clean clothes should be put on in order to obviate all chances of soiling the hands during milking.

4. Persons employed in milking or in its distribution should themselves be free from infectious diseases, and must not even be in attendance on others suffering from them.

5. Vessels and receptacles for milk should preferably be well tinned or be made of enamelled iron, and should be treated with steam or cleaned with boiling water before use. Vessels made of lead, copper and zinc, being liable to chemical action, should not be used. Besides, they should have a tight-fitting cover to prevent infection and absorption of extraneous matters, and should never be kept open.

6. Milk-cattle should be housed in well-ventilated stables provided with openings on opposite sides for efficient ventilation. Their floor and walls should also be covered with impervious materials and provided with outlets for free drainage, and the feeding troughs should preferably be made of stone. They should also be groomed properly at regular hours daily for some time, and taken out in the open fields to allow free grazing and exercise.

7. Though boiling deprives milk of some nutritive value, yet it is by far the safest method of treating it, as a high temperature obviates all risks of infection.

8. The sale of unhealthy and contaminated milk should be made penal by Acts of Municipal legislation, and licenses should be issued by the Municipalities authorising its sale for human consumption.

## PREPARATIONS FROM MILK.

**Cream.**—If milk is allowed to stand for some time, its fatty constituents form a more or less dense layer on its surface commonly known as cream. These may also be separated quickly by means of a centrifugal machine. The amount of fat contained in cream varies from 18 to 25 per cent. It is yellowish-white in colour, and is largely used for feeding children when casein disagrees with them. The remaining thin part of milk left after separation of cream is known as *skim-milk*, which is largely used as an article of diet for children and dyspeptics. To thicken it, a certain proportion of flour or other starchy material may be added. Commercial cream is adulterated with albumin, starch and sometimes other insoluble substances.

**Junket.**—This is an artificial preparation of milk prepared generally by adding rennet to it and allowing it to stand until it curdles firmly. It is recommended for sick people either alone or sweetened with sugar.

**Whey.**—This is prepared by allowing milk to curdle by the addition of rennet or some weak acid while hot ; whey is then slowly collected by straining the curdled milk through a fine piece of muslin. It is a highly nutritious form of fluid food containing as it does not only all the sugar and salts originally present in milk, but also a substantial proportion (1.24 per cent.) of proteins and fat. If added to an equal quantity of cow's milk, the composition of the result very nearly approaches that of human milk. As an article of diet it has been found useful in many ailments specially in enteric fever and diseases of the alimentary canal.

**Butter-milk.**—The part of the milk left after separation of butter is known as butter-milk. It contains more fat and proteins than whey. It contains about 8 per cent. of milk solids. Since casein is present in it in a very finely coagulated state, it has been found to be more easily digestible and beneficial in cases of gastroenteritis.

**Curd.**—In India this is commonly called *Dahi*. It is formed when fresh milk comes to be acted upon by lactic acid bacillus which sets up a process of fermentation and breaks up milk-sugar into lactic acid. It is made by adding some *matha* to boiled and cooled milk and keeping it for some hours. It has been found particularly useful in cases of diabetes and gout. It has also been highly recommended even as an ordinary article of diet on account of its efficacy in preventing the injurious decomposition in the alimentary canal which is attributed by Metchnikoff to the presence of lactic acid bacillus.

**Koumiss and Kefir.**—These are forms of preserved milk containing a certain proportion of lactic and carbonic acids and alcohol. They are largely used in Russia and Tartary, and are prepared from mare's milk by a special process of fermentation. Of the two, koumiss may be prepared also from cow's milk, and being easily digestible and assimilable is largely used for dieting patients suffering from phthisis and other wasting diseases.

**Mawa or Khoya.**—As known in India, this is a form of desiccated milk prepared by a process of prolonged exposure of the milk contained in iron pans to a slow heat. It is largely used for preparing several varieties of Indian sweets. It should, however, be noted that even in this desiccated form it is liable to be infected by cholera vibrios and pus-forming micrococci, as the presence of all these has been demonstrated by Dr. Joshi's investigations.

**Rabdi or Basundi.**—This is still another Indian preparation of milk differing from Khoya, inasmuch as the milk is heated to such a degree as to give it only a thicker consistence rather than to completely desiccate it. As vendors expose it for sale in brass or bronze vessels known as *thalis*, it is very liable to be contaminated by disease germs. Ptomaines are also likely to develop when kept for long, giving rise to choleraic symptoms.

**Butter.**—This is prepared by churning the cream or curdled milk, when the fat globules contained in them tend to coalesce together and to entangle in their meshes some casein, serum and water. The average composition of butter is 8 to 12 per cent. of water, 1 to 3 per cent. of casein, 78 to 94 per cent. of fat and 0 to 7 per cent. of salt. Common salt to an extent of 2 per cent. is ordinarily used as its preservative. Good butter should neither be rancid, nor should it have an unpleasant smell. It is also liable to decomposition and when used in this condition gives rise to symptoms of acid dyspepsia.

**Adulteration of Butter.**—Water is the chief adulterant of butter. In a good sample of butter it should never exceed 16 per cent. Salt in excess, starch and boracic acid are sometimes added to butter, but the most important adulterant which is largely used in Europe and America is margarine. It is prepared by churning melted and clarified beef, or mutton fat with skim-milk. Sometimes it is mixed with vegetable oils, such as cotton, sesame, and cocoanut oils. The chief distinction between margarine and butter lies in the fact that the former contains only about half per cent. of volatile fatty acids soluble in water, and the latter contains nearly 8 per cent. Margarine is but little inferior to butter in its nutritive value, and is somewhat less digestible than butter.

**Ghee.**—This is clarified butter, and is largely used in India for preparing ordinary meals and various kinds of sweets. It is also used as such, being merely mixed with *dal*, rice and *chapatis*.

It is derived both from the milk of the cow and that of the buffalo. The process of its preparation consists in boiling and curdling the milk and in churning the latter diluted with a little water, when a large quantity of butter accumulates on its surface, which on being boiled again yields the fatty constituents in the form of ghee.

The fluid left after its removal is known in India as *chhas or matha* which forms a refreshing beverage, rendered delicious with the addition of a little salt.

Good and genuine ghee should be clear, white or slightly yellowish in colour, and agreeable in smell and should not become stale within a few months. But being largely consumed as an article of food in India, it is frequently adulterated with injurious forms of fat, both animal and vegetable. The principal adulterants are margarine and ground-nut, cocoanut and cotton seed oils. Boiled potatoes and plantains are also added to increase the weight and thickness of its consistence. In short, the adulteration of ghee is practised on such an unprecedented scale that it is time that Municipal legislation were directed towards a stringent enactment of laws to penalise the offence and to offer an efficient protection to its wholesome trade.

**Analysis of Ghee.**—After careful investigations Drs. Dutt and Ghose of Calcutta have adopted the following standard for ghee :—

| | Cow. | Buffalo. |
|---|---|---|
| Specific gravity .. | 911 to 912 | 911 to 913 |
| Soluble volatile acids in terms of deci-normal soda by Reichert Woolney method .. | 24 C.C. | 30.5 C.C. |
| Melting point .. | 34° to 35.5° C. | 34° to 36° C. |
| Oleo-refractometer at 45° C. .. .. | —32 to 35 | —32 to 35 |
| Butyro-refractometer at 40.5° C. .. | 41 to 42.5 | 41 to 43.5 |

The analysis chiefly consists in ascertaining fat contained in ghee, and in determining whether it is butter or animal fat or derived from vegetable oils. The following methods are adopted for this purpose :—

1. **Specific Gravity.**—This is usually taken by the Sprengel tube or the Westphal balance at a temperature of 100°F., this being the temperature at which there is the largest difference between butter fat and other animal fats. The specific gravity of pure butter fat varies between 911 and 913, and that of margarine from 901.5 to 906.

2. **Refractive Index.**—This is determined on a special instrument called a refractometer. At 35° C. it varies for butter from 44° to 49°, the average being 46°. Margarine gives about 54°, and cocoanut oil about 43°.

3. **Valenta Test.**—This depends on the intermiscibility of butter fat and strong acetic acid at a low temperature, whereas animal and vegetable fats mix at a much higher temperature. 3 c.c. of the ghee and 3 c.c. of glacial acetic acid (90 per cent.) are taken in a test tube. It is then immersed in hot water to heat the contents which are agitated all the while by a thermometer, and the temperature is noted when the ghee melts. For pure ghee the temperature should vary from 32° to 36°C., and for margarine the temperature is much higher, about 75°C., while an abnormally low Valenta figure indicates the presence of cocoanut oil.

4. **The Melting Point.**—To take the melting point of ghee, it is melted over a water-bath at a temperature of 60°C., and filtered. A capillary glass tube is then immersed in the ghee, and when about three-quarters full is placed in ice to congeal the ghee inside the tube. It is then fixed to the bulb of a thermometer, and both are dipped in water contained in a beaker with a little ice in it. The beaker is placed in another with water, and the whole is heated slowly over a flame, until the congealed ghee melts and rises. The temperature is then noted and recorded as the melting point. This varies in the case of pure ghee from 34° to 36°C. It is much higher in the case of animal fats, while lower in the case of vegetable fats.

5. **Wellman's Colour Test.**—This is a useful test for determining the presence of vegetable fats. One gram of ghee is dissolved in 5 c.c. of chloroform in a test tube to which are added 2 c.c. of phosphomolybdic acid and a few drops of nitric

acid. The contents are thoroughly mixed by shaking the tube. On allowing it to stand for some time a green colouration appears in the upper layer, if the vegetable fats are present in the ghee.

**Cheese.**—This is another preparation of milk consisting of coagulated casein and a variable proportion of fat, lactose and salts. It is prepared by adding rennet to milk. Good cheese usually contains twice as much nitrogen and three times as much fat as the same weight of meat. On an average cheese contains 33.9 per cent. of water, 4.2 per cent. of ash, 30 per cent. of fat, 4.3 per cent. of nitrogen and 27.3 per cent. of casein. It is a nutritious article of diet, and may form a substitute of proteins contained in a meat dietary. It is, however, difficult to digest unless thoroughly masticated. A special form of ptomaine known as *tyrotoxicon* is said to be elaborated during its fermentation, which causes vertigo, dryness of the mouth, nausea, vomiting, diarrhœa and collapse with cramps in the muscles.

## VEGETABLE FOODS.

These contain a lesser amount of proteins than animal foods, but contain a larger proportion of fats and carbohydrates. In addition, they contain a considerable amount of water and salts. They are not mostly digested in the stomach on account of the presence of starch which forms their chief ingredient, and which is not affected by the gastric juice. They are, therefore, mainly digested and absorbed in the intestine.

Vegetable foods are commonly grouped under the following heads:—

1. Cereals.
2. Pulses.
3. Roots and tubers.
4. Green vegetables.
5. Fruits.
6. Nuts.
7. Fungi.

**Cereals.**—These are wheat, barley, millet, maize, rice, rye and oats. They are all seeds of plants belonging to the natural order "graminacæ." These contain about 70 per cent. of starch and a proportion of proteins varying from 6 to 18 per cent. Besides, they also contain a small and varying amount of vegetable fat and salts.

**Wheat.**—This is largely used as staple food in many parts of India, except in Southern India where its place is taken by rice. Ordinarily two varieties of it are met with, *viz.*, the white and the red. For purposes of consumption it is ground into flour, while some of its by-products are *sooji* and *maida*. The chief nitrogenous substance present in wheat-flour is gluten, which may be obtained as such by adding water to flour and straining it through fine muslin. Besides 8 to 12 per cent. of gluten, it contains about 15 per cent. of water, 60 to 70 per cent. of starch and a little sugar and dextrine. From its composition it is thus evident that it is poorer in salts and fat, necessitating the admixture of both when used as an article of food.

A good quality of wheat-flour should be white or yellowish in colour, and must neither have a musty odour nor feel gritty when rubbed between the fingers. Old and bad flour, on the contrary, has a dark brown or deep yellow colour. Flour becomes unwholesome by storage in a damp place owing to the growth of moulds and fungi, and is apt to produce dyspepsia and diarrhœa.

Wheat-flour is ordinarily consumed by the people of India in the form of thin cakes known as *chapatis*. They are eaten quite fresh, since, if stale, they become rough, hard and difficult to digest. The by-products known as *sooji* and *maida* enter largely into the composition of several kinds of Indian sweets, which are, however, more difficult to digest than those prepared entirely from milk.

Bread ordinarily known as *double roti* in India is also used by certain classes of people, especially Europeans and the domiciled community of Anglo-Indians, and is prepared by adding yeast to the flour prior to baking with a view to give it a spongy consistence through the production of a large amount of carbonic acid gas, which is a product of fermentation of its starchy elements. If added in excess the unaltered yeast left in the bread gives rise to symptoms of acid dyspepsia. To prevent, therefore, the unpleasant symptoms arising out of incomplete fermentation, bread may be prepared by adding baking powders, containing sodium carbonate and tartaric or citric acid, or by forcing through the dough freshly prepared carbon dioxide gas under pressure. Alum, though it causes constipation and flatulent dyspepsia, is largely used to impart a fine white colour to bread and as a preservative against such injurious fermentation as makes it sour and unfit for consumption.

Biscuits are small well-baked cakes made out of a simple mixture of flour and water, but sometimes to improve their nutritive qualities or to make them more palatable, egg albumin, butter, milk or sugar are also added. They are said to be more nutritious than bread on account of their containing a larger amount of protein and carbohydrates bulk for bulk; besides, they keep well for long on account of their containing a very small proportion of water. On account of their condensed form they are more easily portable, and their provision is, therefore, largely requisitioned in campaigns and war.

**Barley.**—This is grown on a large scale both in temperate and tropical climates. It is known as *jau* in India. The whole grain when ground constitutes barley meal. It is unsuitable for making bread or *chapatis* owing to very little gluten contained in it ; hence it is mixed with wheat or gram flour before it is made into *chapatis.*

Barley water is used as a beverage for the sick and infants. Barley is also largely used as horse-food.

**Millets.**—Millets are largely grown in India, and used as food chiefly by the poor people. The chief varieties are *joar* and *bajra*. From a dietetic point of view they are less nutritious than wheat.

**Maize or Indian Corn.**—This is commonly known as *maccai* or *bhutta*. It contains a large proportion of fat and proteins, and is, therefore, a very nutritious article of diet. Its flour being deficient in gluten, it cannot be taken in the form of *chapatis*, but is ordinarily consumed in the form of porridge. Its fried seeds are commonly eaten by the poor after treating them with hot sand as is ordinarily done by "bharbhunjas." A special form of fungus is known to infect this variety of corn which causes pellagra in man.

**Rice.**—This is another staple food of Indians in many parts of the country, specially Bengal and Southern India. It contains over 78 per cent. of carbohydrates but a very small proportion of protein. It is also deficient in salts, and to make up these deficiencies it is taken along with other articles of food that are richer in proteins and salts.

Stored up rice of some standing is more easily digestible than that derived from a fresh harvest; the latter, when consumed, gives rise to symptoms of indigestion and diarrhœa. The usual practice of boiling rice in a very large quantity of water and of subsequently draining away the excess of fluid deprives it of much of its nutritive value, inasmuch as the salts in solution are also got rid of along with it.

As in the case of wheat the storage of rice in damp places is also injurious, seeing that excess of humidity not only sets up decomposition and makes it unfit for consumption, but, also when rice is used as an article of diet, it is liable to produce a specific disease, known as beri-beri.

**Rye.**—The black bread used in Germany is derived from rye. It is very nutritious, as it contains about 10 per cent. of proteins and 2 per cent. of fat, but it is very acid and unpalatable and apt to produce diarrhœa. Rye is also liable to be attacked by a fungus, known as ergot of rye, the prolonged use of which may give rise to the symptoms of ergotism, *viz.*, painful cramps in the limbs, and gangrene of the extremities.

**Oats.**—These are commonly known as *jai* in India. They contain a large amount of proteins, fat and mineral salts, and are, therefore, highly nutritious. Oatmeal is used in the form of gruel or porridge as it cannot be made into bread or *chapatis* owing to the lack of gluten.

**Pulses.**—These are the seeds derived from the plants belonging to the natural order "leguminosæ." Those that are chiefly used in India are *arhar* (*tuwar*), *moong*, *chana* (gram), *mattar* (peas), and *seims* (beans). These legumes contain a greater amount of proteins, vegetable fats and salts than the cereals. The protein present in them is legumin or vegetable casein varying from 17 to 35 per cent. This albumin generally contains in combination sulphur and phosphorus, which, while adding to its nutritive value, render it somewhat difficult of digestion, and are therefore likely to produce flatulence on account of albumin breaking up during the process of digestion into a large quantity of sulphuretted hydrogen. The salts contained in them are chiefly those of potash and lime.

They are eaten fresh as well as dry. Fresh seeds become soft and succulent by cooking, and so are easy to digest, but the dried ones are apt to lead to indigestion owing to a large amount of thickened and indigestible cellulose. It is supposed that the dried pulses are deprived of the vitamines contained in them, but if they are soaked in warm water and allowed to germinate, the vitamines reappear in 48 hours. Hence the practice of eating germinated pulses (*ghoogni*) among Hindus is most scientific from a health point of view. As pulses are largely used by the majority of vegetarian Indians in the form of *dal*, they are thoroughly decorticated prior to cooking, to render them more digestible. They are also used after being finely ground as flour, which latter enters largely in the composition of some forms of sweets and vegetable cakes.

These pulses are also liable to undergo decomposition if stored in an undried state or in a damp place. The use of decomposed pulses should be condemned as it is liable to cause vomiting and purging. *Masoor* or *kesari* (*Lathirus sativus*) when largely eaten is apt to give rise to a train of symptoms simulating that of spastic paraplegia ordinarily described as *lathyrism*. It is alleged that the specific poison giving rise to these symptoms is contained in the husk, and thus people, who are accustomed to use it thoroughly boiled and after the husk has been thoroughly separated, owe their immunity to these precautions.

**Roots and Tubers.**—These contain chiefly starch and sugar with a large amount of water, but very little of nitrogenous matter. As an article of food they are, therefore, less nutritive than both cereals and pulses. Their chief examples are potatoes, turnips, beetroots carrots, radishes, sago and arrowroot.

Potato is the most important member of this group. When properly cooked it is easily digestible. In order not to allow its salts to pass into water it should be boiled without peeling off the skin, or should be steamed or roasted in its skin. These salts are a great preventive against scurvy.

Sago and arrowroot, when cooked with milk and sugar, make an easily digestible food for sick people.

**Green Vegetables.**—Green vegetables are largely used in India. They contain about 90 per cent. of water, 2 per cent. of nitrogenous substances, about 4 per cent. of starch, about ½ per cent. of fat and a large quantity of alkaline salts combined with organic acids. They should always be made to contribute largely to a mixed or a purely vegetable dietary on account of their antiscorbutic properties. The principal ones possessing such antiscorbutic properties and in common use, are onions, brinjal, lettuce, salads, tomatoes, cauliflower and cabbage. Most of these vegetables are grown on soils treated with sewage or sullage water and are, therefore, liable to cause cholera, enteric fever and dysentery, or are apt to convey round worms, ankylostoma, etc., unless they are thoroughly cooked and boiled.

Green vegetables are also beneficial to persons suffering from habitual constipation, since a large quantity of cellulose contained in them is likely to aid in stimulating the intestinal peristalsis.

**Fruits.**—These contain a large amount of sugar, vegetable acids and salts besides water. They derive their pleasant taste from the constituent vegetable acids. Their prohibitive cost is, however, a bar to common use. Some of them, specially lemon, mango, papaya and tamarind, possess highly antiscorbutic properties. They should ordinarily be eaten when fresh and ripe after they are washed, as they are likely to be contaminated with dirt and other infectious material by the fruit-pickers, as well as by the vendors. The use of unripe or over-ripe fruits is harmful, as it is likely to produce diarrhœa and dysentery, and thus to predispose to choleraic attacks.

**Nuts.**—The chief examples of these are cocoanuts, almonds, walnuts and dry dates which are highly nutritious, and as they contain more proteins than carbohydrates, they are largely recommended for the use of diabetic patients.

**Fungi.**—The chief varieties of the edible fungi are the mushroom, truffle and morel. They have got very little nutritive value and are difficult to digest, but possess an excellent flavour.

**Food Auxiliaries.**—These include sugar, honey, salt, condiments and beverages which, though not nutritious themselves, are largely used for imparting a delicious aroma to articles of food and to render them generally palatable. They also help digestion by stimulating the healthy secretion of the gastric juice. Sugar, honey and salt are strictly speaking not included in food auxiliaries, but may conveniently be described here.

**Sugar.**—This is derived from the sugarcane, sugar-beet, sugar-maple, etc. Only a small portion of it is absorbed in the stomach, but the remainder is absorbed in the intestines without leaving a residue. Taken in excess it gives rise to acid fermentation and irritates the intestinal canal. It is a source of much energy and muscular power. The use of sugar lessens fatigue. Hence the custom among Indian labourers and cultivators of eating *goor* (treacle) with their *chabena* (parched gram and rice). It is the basis of all sweetmeats, and is the preservative agent in jams.

**Honey.**—This is commonly used by Indians in winter. It consists of the saccharine substance collected by bees from the nectaries of flowers, and deposited in the cells of the honeycomb. Honey contains dextrose and lævulose. It is largely adulterated with glucose, starch paste and cane sugar, and imitated by the itinerant vendors by adding a piece of genuine honeycomb to a vessel containing glucose syrup. Under the microscope genuine honey shows the presence of pollen grains.

**Salt.**—About half an ounce of common salt or sodium chloride should be used per day with the food rations, as most of the food stuffs are deficient in it. Vegetarians need salt more than meat-eaters. Owing to its taste it is not possible for any one to take it in excess but, if any one did, it would cause diarrhœa.

**Condiments.**—The condiments that are chiefly used in India are chillies (*lal mirch*), coriander (*dhania*), cummin (*zira*), turmeric (*haldi*), cinnamon (*dalchini*), black pepper (*kali mirch*), mustard (*rai*), saffron (*zafran*), dill (*suwa*), cloves (*lavang*), nutmeg (*jayfal*), cardamom (*ilaichi*), fenugreek (*methi*), pimento (*tamalpatra*), and mace (*javitri*). Vinegar, chutnies and pickles of limes, mangoes and bael fruits are also used.

**Beverages.**—Those in ordinary use may be divided into three groups, *viz.*, (*a*) mineral waters, (*b*) infusions of tea, coffee and cocoa, and (*c*) alcohols or fermented liquors.

**(a) Mineral Waters.**—Mineral waters are either natural or artificial. Natural are those derived from springs and which contain salts of potassium, sodium, lithium and magnesium or merely gases, for instance, carbonic acid gas ($CO_2$) in solution. The artificial forms are usually prepared by subjecting water containing different salts in solution to a process of gaseous saturation. Both forms of mineral waters are in common use. It is said that cholera bacilli are unable to contaminate waters saturated with carbon dioxide gas, and thus their use in the form of soda-water has been particularly recommended in places where the disease may be prevalent and the source of water-supply be doubtful. Soda-water is also largely used for diluting a purely milk dietary of invalids. Boiled or distilled water should invariably be used in manufacturing ærated waters to avoid all chances of contamination and infection.

**(b) Tea.**—This consists of the dried leaves of *Camellia thea* grown in China, India, Ceylon and Japan. It contains principally an alkaloid thein, besides a varying proportion of tannin and other extractives. An infusion prepared from the leaves is ordinarily used, while a decoction has been found injurious on account of its containing a very large proportion of tannin. Tea helps to digest milk, and should be used by those who cannot digest milk by itself. It is, however, advisable not to take a very large quantity of tea along with the principal meals, as the tannin contained in it is liable to coagulate their albuminous ingredients and thus to render them difficult of digestion. If taken in moderate quantities it acts as a mild stimulant and restorative; but when taken in excess, it causes constipation, indigestion, nervous depression, insomnia and gives rise generally to a state of neurasthenia.

**Coffee.**—This is obtained from the seeds or berries of the *Caffea arabica* grown in Arabia, Abyssinia, Southern India and other tropical countries. It contains an alkaloid caffein, together with a certain amount of fat, nitrogenous substances, sugar and mineral salts. It is ordinarily used in the form of powder, the seeds having previously been roasted and ground. A decoction prepared from it is ordinarily used mixed with a little sugar and milk. It is said to be an efficient restorative, and is thus known to dissipate symptoms of brain fag. It stimulates the nervous system and removes the sensation of fatigue. It causes wakefulness and increased brain action.

Its chief adulterant is chicory, the root of which is dried, powdered and mixed with coffee powder.

**Cocoa.**—This is derived from the seeds or beans of *Theobroma cacao* growing abundantly in the West Indies. These beans contain an alkaloid theobromine, together with a certain amount of fat, starch and salts. As a beverage it is preferred by some persons to tea and coffee on account of its being more palatable and less astringent in its action.

The adulterants of cocoa are ground-nut seeds, sesame seeds, cotton seeds, potassium carbonate, iron oxide, starch and sugar.

Chocolate is a preparation consisting of ground cocoa from which fat has not been removed, and is mixed with sugar, starch and flavourings.

**(c) Alcohols or Fermented Liquors.**—These are divided into three classes, *viz.*, spirits, wines and beers according to the amount of alcohol contained in them. The forms of spirits in ordinary use are brandy, rum, whisky and gin. The percentage of alcohol in them is about 40. Those belonging to the class of wines may be divided into light and strong according to the percentage of alcohol contained in them. To the former belong the Bordeaux, Burgundy, Rhine wine, Champagnes and Moselles, all of which contain less than 15 per cent. of alcohol; while under the latter are included Port, Sherry and Madeira in which the percentage of alcohol is higher and ranges from 15 to 25. All these wines are derived from grape juice by a process of fermentation. Beers are derived from malt, hops and barley, and contain from 4 to 5 per cent. of alcohol.

The indigenous forms of liquor ordinarily used by poor Indians are those derived from fermentation of rice and *mahua* (known as arac), and toddy (*tadi*) derived from fermentation of palm or date juice.

Alcohol in some form or other has from the very earliest time been used as an exhilarant by the human race in every part of the globe. Even the ancient vegetarian Hindus used it in the form of "somarasa." If taken in small doses it is said to promote digestion by increasing the secretion of the gastric juice. Taken in such small quantities or within a moderate limit of an ounces or two it may even form an article of food, when it is desirable to minimise oxidation in the process of food metabolism; but its use in case of fever on account of its hypothetical antipyretic virtues is erroneous, while its consumption in large quantities as a preventive against the injurious effects of cold is positively mischievous as it is well known that its perniciously excessive use in temperate and cold climates strongly predisposes persons to fatal respiratory affections of a catarrhal type, for instance, pneumonia. Even under ordinal climatic conditions, when taken in excess, alcohol is apt to delay digestion, to cause intestinal catarrh and eventually to lead first to congestive and then to cirrhotic conditions of the liver and kidneys, accompanied by hydræmic conditions of the body cavities (dropsy) and tissues generally (anasarca); thus verifying a well-known Spanish saying to the effect that "Those who drink wine die in water."

# CHAPTER XIII.

## THE DISPOSAL OF REFUSE.

THE refuse of a town may well be described under the following headings:—

1. The dry refuse of a house, such as ashes, dust and crumbs of food.
2. Washings from the house, particularly those of the kitchen, lavatory and bath-room.
3. The sewage refuse consisting of human excreta.
4. Refuse from stables and cowsheds containing the animal excreta.
5. Refuses from slaughter-houses.
6. Market refuse.
7. Refuses and waste water from factories.
8. Street sweepings.

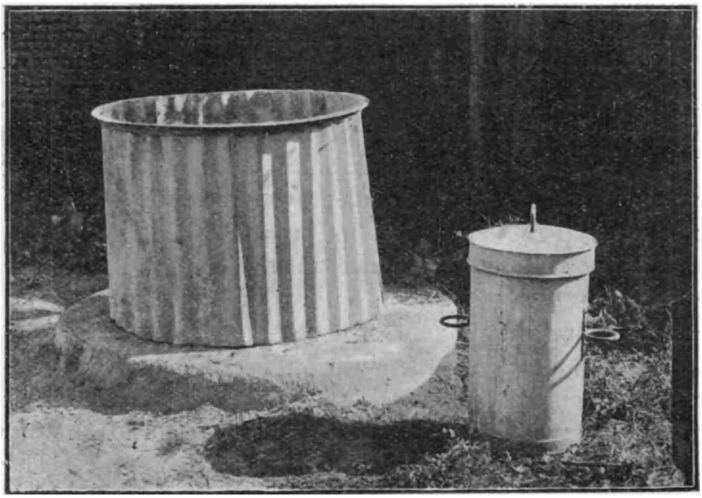


Fig. 18—Dust-bin and receptacle.

To ensure an efficient sanitary condition of a town the disposal of all these forms of refuse should be properly arranged for.

All forms of dry refuse derived from houses, stables, markets, slaughter-houses, factories and the streets should first be collected in receptacles ordinarily known as dust-bins. These dust-bins should be placed at convenient places in the streets and busy parts of a town on a slightly raised and paved platform. The platform should be in a position as far from the dwelling houses as possible, and sheltered from winds and sun. It should be protected from rain by a roof over it. A drain should lead away any liquid collecting on the platform. The dust-bins are either fixed on the platform, or are movable and fit into a groove made thereon. The fixed ones are square in shape, and made of bricks plastered on the inside with cement. These are difficult to clean. The movable are circular, made of corrugated iron and open at both ends. To facilitate the removal of refuse the small dust-bins provided with a pair of handles are better than large and unwieldy ones. They should be cleared at least once a day. One dust-bin is sufficient for a population of 1,000 inhabitants. If possible, small, covered dust-bins should be kept near the doors of private houses or in the compounds of private bungalows.

The collections of refuse in these receptacles are eventually disposed of in either of three ways, *viz.*, incineration, dumping or sorting.

**1. Incineration.**—Incineration of refuse in destructors or incinerators has been largely adopted by most of the municipalities in India, as it is the safest and most hygienic method of getting rid of refuse. The incinerator consists of one or more furnaces, which require coal to start the burning of refuse, but, after a time the heat generated is so much as to consume the whole of the refuse. To prevent nuisance, the escaping foul-smelling smoke may be led into the furnace and burned. During the process of burning the temperature may be raised as high as 2,000°F. by means of a forced draught, and the heat generated may be used for producing steam, which can be utilised for public purposes, *e.g.*, lighting or driving a mill. The chief advantages of incinerating the refuse are that the cost of carting it is minimised to a very large extent, it is reduced to almost one-third of its volume, and the residual ash or clinker can be used for making roads, mortar, cement or filter beds. The only disadvantage is that the incinerators will not burn in the rains.

At some places the night-soil is mixed with the refuse, when nuisance generally arises, inasmuch as the menial staff are found, as a rule, careless in the matter of mixing up a due proportion of combustible material, such as wood shavings, saw dust, coal dust, and damaged *bhoosa*. There is, however, very little nuisance, if the process is thoroughly supervised, or if a high-temperature incinerator is used. In such an incinerator condemned carcasses and waste materials resulting from offensive trades can also be consumed.

There are several types of incinerators, but the Sialkote improved-type incinerator, Harrington's improved refuse incinerator and the Horsefall incinerator are the best and most useful.

The Sialkote incinerator is quite economical. One having a four feet diameter is capable of consuming about 400 cubic feet of refuse per day.

Harrington's incinerator has been in use in India for several years. Each furnace is capable of burning 500 to 1,500 cubic feet of refuse in a day, and is managed by one man only. The furnace is charged at the top, and

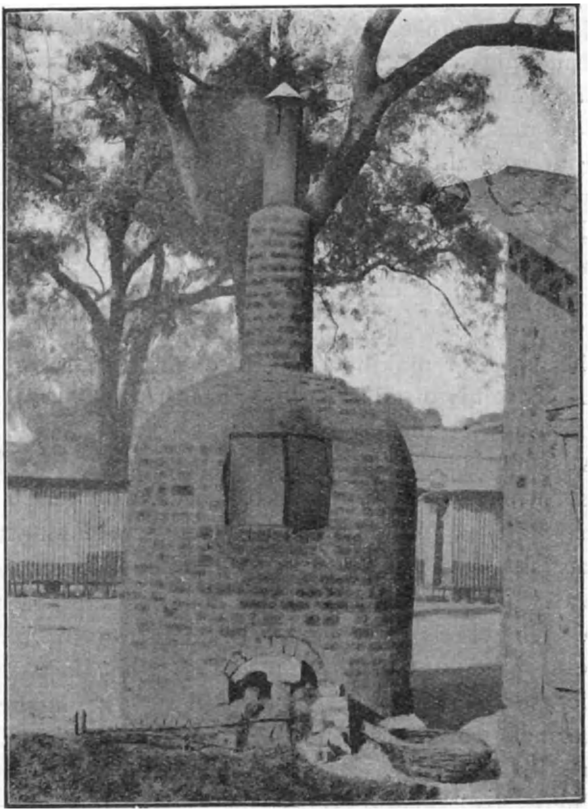


Fig. 19—Incinerator.

the ashes removed from below the fire bars.

The Horsefall incinerator is used in Colombo. It consists of 6 large cells and combustion chambers, each cell burning 10 tons in 24 hours.

**2. Dumping.**—In this method the receptacles are emptied into refuse carts fitted with covers, which are taken out of the town. The refuse is then dumped into pits or hollows to fill them up. Sometimes it is dumped to fill up low-lying lands in the town itself. When thus filled up, the ground is called "made soil," which should not be selected for building a house for at least 20 years. This method of disposal is, however, not an ideal one, as the accumulations of refuse are liable to pollute the

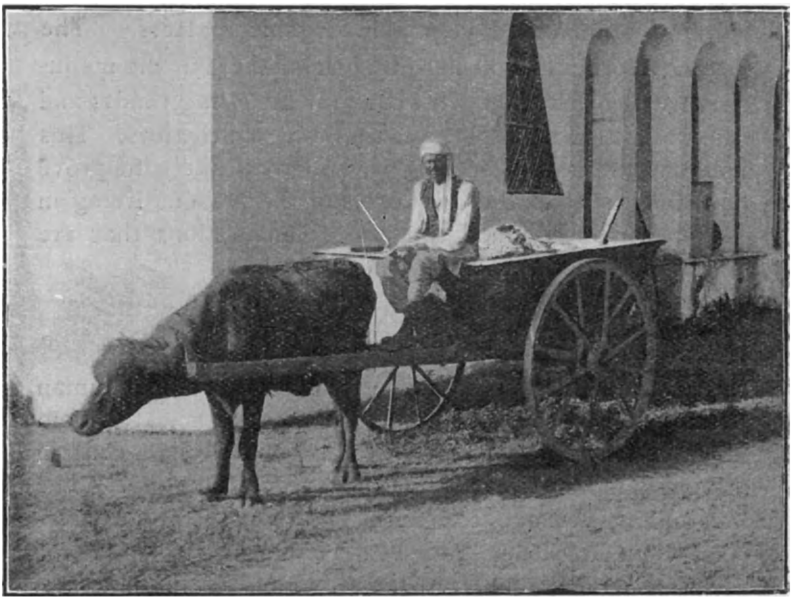


Fig. 20—Refuse Cart.

neighbouring water-supply, to breed rats and flies and to be disturbed frequently by dirt-seeking animals like pigs, and thus to give off offensive effluvia. Hence the dumping ground should be far away from habitations, and not near any well. At the same time it should not be too far away, and should be dry and not subject to flooding. It should be filled up by successive layers of 2 feet of refuse and 6 inches of earth, until the ground-level is reached. The ground can then be cultivated, and grass and vegetables grown over it.

**3. Sorting.**—This method consists of sorting the refuse in three parts known as breeze, hard core and soft core. What is technically known as breeze should consist of cinders, and small particles of coal ; hard core of bottles, bones, broken crockery and tiles; and soft core of animal and vegetable organic matters. The breeze is ordinarily utilised by brickmakers in the manufacture of bricks; the hard core for metalling roads; and the soft core is used as manure by cultivators. This dilatory method of sorting is, however, likely to prove injurious both to the workers and the persons living in the neighbourhood on account of emanations that are likely to be given off during the process.

## SEWAGE.

What is known as sewage, consists of the human excreta, *viz.*, fæces and urine, together with water from kitchens and bath-rooms. All these constituents contain a large amount of decomposable organic matters. The average daily amount of fæcal matter passed by a vegetarian Indian varies from 8 to 12 ounces, while that of urine is about 50 fluid ounces, to which 30 ounces of the ablution water may be added. As regards the disposal of sewage, either of two methods is ordinarily followed, *viz.*, the dry or conservancy system, or the wet or water-carriage system.

## CONSERVANCY SYSTEM.

In this system sweepers have to collect fæces and urine separately from privies and latrines, and then to remove them by cartage before they are finally disposed off.

**The Privy.**—This is meant for private use, and should be situated on the ground floor of a house at a distance of at least 6 feet from a living room, and 40 feet from any well or other source of drinking water. The floor of the privy should be made of impervious material, such as stone or cement, and raised at least 6 inches above the ground level. The walls should also be made perfectly impervious by a layer of smooth cement. The ventilating opening of an area of two square feet should be placed in the outer wall near the roof, so that it may afford sufficient ventilation and light, when the door is closed. The chamber for the receptacle should be constructed of hard, smooth stone or of bricks plastered with cement, or of any other non-absorbent material. The floor should slope towards a drain so as to cause a flow in that direction. The trap door of the chamber should open outwards on to a space behind the privy to facilitate the cleaning of the receptacle by the sweeper without being seen from outside. This ought to be done twice a day.

The space for foot-rests should not be wider than 9 inches. A movable receptacle for night-soil having a capacity of not more than 2 cubic feet should be placed 6 inches under the seat to avoid splashing. Anti-splash receptacles have been designed for this purpose. It is much better to have an arrangement for receiving night-soil, and urine and ablution water into separate receptacles, as the separate system prevents splashing, retards decomposition of the fæces, and facilitates the trenching and incineration of the solid excreta.

In some cantonments a solution of perchloride of mercury 1 to 500, or of saponified cresol in the proportion of half an ounce to a gallon of water, is added to urine and fæces before being treated in incinerators along with dry refuse.

**The Sandas or Well Privy.**—In Northern India an entirely different pattern of a privy, known as *sandas*, is in use. This is usually placed on the upper floor on what may be called a ditch or a small well. It is, however, a most insanitary pattern, as it may cause contamination of the house with effluvia from the accumulated excreta. Wherever possible, these should gradually be replaced by privies of the modern type, while those that are in use should be provided with well-cemented and smooth chimney-like conduits of at least 18 inches in diameter and ventilating openings at the bottom, and the accumulated contents of the sink should be periodically treated with slaked lime.

**The Earth Closet.**—This is another type of a privy in which the excreta immediately after defæcation are covered with a thick layer of dry earth or ashes, which act as a deodorant. Good garden loamy soil, brick, earth and dry clay are the best. Sand, gravel and chalk are not good deodorants, and should not be used. In Moule's earth closet the earth is placed in a hopper behind the seat, and on pulling a handle about 1½ lbs. of the earth are thrown over the excreta in the receptacle, and this is enough for the purposes of deodorisation of the excreta of a meat-eater, but for the closet of vegetarians 2½ lbs. of earth are required.

**The Commode.**—This is used by Europeans and Indians living in European fashion. The commode is placed in the bath-room, and consists of an enamelled or porcelain vessel fitted in a wooden box or iron stand. Immediately after use it is taken away by the sweeper and emptied into an iron receptacle kept in an outhouse of the bungalow. It is then cleaned and replaced in the box. This is a very clean arrangement from a sanitary point of view.

**The Latrine.**—Latrines are meant for public use, and are temporary or permanent. The temporary latrines are movable and are generally used, when people are

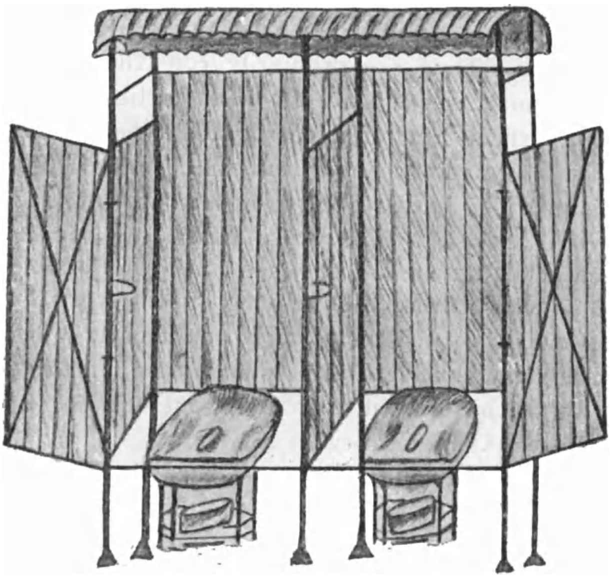


Fig. 21—Latrine.

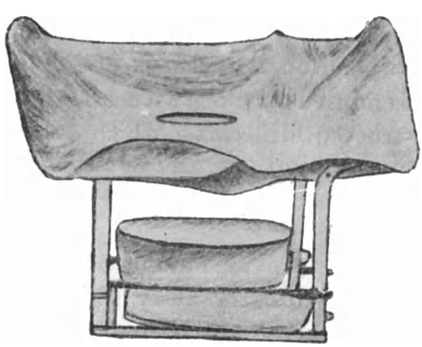


Fig. 22—Latrine Seat.

congregated during short periods as in fairs or camps. The permanent latrines should never be located within 20 feet of any dwelling house, public road or place of public resort, or within 50 feet of any source of water-supply. They are ordinarily constructed in the form of small sheds covered and partitioned with galvanised sheet iron of a corrugated type, and their seats are also made of similar material. Each compartment is provided with a door to ensure privacy, and an improvised socket to hold a *lota* containing water for ablution. The latrine sheds, besides being well covered, should be well ventilated by leaving openings at the top of their enclosure, that may freely admit both light and air. They should be separate for males and females, and should be so constructed as to allow one seat for every thirty residents of a locality.

They should be built either on a hard plot of land or one provided with an impermeable layer or bed of concrete, which should ordinarily be 6 inches higher than the surrounding land. Beneath their seats these latrines are provided with iron or glazed earthenware pans for receiving urine and fæces separately. These pans should be tarred when first made, and then re-tarred every month. The sweepers empty the contents of these into iron drums provided with covers, and placed in a convenient position at the back of the latrine. The latter are then emptied once or twice a day into municipal specially constructed filth carts, which are then carried well away from habitations and trenched in specially selected sites. These drums should also be kept clean and well tarred.

A drain should be provided along the rear wall of the latrine and inside it to carry away the washings of the latrine, which should be discharged into a municipal open drain. In the absence of a drain the washings may be discharged into a cesspool, which should be emptied by the sweepers into the conservancy cart. The cesspool should be semi-circular in shape, built of masonry and plastered on the inside with Portland cement. The washings may also be led on to a filter bed in a garden, or on to a filter trench located behind the latrine, if it is situated on the outskirt of a town.

In the case of masonry-built latrines, the floor and the walls should be smooth and well polished to allow of easy cleansing. The floor should be made of glazed tiles or bricks and the inside of the walls should be plastered with cement to a height of 3 feet.

**Patterns of Latrines.**—Several patterns of permanent latrines are used in India. The chief of these, which are considered good and suitable, are Bailey's patent latrine, Donaldson's separation latrine, and Macfarlane's latrine.

Bailey's patent latrine has an arrangement for efficient ventilation, and is provided with double trays, which prevent saturation and consequent pollution of the soil on which it stands. The only disadvantage is that the seats are very small.

In Donaldson's separation latrine, there is an arrangement for receiving urine and the solid excreta into separate pans, and the drain is closed or open.

Macfarlane's latrine is constructed of cast iron, and is very suitable for the use of railways, workshops, schools, etc. The urine and fæces are separately received into pans, which are provided with closely-fitting lids. These, when full, can be removed and replaced by empty ones. The foot-rests, which are made of iron, are so hinged, that they can be lifted up, and made to rest against the back wall of the latrine.

**The Filth Cart.**—Filth or night-soil carts are made of iron, have a cylindrical body and have double lids. They have generally a capacity of 12 cubic feet. Of all the different kinds of filth carts Crowley's patent night-soil cart is about the best. It is made entirely of wrought iron. Its body has a capacity of 75 to 200 gallons, and is fitted with an air-tight lid. It is hung on an axle,

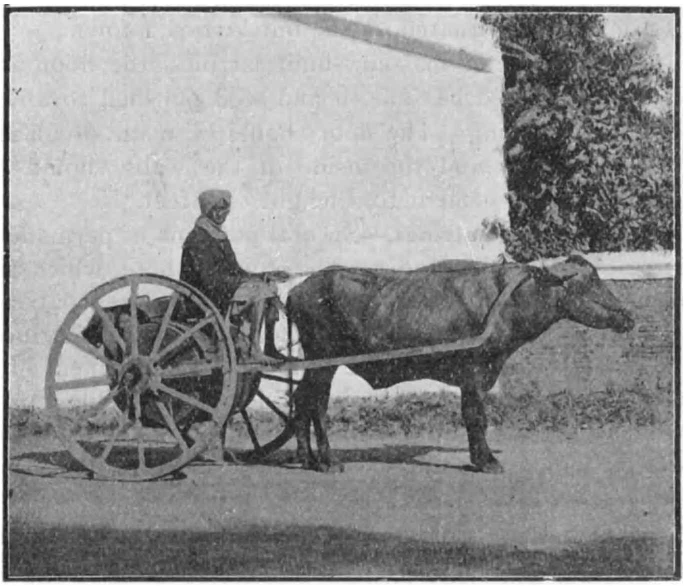


Fig. 23—Filth Cart.

so that it is easily tilted over and shoots out its contents on opening the lid. Another variety of a filth cart is known as a receptacle cart. It carries the covered receptacles, when full, direct from the latrines. It is very convenient for groups of small latrines, as it does away with the nuisance caused by emptying of the receptacles into the carts and spilling the contents.

The night-soil should be removed in these carts after 9 o'clock at night or in the early morning, so that as little nuisance as possible may be caused to the people in the streets. But the carts being driven by bullocks or buffaloes are very slow. Hence light tramways for carrying pails or receptacles are more convenient.

Special precautions should always be taken about the cleanliness of these carts and against any leakage from them. They should be properly washed at the trenching ground before they are brought back at the depôt, where they should be treated both inside and outside by a liquid disinfectant.

## DISPOSAL OF NIGHT-SOIL.

The methods adopted in municipal towns for the final disposal of night-soil in the conservancy system are the following:—

1. Trenching.
2. Pitting.
3. Incineration.
4. Selling for the use of brick-kilns.

1. **Trenching.**—The best method of disposal of night-soil is by trenching it in suitable trenches and subsequently disposing of it to cultivators after it has remained a sufficient length of time in the ground.

**The Site of a Trenching Ground.**—The site for a trenching ground should be carefully selected. The ground should not be low-lying or water-logged, but must be high well above the flood level and properly drained. If such a site is not available, it may be necessary to raise its level above that of the neighbourhood by putting more earth. The earth can be obtained by excavating a tank in the vicinity. The tank can be filled up by rain water, and can then be used for washing the filth carts.

The ground should be loamy and alluvial, but should not be sandy. It should be located on the outskirt of a town, but not to its windward side. It should be at a distance of at least 300 yards from any source of drinking water, and at a distance of 600 yards from human habitations. It should be well concealed from the public view. The approach to the trenching ground should be easily accessible, and the road should be well metalled for quick carriage.

The necessary plot of land having been selected, it should be properly levelled, drained and divided into 12 equal parts. Each part should be of sufficient size to trench the night-soil for one month. The plot that is once trenched should not be again used for trenching purposes for at least two years. After this time there will be no earth left to fill up the trenches over the night-soil deposited in them.

**The Systems of Trenching.**—The systems of trenching may be described under the following headings:—

(*a*) Deep system.
(*b*) Shallow system.
(*c*) Thornhill system.
(*d*) Allahabad system.

(*a*) **Deep System.**—In deep trenching the trenches should be 2 feet broad and 1½ to 2 feet deep. They should be dug in straight parallel lines and 2 feet apart from one another. Night-soil to the depth of 8 inches to 1 foot should be placed in them, and the trenches should then be filled in with all earth taken out, so that they appear like elevated mounds. These will subside in a few months to the general ground level. Filth thus trenched will usually be resolved into harmless products after six months' burial, but inasmuch as the rapidity with which changes are effected depends largely upon the character of the soil, it is desirable in every case to ascertain by an experimental excavation whether the contents of a trench are dry and inodorous before they are sold.

The length of a trench or trenches occupied by the night-soil of each month should be marked with a small post with the number of the month and the year pasted on it. Separate trenches should not be used for each month, but a post put in on the first day of each month at the point filled in on the previous day.

The area required for deep trenching per 1,000 persons for one year is about 1|3rd of an acre.

Urine is also best disposed of by trenching in a similar manner, or pouring it on to the surface of four plots of land, which are used in rotation. One plot is used for a week, then given two weeks' rest and ploughed before being again taken into use.

(*b*) **Shallow System.**—In the shallow system of trenching the trenches are made 2 feet wide and 9 inches deep with a space of 1 foot between the rows of trenches. These are first filled with night-soil to a depth of 2 inches, and then covered over with dry earth to fill the rest. The sinks are dug by municipal *beldars*, who remain there during the working hours. The land is put directly under cultivation, and a succession of exhaustive crops, such as tobacco and sugarcane, is taken. After the first crop vegetables are grown. The actual area of land required is four times that required in deep trenching, *i.e.*, $4 \times \frac{1}{3} = 1\frac{1}{3}$ acres per 1,000 inhabitants for one year.

It is used only in a few cantonments. Flies are apt to breed, night-soil being trenched superficially. Again it is necessary to irrigate the land in very dry climates to prevent the particles from being blown away by the wind.

(*c*) **Thornhill System.**—This system is known after Colonel Thornhill, who first introduced it at Bareilly. It is best suited for the treatment of semi-solid matter consisting of night-soil mixed with urine. It consists in digging trenches 16 feet long, 5 feet wide, and 1 foot deep, with a space of 6 inches between each trench and between each row of trenches. The soil removed is broken up and pulverised, and 2 to 3 inches are returned into the trench into which the contents of one or two filth carts are emptied and immediately covered with the earth excavated. The liquid contents are absorbed. No flies are hatched out. A horse should be able to gallop over these trenches on the next day, and they should be fit for ploughing in three weeks. Rich crops of potatoes and tobacco can be grown by direct cultivation. The land thus treated does not require manuring again for about four years.

This system is very remunerative provided that the Municipal Board owns the land, that the cultivators do not object to the use of night-soil or to work land that has been manured with it, and that there is a sufficient supply of water for irrigation. It may be adopted even in the sandy soil.

(*d*) **Allahabad System.**—This system also deals with the solid excreta and urine and slop water mixed together. It consists in measuring a space, 16 feet long and 5 feet broad, and digging out 3 inches from its top surface so as to make it a shallow trench. The subsoil thus exposed is further dug up, loosened and pulverised to a depth of 9 inches, when a filth-cart containing excreta and slop water is emptied into the trench. The liquid contents of the cart rapidly sink into the loosened soil, and the solid excreta form a thin layer about ⅛ inch in thickness at the top. This is covered over with 3 inches of earth removed from another trench similarly dug up in the close vicinity but parallel to the first. The trenches should be put at once under cultivation with grass, millet and sorghum, which should be done without ploughing the ground.

It has been found from experience that night-soil, treated in this manner, decomposes in less than a week. A large area of land, *i.e.*, about four times the area of the shallow trenching, is required in this system, as manuring done once is sufficient to last for four or five years. The chief objection to this system is the breeding of flies, but this can be prevented by sprinkling chloride of lime or quicklime on the top of the trenches.

To find out whether flies breed in any trench or not, the earth from the trench should be mixed with night-soil and placed in a wooden box. The box should then be covered over with a muslin cloth and kept in the sun. The flies would hatch out in a week's time, if the eggs were present.

2. **Pitting.**—This system for the disposal of solid and semi-solid night-soil is unsatisfactory, unless most carefully supervised. It is employed where private sweepers have the customary right to scavenging. The night-soil is sold direct to cultivators on the understanding that they will pit the material on their own fields.

Ordinarily the pits, which are dug up, are 20 feet square and 4 feet deep, and filled with the night-soil. The night-soil, which is also mixed with urine and slop water, gets fermented and decomposed by the heat of the sun, and an offensive smell emanates. When it becomes dry, it has already lost its fertilizing power by the gases of decomposition.

Pitting should never be carried out within 300 yards of habitations and any source of water-supply. The pits should be at most 5 feet wide and 3 feet deep. They should never be more than 3 feet deep, as there are very few nitrifying organisms in the soil below this depth. A layer of earth should be placed over each cart-load of night-soil after it is deposited into the pit. Each pit should also be covered over with a foot of earth. If treated in this way, the night-soil will be fit for manure after 3 months, but will lose its fertilizing value, if allowed to remain too long.

3. **Incineration.**—This is most suitable in cantonments, jails, and hospitals, where a separation of liquids and solids is carried out, and where a sufficient supply of dry fuel is available. The rainfall should also be small. The incinerator is either placed near the public latrines it is to serve, or near the pail depôts or *dalaos* made at convenient places near the habitation, where the sweepers take the night-soil mixed with house refuse from private houses. There should be a sweeper in constant attendance. It is necessary, therefore, that his quarters must be constructed near the incinerator. A shed for the collection of dry fuel must also be constructed near the incinerator. The night-soil should be placed on the fire in small quantities, and not in bucketfuls.

4. **Selling for Use in Brick Kilns.**—The selling of night-soil mixed with rubbish for use in brick kilns is most objectionable. The night-soil accumulates in large quantities until the kiln is ready for firing and breeds out flies, and the danger is obvious, since the kilns are often in the midst of towns near a populated locality. The practice may, however, be tolerated in cases, where the kiln is situated at least half a mile from a populated area, but only when the cleanliness of the surrounding area is ensured and the actual firing is likely to be quickly carried out.

## URINALS.

People are in the habit of committing a nuisance by passing urine in lanes or at the corner of a street or even the back wall of a house. Hence it is very necessary that proper urinals should be constructed at convenient places in too-frequented streets and bazars, and the people should be enjoined to pass urine at those urinals and nowhere else. For this purpose a cart urinal or a cantonment urinal can be used. In the cart urinal a receptacle of a convenient size rests on a masonry floor, and is placed under a raised and enclosed platform on which the squatting seat is fixed. The receptacle, when full, can be easily removed and replaced by an empty one. It can then be carried to a trenching ground.

The cantonment urinal is a cheap and sanitary type of urinal and is largely used in cantonments. It consists of two galvanized pans, one below the other. The upper one is perforated and contains saw-dust through which the urine trickles as an inoffensive liquid into the lower pan. The saw-dust should be periodically removed and burned.

## SULLAGE FARMS.

In the conservancy system the slop water from kitchens, bathrooms, etc., is carried away by municipal surface drains constructed along the sides of the roads. These are constructed of stone or some non-absorbent material, and are shallow with a rounded bottom, so that they can be easily cleaned. In lanes and near houses they are very often used by children for defæcation, and all sorts of filth are also thrown by the people. Hence it is very essential that they should be cleansed and thoroughly flushed twice a day. The sullage water from the drains is discharged into rivers at some places, but, where possible, it should be utilized for growing crops, as it usually contains a large amount of nitrogen, and is a most valuable fertilizing medium. In small towns without a piped water-supply in the irrigation of crops with sullage the "ridge-and-furrow" principle should be adopted, as the direct application of strong sullage burns the vegetation. In cases where there is not sufficient fall, sullage water can be lifted by baskets and the land irrigated. Waste land so irrigated becomes very fertile.

## WATER-CARRIAGE SYSTEM.

In adopting the dry system of conservancy the excreta have to be collected and kept for some time before their final disposal; the chief disadvantages of this system are (*a*) the accumulated excreta unless kept well covered are liable to attract flies, (*b*) the cost in the matter of keeping a large supply of carts and bullocks and a staff of sweepers is likely to prove prohibitive, (*c*) a proper disposal of them will, in spite of a careful arrangement, have to depend on the efficiency and carefulness displayed by the staff of sweepers which, as not infrequently happens, may go on a strike, on pretences of various imaginary or real grievances. The water-carriage system is, therefore, the more preferable which enables a more independent disposal of solid and fluid excreta, as also of sullage water. The latter has been adopted in large cities in India, provided with a plenty of supply of water through installations of water works, but are yet unsuited for smaller cities and towns which have no sufficient water-supply.

## SANITARY APPLIANCES.

The chief sanitary appliances necessary for the water-carriage system are water-closets, soil-pipes, house drains and sewers.

### 1. WATER-CLOSET.

This is an apartment in which the sanitary apparatus or closet for receiving the excreta is generally placed. It also contains a separate cistern for flushing purposes.

The water-closet should be constructed outside of the main wall, and connected with the house by a short lobby, which should be properly lighted and ventilated. The closet and lobby should have separate doors. The walls should be smooth and

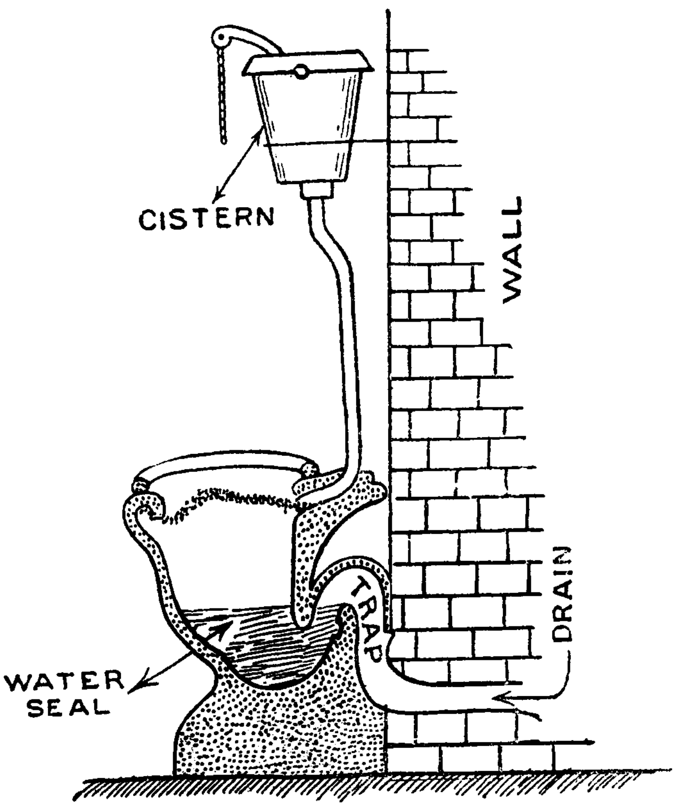



Fig. 24—The water closet with a cistern.

plastered inside with cement or varnished with paint or should be made of corrugated galvanized iron sheets. One of the walls should be an external wall abutting on an open space, and should have a window or grating at least 2 feet by 1 foot in area opening directly into the external air. In many-storied buildings as met with in large commercial towns the water-closets should be constructed one above the other forming a turret detached from, but within easy access of, the main habitable blocks.

**Closet.**—The closet is a basin or pan of some such impermeable material as glazed earthen-ware or stone-ware, and is made of such a shape and capacity as to receive and contain a sufficient quantity of water and to allow the dejections to fall directly into the water without splashing against its sides.

**Types of Closet.**—There are two chief types of closets; *viz.*, those in which there is no movable apparatus for retaining water in the basin, and those in which there is a movable apparatus for such purpose. The various types of the hopper closets belong to the first type, and pan, valve and plug closets belong to the second type.

Of all these varieties the best and the cheapest is the short hopper or the wash-down closet, in which the basin and trap are made of one piece and not of separate pieces as in long hoppers. The basin is conical in shape and constructed of glazed stone-ware or porcelain, and provided with a flushing rim, which washes its sides and keeps it clean. To avoid soiling the posterior wall of the basin is made vertical, whilst the anterior wall is oblique. It is connected below with a syphon trap—a bent tube always containing a column of water technically known as a water seal.

**The Modified Indian Type.**—In India the majority of the people are in the habit of squatting at the time of defæcation. and therefore the basin or the pan is arranged with two foot-rests. one on each side almost flush with the floor of the closet. which is generally made of hard, smooth and impervious material, such as stone, tile or cement having a fall of half an inch to the foot from all sides towards the seat. The superficial area of the floor should be 9 square feet (3 feet by 3 feet) as far as possible, and should never be less than 6 square feet.

The basin is made either of Doulton, Hindustan or Oriental pattern, or is made of cement in the shape of the same patterns. The outlet of the basin is so arranged that it may be a little hinder than the posterior rim of the basin. The splashing of the water in the trap at the time of deposition of the dejecta is thus prevented.

If the basin is made of cement, it should be provided with a perforated lead ring 1⅛ inches in diameter going round the rim of the seat.

**Cistern.**—For flushing purposes the water closet should be furnished with a tank or cistern placed against the wall at a height of 5 to 8 feet above the closet made of galvanized iron, slate or zinc, and provided with a cover to prevent ingress of the dust, flies and mosquitoes. It has a capacity for holding 3 gallons of water, and is connected with the posterior part of the flushing rim of the closet below by means of a lead supply pipe, 1½ to 2 inches in diameter. It should, on no account, be connected with storage water tanks used for drinking purposes.

The cistern is usually supplied with a ball trap to regulate the admission of water, and provided with an overflow-pipe. The working of the cistern depends upon automatic syphonic action, so that every time the chain is pulled, only 3 gallons of water (its capacity) are dicharged. Hence it is commonly known as the water-waste preventer.

In case some of the high class Hindus may object to touch the handle of the chain, flushing of the closet may be effected by the siphon cistern acting periodically and automatically, by the action of lever on opening or closing the door, or by closet-seat action, which comes into operation, when the man leaves the seat. All these three arrangements are not satisfactory, as they cause a large waste of water and are liable to get soon out of order.

**Trap.**—To prevent the reflux of foul gases an efficient trap capable of maintaining a water-seal must intervene between the pan and the soil-pipe to which it is connected. The pipe bsyond the trap must be ventilated.

**Trough Closet.**—A typical form of this variety of closet consists of an open long trough made of stone-ware, galvanized iron, or glazed earthen-ware divided into compartments placed on an inclined plane sloping at one end and furnished with a weir towards the drain

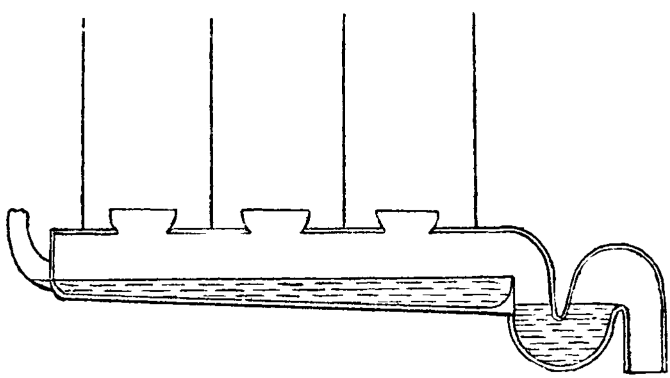


Fig. 25—Trough closet

that remains filled with water to receive the excreta. This form of closet is particularly suited for a large collection of people as in boarding schools, asylums, workshops and factories. Its chief disadvantage lies in the fact that unless automatic flushing is provided for, its efficient working has to depend altogether on a staff of menials.

**Slop Closet.**—This is a form of closet, which consists of a wide vertical shaft placed over a large siphon trap, so that the excreta fall into the water of the trap and are flushed out by the waste waters of the house. These are collected into a tipper, an earthenware vessel having a capacity of about 3 gallons, which automatically discharges its contents when full.

**Sinks.**—These are the appliances provided for receiving waste waters from the kitchen and the pantry. These are best constructed of enamelled iron or earthenware, and provided with grease traps to prevent the fittings or drain from being choked. They should be placed in the open to allow of cleansing and should not be surrounded by wood work, which is likely to get sodden and accumulate dust and other decomposing materials.

The contents of the sinks and the waste water from the baths, etc., should be made to discharge into a main waste-water pipe through trapped and ventilated waste pipes. The main waste-water pipe should open into a ventilated diconnecting trap before it enters the house drain.

**Urinals.**—These should be constructed of non-corrosive and non-absorbent material, such as stone, slate or fireclay, and should be flushed from a cistern, which works by siphon action automatically at regular periods. They should be connected with a soil-pipe by means of a siphon trap.

## 2. SOIL-PIPE.

This is a conduit that is connected at one end with the closet or urinal trap and at the other the house drain. It should only convey the discharges from water-closets and urinals, but under no circumstances must be made to carry the discharges from sinks or baths. It

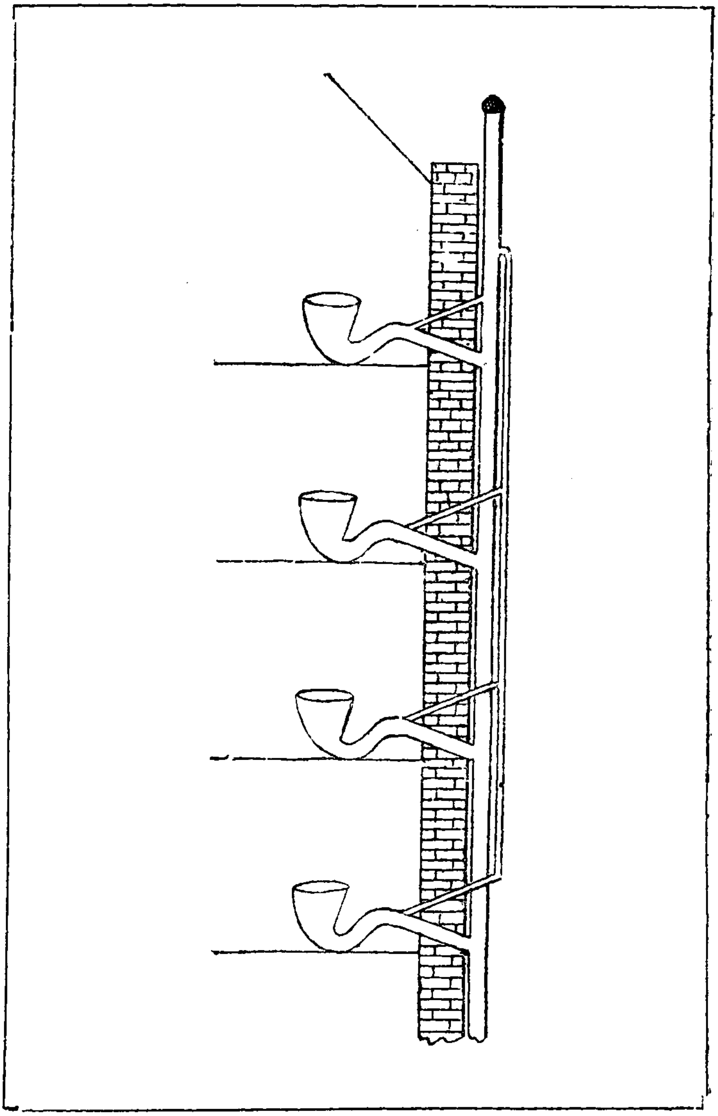


Fig. 26—The soil-pipe and ventilator with anti-siphonage pipes.

should be circular in shape, and have an internal diameter of 4 inches. It is ordinarily made of drawn lead, or cast or galvanized iron. It should have a smooth surface and be soldered at its joints. It should be placed against the outer wall of the house, so that it may easily be inspected and extended beyond the roof, and well away from windows, chimneys and sky-lights for purposes of ventilation.

To allow a free circulation of air and the escape of foul gases generated, the lower end of the pipe should open over a disconnecting trap outside the house, and the upper end should be carried at least 5 feet above the roof of the house, and should be provided either with a revolving cowl or a wire gauze cover.

**Prevention of Siphonage.**—When the soil-pipe happens to be common for the closets constructed for the different flats of a several-storied house and placed one above the other, there is always a risk of the water being sucked or siphoned from the traps of the lower closets, when the upper ones are flushed. This siphonic action can be prevented by carrying a ventilating pipe, full bore, from the upper and distal parts of each trap or by carrying anti-siphonage pipes from beyond the trap of every closet through the house wall and connected with a vertical pipe, 2 or 2½ inches in diameter, placed alongside the soil-pipe. This vertical pipe should open above into the soil-pipe, after it has received the anti-siphonage pipe from the highest water-closet.

## 3. HOUSE-DRAIN.

The house-drain is a pipe intended to convey the waste water and water-closet discharges from the soil-pipe to the sewer. The requirements of an efficient drain are that it should be absolutely water-tight, its interior should be perfectly smooth to prevent accumulation of filth, and all its branch connections should be made at acute angles and in the direction of the flow. It should also be provided with inspection openings at convenient intervals, should be laid in straight lines and should have a definite and uniform gradient.

The house-drain is usually constructed of glazed stoneware or earthenware pipes with cemented joints, but they are constructed of cast-iron pipes, in 9 feet lengths and jointed with lead, when the ground is soft or when the pipes are likely to be subjected to considerable strain. The cast-iron pipes should be coated on the inside and outside with a non-corrosive material like magnetic oxide of iron.

The drain should always be laid on an impermeable bed of concrete to prevent the joints opening if the soil were washed out from beneath. It should have a sufficient gradient to ensure easy and thorough flushing with a velocity of flow of 3 feet per second. The gradient varies with the diameter of the drain in the ratio of 1 in 10. Thus the usual diameters of drains are 4, 6 and 9 inches, and their gradients would be 1 in 40, 1 in 60 and 1 in 90, respectively

The drain should not pass through or under a house, but if this is not possible, the drain should be made of cast-iron pipes, should be surrounded by a 6-inch layer of concrete, and should be provided with disconnecting man-holes at each side of the house as a means of easy access.

**Disconnection of House-Drain.**—The house-drain should be disconnected from the sewer by an efficient intercepting or disconnecting ventilating trap. This trap prevents the reflux of foul gases from the sewer, but allows a free circulation of air through the drain and soil-pipe. It is usually placed at the bottom of a manhole or disconnecting chamber, immediately before the house-drain leaves the private property, and enters the public thoroughfare. The drain should be ventilated at intervals by air shafts passing up to gratings at the

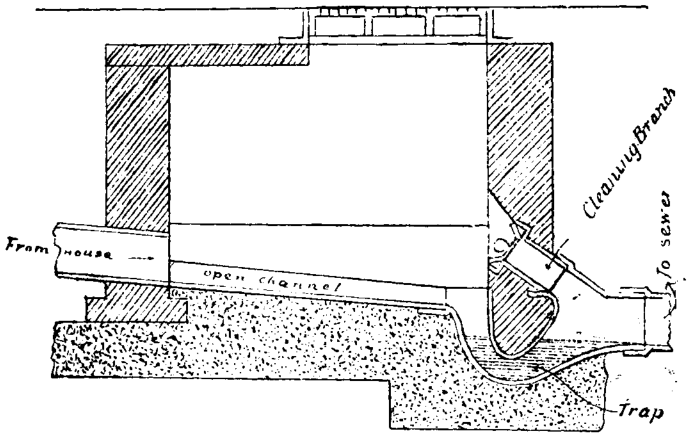



Fig. 27—Disconnecting Chamber.

surface of the ground, or these may be carried up the side of the house to prevent nuisance.

**Traps.**—These are intended to prevent the reflux of the foul-smelling gases of decomposition from the soil-pipe or drain from entering into the house, though they allow the onward passage of wastes. A trap in its simplest form is merely a pipe bent more or less into the shape of a U which always retains a certain quantity of water, and thus prevents gases from passing through. The column of water lying in the bend is known as the "water-seal" or "water-lock," which is the distance between the upper suface of the water in the trap and the point where the bend of its smaller curvature begins.

A trap is apt to be unsealed or get out of order, (1) by evaporation of water due to the bend being too shallow or from disuse; (2) by accumulation of solid matters due to faulty construction ; (3) by momentum of the flushing water being maintained to the very end of the flushing; (4) by the backward passage of gases when the drain is not ventilated : and (5) by syphon action. A good trap for house fittings should be constructed of strong, smooth, non-absorbent material, should be free from all angles and corners so as not to allow readily the accumulation of filth, should be self-cleansing and should have a water-seal at least 1½ to 2 inches in height. It should be fixed straight in a perfect level, so that it may not be converted into a cesspool. It should also have an opening in the form of a brass screw plug at its lower end for inspection or cleansing purposes, and should have a ventilating opening equal in diameter to that of the soil-pipe.

**Forms of Traps.**—Traps vary in their forms according to the positions where they are fitted up in the drainage system of the house. The best and the safest traps are those which are known as syphon traps. These are also called P. or S. traps according as the outlet passes directly outwards or downwards. These are usually fitted to

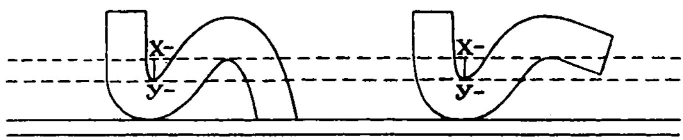



Fig. 28—Trap.

closets, sinks and baths. D-traps fitted to pan closets, are very large, and are easily corroded and eaten into holes by the excreta. Hence they are now condemned. Bell traps and Antill's (lip) traps are also unsuitable, as they are easily choked up, and get out of order.

Grease traps are fitted to kitchen sinks with a view to prevent the choking of the drain by the grease collecting and congealing in it. The traps are made of earthenware or iron and contain a large volume of water, which allows the grease contained in it to float to the surface and solidify, and thus arrests its inward flow, while allows the dirty water to flow away from beneath it.

Gully traps are interposed between rain water and waste pipes and the underground drains. They are strongly made of iron, are placed in courtyards, and are intended to arrest the solid suspended matters in their downward passage, and allow the rain and muddy water to flow off to the sewer. The most convenient of these traps is Dean's gully trap. It contains a movable bucket-like receptacle for solid matters, which can be emptied periodically by removing the bucket by means of a handle.

Intercepting traps are made of glazed earthenware, and are placed between the house drain and the sewer. These are usually large and are placed at the bottom of the man-holes. Buchan's, Weaver's and Hellager's intercepting or disconnecting traps are some of their varieties.

**Testing of Drainage System.**—The efficiency of all the fittings of the drainage system in the house has frequently to be tested after laying a new house drain and periodically in the case of all old ones. The tests which are ordinarily applied are the following:—

1. Hydraulic test.
2. Smell test.
3. Smoke test.
4. Pneumatic test.

1. **Hydraulic Test.**—This is a severe test, and should only be applied to new drains, and only to the drain, not to the soil pipe. It is carried out by plugging the distal end of the drain with a rubber cork after filling it up with water. In the event of a leakage the level of the water at the inspection (disconnecting) chamber will be found to be lower.

2. **Smell Test.**—This is applied by pouring boiling water containing peppermint oil into the water-closet. In the event of a leakage the menthol fumes will get regurgitated into the house. This test can also be performed by employing calcium phosphide which, in the presence of moisture, evolves phosphoretted hydrogen gas known by its characteristic garlicky smell. The calcium phosphide is put up in a small closed box to which a string is attached. The box is placed in the trap of a water-closet which is flushed with water from the cistern. On pulling the string the box is opened, and the gas evolved will escape through the joints, if any of them are leaky.

3. **Smoke Test.**—This test is applied by burning waste cotton dipped in tar or by igniting smoke rockets in the drain after the top of the ventilating shaft is closed. The waste cotton gives off very pungent smoke, and the smoke rockets give off dense volumes of smoke, as they contain sulphur. If the doors and windows are closed, the smoke will be noticed escaping in the house, if any of the joints are faulty or leaky. The smoke can also be pumped into the pipe by means of a special bellows (Eclipse smoke generator). The test is commonly applied to underground drains, vertical soil pipes, or drain-ventilating pipes.

4. **Pneumatic Test.**—This is very similar to the smoke test and consists of air being forced into the drain or soil pipe by means of a pump under pressure. Any leakage is noted by a change in the level of manometer attached to the generator. It is a very searching test, for it reveals the presence of a leakage, but fails to locate it owing to the escaping air being odourless and colourless.

## 4. SEWERS.

These are the channels intended to receive discharges from several house drains and provided with man-holes and flushing gates for the purposes of inspection and cleansing. They may belong to either of the two systems, *viz.*, separate and combined. The separate system necessitates a provision of two sets of sewers, one for receiving rain and storm water, and the other for household sullage matter. The great advantage of this is that the sewage is concentrated and uniform in quality and quantity, and can be used directly for irrigation, etc., but the chief disadvantage is of the cost and the difficulty with which the separate systems are to be maintained and the danger of joining the house drains to the rain-water sewers, or *vice versa.*

The combined system has a common sewer to carry away both sewage and rain-water. The sewers must be large enough to carry away the largest amount of water, or some method must be adopted to prevent them running quite full, or else they are apt to burst. It should, however, be noted that in India where the rainfall is periodic and limited, the combined system cannot generally be adopted.

Sewers are placed underground, usually at a distance of ten feet from the surface of the road, on a bed of impermeable concrete, straight in their course as far as possible, and provided with an easy gradient for efficient flushing, and jointed with others obliquely to prevent clogging.

Sewers up to 18 inches and 2 feet in diameter are constructed of earthenware or iron pipes and are circular in shape. Sewers of a larger diameter are made of glazed bricks or cement, and are of an oval or egg shape, the narrow end (or invert) being placed below, and the broad end forming the top or the crown. Their size depends upon the amount of sewage, rainfall and the available gradient. Under no circumstances, however, should a sewer be less than 9 inches in diameter.

The gradient for sewers should be sufficient to produce a velocity of not less than 3 feet per second in India, so that the sewage may be quickly carried away without leaving any deposit of silt at the bottom or invert. The larger the sewer the less will be the gradient to produce the same velocity. Hence a sewer, 10 feet in diameter, should have a fall of 2 feet per mile, a sewer, 5 feet in diameter, should have a fall of 4 feet per mile and a sewer, 1 foot in diameter, should have a fall of 20 feet per mile. With such a gradient the sewage is ordinarily capable of being conducted away to its outfall by gravitation; but when a sufficient gradient cannot be obtained in flat and low-lying districts, pumping has to be resorted to for lifting the sewage from a lower level to a higher level. This is effected by Shone's system or by Liernur's system.

**Shone's System.**—This is a system in which compressed air from a central station is used as a motive power for raising the sewage. It consists of ejectors or cylindrical reservoirs, which are made of cast or wrought iron and have an inlet and outlet pipe for the entrance and exit of the sewage, each pipe being provided with a ball-valve, and the inlet pipe having the shape of a siphon. The ejectors are situated underground in brick-work chambers at different parts of the town to receive the sewage from the street sewers. When the ejectors are filled with sewage, compressed air is injected from tubes carried along the upper surface of the outside of the reservoir by means of a float acting automatically on a counterpoised lever. The effect of the entrance of compressed air is that the inlet valve closes and the outlet ball-valve opens so that the contents of the reservoir are forced out into a gravitating sewer at a higher level. The compressed air escapes through a ventilating shaft. and mixes with the atmospheric air, as soon as the ejector is empty, and thus it is ready for a fresh charge. This system has been adopted in Southampton and other towns in England, and has been in use for some years in Bombay and Karachi.

**Liernur's System.**—In this system the motive power for conducting the sewage is also compressed air. It is supposed to be well suited to towns where the water-supply is limited, and where a sufficient gradient for sewers cannot be obtained. It has already been adopted in Amsterdam and other places in Holland, France and South Africa. The system requires two sets of channels, one for conducting away storm water, and the other for sewage. The water-closets of a number of houses are connected by means of hermetically closed iron pipes with an air-tight tank, which is periodically exhausted of air, so that the excreta are drawn into it. These tanks are placed underground at different parts of the town, and are connected by means of pipes with the central air-compressing machinery, by means of which the contents are drawn at intervals into a steam concentrator at the central pumping station, where the sewage is converted by boiling and evaporation into a dried solid sludge or poudrette. This poudrette is then sold as a manure.

**Manhole.**—This is a side entrance into a sewer provided at intervals throughout its course especially at points of divergence. It consists of a masonry chamber down to the sewer, through the centre of which the main sewer runs and through the sides of which the branch sewers open. It is wide enough to allow of easy ingress and egress for purposes of cleaning and inspection, and is provided at its street end with a pair of well fitting iron doors. It is better that is should be provided with gratings for ventilation.

**Flushing Gate.**—This is a contrivance placed generally at the ends of sewers for purposes of efficient flushing and to prevent stagnation of sewage matter at its bottom. It is automatic in its action, and covers the whole or a part of the sewer end. When closed, it draws back the flow of the sewage which, on opening it, escapes with a rush and thus cleans the sewer as well. The wider upper part of the sewer does not, however, get cleansed by this flow at its lower end. Hence a separate arrangement will have to be made for its periodic cleaning by means of automatic flush tanks supplied from mains in cities provided with water works, or through the agency of water carriers or *bhistees* in towns unprovided with such. The sewer may also be flushed by pouring a large volume of water into it through a manhole.

**Ventilation of Sewers.**—The sewers should be provided with an efficient means of ventilation at intervals of a hundred yards to provide for an easy escape of noxious gases and effluvia resulting from the decomposition of sewage. This is ordinarily secured by means of iron outlet shafts connected with the crown of the sewer, and fixed to the sides of the neighbouring houses, but carried well above their roof level. The top of the shafts is usually covered with aspirating cowls.

Various forms of deodorising apparatus have also been adopted in some places for the purpose of purifying the air of sewers. Charcoal trays placed in the ventilating shafts of sewers are useless as charcoal is non-absorbent, when wet. The simultaneous discharge of sulphuric acid and potassium permanganate as in Reeve's apparatus liberates the oxygen which, in its turn, oxidises the organic effluvia and renders them inodorous. In other cases gas lamps are kept burning continually in the ventilating shafts, or the street lamps are used as vent shafts, fans and ejectors (Webb's system).

## FINAL DISPOSAL OF SEWAGE.

The sewage of towns carried by means of the water-carriage system may be disposed of finally in one of the following methods:—

1. Discharge into the sea.
2. Discharge into rivers.
3. Disposal after rendering purification.
4. Disposal after biological treatment.
5. Disposal by direct land treatment.

1. **Discharge into the Sea.**—This is the readiest and best way for the disposal of the sewage of towns situated on the sea side. The end of the sewer should be placed well below the lowest level of the ebb-tide, so that the discharge may not be driven back on the foreshore during the incoming tide.

2. **Discharge into Rivers**—Though commonly in vogue in many large Indian towns this is likely to prove injurious, if the discharge takes place at a point up the stream, for the reason that people living on the banks down below will draw polluted water for their domestic purposes, which may prove exceptionally injurious in times of the year when the river flow is at its lowest.

The Rivers Pollution Prevention Act was passed in England in 1876, which makes it illegal to allow crude sewage to pass into rivers or streams. The sewage must be purified before it is discharged into them. The standard of purity to be aimed at is that the effluent should not contain more than 0.15 part of albuminoid ammonia in 100,000 parts.

3. **Disposal after rendering Purification.**—Purification means the removal of the organic and oxidisable matter, and is effected in either of the three following ways, *viz.*, subsidence, straining or precipitation.

**Subsidence.**—In this method crude sewage is collected in large tanks made of cement or brick to the bottom of which the solid suspended matter slowly gravitates leaving a comparatively clear fluid at the top. The effluent, however, is not harmless, as it still contains large quantities of organic matter and bacteria and is still capable of undergoing decomposition and of causing a nuisance and danger to health.

**Straining.**—In this method crude sewage is carried over a bed of ashes or charcoal through which its liquid portion slowly percolates leaving the heavier solid matter covering the bed as a thick crust. This method does not seem to be ordinarily practicable, as it necessitates a frequent cleaning of the filtering beds to ensure its efficiency.

**Precipitation.**—This process consists in the addition of some chemicals, which form insoluble compounds, and these, precipitating to the bottom, carry with them suspended solid matters as well as a proportion of dissolved organic matter in the sewage. The fresh sewage is thoroughly treated with the chemical agents, and is then caught in a double row of tanks, four to six feet deep, in which its solid particles quickly settle down, while the liquid portion at their top is either discharged into a stream or river, or carried along specially constructed drains into adjoining land for purpose of irrigation or of fertility. The following are the chemical agents which are commonly employed for purifying sewage:—

*a.* **Lime.**—12 to 16 grains of lime are added to each gallon of sewage, when the lime combines with the carbonic acid forming an insoluble carbonate of lime, and also with some of its organic bases. These and the suspended matters fall together to the bottom and form the sludge. Lime in solution is much more effective. The treatment of sewage with lime is cheap, and is especially suited for those towns where sewage contains salts of iron and mineral acids and carbonic acid as in breweries. However, the chief disadvantages are that the effluent is rendered more alkaline and more putrescible, and the sludge is also bulky and decomposable.

*b.* **Alum.**—Alum sulphate from 5 to 10 grains is used for each gallon of sewage. It produces a flocculent and gelatinous precipitate which entangles and carries down with it most of the particular matters in suspension. The effluent is neutral, and is, therefore, not liable to decomposition. In Anderson's process alum in a crude form is made by acting on clay with sulphuric acid.

*c.* **Mixture of Lime and Alum.**—When 5 grains of lime and 5 grains of alum are mixed together for each gallon of sewage, the sulphuric acid of the alum combines with the lime, and a precipitate of alumina hydrate is formed, which carries down with it all the suspended matter and much of the organic matter. This method is more efficient than alum or lime alone.

*d.* **Proto-Sulphate of Iron.**—This salt added to alkaline sewage or to sewage previously treated with lime forms a flocculent precipitate of hydrate protoxide of iron, which falls to the bottom carrying with it solid organic matters. It is also a strong antiseptic and prevents the secondary decomposition of the sludge and the effluent, when added in a sufficient quantity. Ordinarily 2 to 5 grains of the salt are added per gallon of sewage.

*e.* **Sillar's A. B. C. Process.**—The chemicals used in this process are alumino-ferric, blood, clay and charcoal, and the process is so named from the initial letters of these substances. When they are used together, they produce a precipitate, which also causes a sedimentation of solids.

*f.* **Hillé's Process.**—In this process magnesium chloride is used as a precipitating agent together with lime. Sometimes tar is also added to them.

*g.* **Amines' Process.**—In this process the sewage is treated with milk of lime and herring brine, when a volatile aminol is evolved. It acts as a deodorant and antiseptic, and renders the sludge inodorous.

*h.* **Hermite System.**—This system consists of treating sewage with electrolyzed sea water. An electric current is passed through sea water contained in a galvanized iron tank, when magnesium chloride is decomposed and forms a disinfecting solution of a strength equal to 0.75 gramme of chlorine. It is asserted that this solution decomposes at once the fæcal matter contained in the sewage and thoroughly sterilizes it, but this has not been borne out by experiments. Again, bleaching powder dissolved in water is equally efficacious and much cheaper.

*i.* **Webster's Process.**—In this process purification of sewage is effected by electrolysis. The sewage is electrolyzed as it is passed at a low velocity through a chamber, fitted on its interior with large iron plates. At the positive pole chlorine and oxygen are given off, and these unite and form hypochlorous acid. The acid acts upon the organic matter, and also forms hypochlorite of iron. At the negative pole ammonia, potash, soda, magnesia and other alkaline bases are set free, and these in their turn decompose the iron hypochlorite into the hydrated oxide of iron. This rises to the surface as a scum, along with bubbles of air, and so purifies the sewage. The effluent is rendered pure by the disinfecting action of the chlorine and also by the precipitating action.

Owing to the nuisance arising from rapid putrefaction of sewage from its exposure in large open tanks this method of purification by chemical agents is not suited to the hot climate of India. It is also being given up in England, as the effluent is in no way free from organic matter and pathogenic bacteria, and is also harmful to fish life owing to salts added to sewage, if directly allowed to pass into streams; while the sludge formed is very bulky and contains as much as 95 per cent. of water. It has, therefore, to be dried, and compressed into cakes for distribution as manure.

(4) **Disposal by Biological Treatment.**—As is well known, micro-organisms found in soils are liable to act on organic matter—animal or vegetable—and to break it up into simpler oxidisable substances which ordinarily supply nutrition to plants. This natural process of oxidation through the agency of micro-organisms may also be applied for the disposal of sewage. Two kinds of micro-organisms are ordinarily met with in sewage, known respectively as anærobic and ærobic. The former liquefies the solid organic matter and converts it largely into ammonia and ammoniacal products, while the latter effects further chemical changes resulting in the conversion of these ammoniacal substances into the simpler forms of nitrites and nitrates. It is said that through the action of a preponderating number of these organisms pathogenic germs come to be largely destroyed.

**Septic Tank System.**—Several devices have been put forward for this particular method of biological treatment, of which the most important is the one ordinarily known as the septic tank system advocated by Mr. Cameron, Borough Surveyor of Exeter, and adopted by Major Clemesha, I.M.S., for the use in Indian towns. This system is particularly suited to the requirements of small towns and cantonments, and it has an advantage that the latrines can be constructed over septic tanks into which the excreta at once pass. These are called septic tank latrines and are usually built in jails and hospitals, where a large latrine accommodation has to be provided, and where a sufficient supply of water is available.

The system consists of a septic tank and contact beds (filtering beds).

**Septic Tank.**—The septic tank is an underground air-tight tank made of brick lined with cement, and 6 to 8 feet deep. It may be open or closed, but in India it should be closed to suit its climatic conditions. It should be 45 feet long and 9 feet broad to hold the accumulated sewage derived from a locality having a population of 1,500 inhabitants. It is provided with an inlet pipe for receiving the excreta, which opens below the water in the tank, and an outlet pipe for the discharge of the effluent, which is also situated below the surface. The sewage is first allowed to pass into a grit chamber, where pieces of stone, grit, etc., are deposited and then it drains slowly into the septic tank proper, so that solid organic constituents have time to settle at its bottom, and a scum collects at the surface. The anærobic micro-organisms split up the solid organic constituents into soluble and unstable compounds and liquefy them. The sludge, which is formed, is largely composed of mineral matter, and is so small, that it hardly necessitates the cleaning of the tank. As a result of fermentation a thick scum forms on the upper surface, varying from 2 to 12 inches in thickness. The scum further undergoes digestive changes owing to the action of anærobic bacteria, and the organic matter is decomposed into water, nitrites, nitrates and gaseous products, such as carbonic acid, ammonia, marsh gas and sulphuretted hydrogen. These gases may be employed either for heating, or after carburetting for lighting purposes. The flow of sewage through the tank must be slow, so that the pathogenic organisms present in the sewage are destroyed. For the proper action of the anærobic bacteria the sewage ought to be allowed to remain in the septic tank from 12 to 24 hours, but in India it is sufficient to keep it for 8 to 12 hours.

**Contact Beds.**—The liquefied portion of the sewage is passed out in a trough or "ærator" placed outside, from which it flows into channels, and ultimately is discharged on to filter or contact beds. Each bed is either made by building artificial walls or by simply digging out the ground where it is of clay. The bottom is made of concrete and slopes from its centre to the sides, which are surrounded by a drain for collecting and carrying away the effluent. Upon the bottom are placed filtering materials consisting of pieces of broken stones, furnace clinkers and gravel to a height of from 4 to 10 feet. Each piece should be from ½ in. to 2 ins. in diameter. The sewage is distributed evenly over each bed by means of stoneware channels, or by fixed or revolving hollow perforated tubes known as sprinklers, so that the sewage simply trickles through the filter. In passing through the filter the organic matter contained in the fluid portion of the sewage is further broken up into ammonia, carbonic acid, sulphuretted hydrogen, water, as well as nitrites and nitrates by the action of the ærobic organisms present as a gelatinous layer on the upper portion of the filtering mediums. It is necessary that the filtering bed must be ærated. Hence the liquid should be allowed to percolate at intervals in the case of small contact beds. To obtain this rest there should be several contact beds, so that they can be used in rotation. Each small one should be made to work only 4 hours a day and should have a rest of 20 hours. In the case of large contact beds the liquid may be supplied continuously, but slowly, by means of revolving sprinklers. These beds are also called percolating continuous filters. Both the filter beds are quite effective. The area required for a population of 1,500 persons is generally half an acre.

**Scott-Moncrief System.**—This is another system in which both non-ærobic and ærobic organisms play their part in purifying sewage. The sewage is first allowed to flow through a perforated grating, which forms a false bottom of a tank (cultivation tank) filled with various sizes of broken stone, gravel, etc., and then to pass upwards slowly and continuously. In its upward passage through the filter the solid suspended matters are retained, and solid dissolved organic matters are liquefied by the action of anærobic organisms present in the sewage. The effluent escaping from the top of the tank is conducted into a series of nitrifying trays containing large pieces of coke placed one above the other. Here the ærobic organisms further act on the effluent with the result that it becomes clear, odourless and non-putrescible.

(5) **Disposal by Direct Treatment.**—In this process the sewage is first treated with chemicals to allow of a rapid precipitation of its suspended matter. The liquid portion is then discharged on a plot of land either by intermittent downward filtration or by broad irrigation or sewage farming.

For purposes of intermittent filtration the land should be porous in consistence and provided with means of

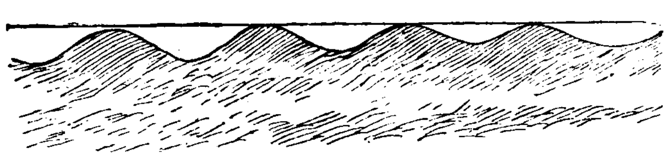


Fig. 29—Ridges and Furrows.

subsoil drainage at a depth of 6 feet. Such a plot of land in order to ensure efficient irrigation should have a level surface divided into small sections by ridges and furrows, the latter allowing a free flow of the liquid sullage, while vegetables and grass may grow on the former. The purification of sewage is both mechanical and biological, effected by filtration and nitrifying organisms present in the soil.

For purposes of broad irrigation or sewage farming a considerably large plot of land is brought under operation. Its consistence should be porous and, wherever clayey or hard, it should be made thoroughly loose and porous by being dug up and mixed with ashes, sand or lime. A proper drainage should be arranged for it, and it has been found by experience that an acre of land is sufficient for a population of 1,000 persons. Grass, sugar-cane and vegetables, such as cabbages, grow abundantly on such sewage farms. The disadvantages of such a method of disposal are that it may encourage the breeding of mosquitoes, and may pollute wells, if situated in the neighbourhood.

# CHAPTER XIV.

## PERSONAL HYGIENE.

PERSONAL Hygiene relates to individual conduct towards the maintenance of physical health and freedom from disease. It should be based on a due observance of certain elementary principles of sanitation with reference to personal habits and cleanliness, as also to the articles of clothing, the amount of exercise and the hours of sleep.

### HABITS.

The habits should be regular and healthy as regards the hours of meals, the evacuation of bowels, the professional work, and the use of restorative drugs. Meals should be taken after due intervals, at fixed hours and in quantities compatible with one's work. The proverbial thirty-two bites for every morsel of food should never be forgotten. The bolting of unchewed morsels is most objectionable as it is difficult for the stomach to digest them. Excessive ingestion and irregularity of meals usually bring about symptoms of indigestion. Similarly inattention to a regular easing of the bowels is likely to bring about unhealthy consequences, such as constipation, toxæmia, headache and a general sense of malaise. Intellectual work, especially of the kind necessitating prolonged application at desk, cannot be performed efficiently after heavy meals and without being varied with short periods of rest. It may be observed that Indian students generally are scarcely cognisant of the importance of these essentials pertaining to their work. It is, therefore, not infrequent to come across most pitiable instances of physical ruin brought about solely through a lamentable ignorance of such commonplace hygienic facts.

As far as possible no other fluid except water should be taken. Water, if it is pure, may be taken with impunity by any person of any age. It should be remembered that infants like adults do suffer from thirst and should, therefore, be given sips of water to drink.

Water should not be taken at meals, but should be taken freely in the intervals between meals. It is best to take a glass of cold water early in the morning on rising and at night before going to bed.

Alcohol or other fermented liquors must be avoided. In a tropical country like India they are both unnecessary and harmful. Old persons may require alcohol to stimulate them, just as an old tired horse requires flogging, but young persons have no excuse to use it.

Tobacco is the drug which is habitually used by the large majority of Indians as a restorative. The principal forms in use are the leaves for chewing, powdered leaves for inhaling as snuff, and the prepared tobacco for smoking. Its use particularly as a smoke is indiscriminate, even though it harms digestion, is likely to bring about a sense of depression and may also injuriously affect the eyesight. It is extensively used by the people of India, and still cases showing injurious consequences are seldom met with.

Nevertheless, its use by young persons under twenty years of age should always be discountenanced, and older persons should be advised to use it regularly and in moderate quantities only. The habits of chewing it and of using it as snuff are, to say the least, dirty, while the former usually proves injurious to a healthy preservation of teeth.

**Sleep.**—Sleep at regular hours is necessary to repair the waste of the brain and the nervous system incurred by the body during the period of activity. It is in fact a time of repose for all the organs. The amount of sleep required by the same individual in different periods of life, seems to be in inverse proportion to the intensity of consciousness. Consciousness is not intense at the two extremes of life, and hence in infancy and in old age much sleep is required, but in adult life consciousness is more intense and so less sleep is necessary. Ordinarily seven hours' sleep is enough for grown-up persons, but it is impossible to fix the exact period of time for sleep for every individual as it is difficult to estimate the amount of food required by different people. Night is the best time for sleep owing to the prevailing quiet, as the presence of external stimuli to the brain causes insomnia. The bed-room should be well-ventilated and the bed should be firm and elastic. The bedding should be kept neat and clean, and should be frequently exposed to the sun. It is injurious to sleep on the floor. Besides the danger of being bitten by scorpions, snakes and other poisonous insects, there is always a danger of contracting rheumatism, diarrhœa, dysentery, fever, pleurisy and other lung affections owing to the dampness of the soil and the inhalation of foul air emanating from it. It is also advisable to have a sleeping-room on the upper floor if the house has more than one storey. The head should not be covered up during sleep, lest the foul gases exhaled might be inhaled. Two persons should not sleep in the same bed, as they will inhale each other's breath. The trunk should always be well-covered to avoid catching chill, and the bed should never be kept in the direct draught of air, though the windows of the room should be kept open at night for thorough ventilation. There should be an interval of at least three hours between the last meal and the hour of bed, for a heavy meal taken just before going to sleep causes insomnia. Lastly, the popular adage, " Early to bed and early to rise makes a man healthy, wealthy and wise" should always be borne in mind.

## CLEANLINESS.

Cleanliness is very essential for the upkeep of the health and for the growth of our body. Attention should, therefore, be paid to the cleanliness of the skin, teeth, hair and clothes. The skin should be kept clean and free from dirt. In India owing to excessive perspiration it becomes necessary to keep the pores of the skin free from dirt, so that the sweat glands may do their work properly; for if they are clogged, and if the dead scales from the skin are not removed, its action will fail, and to remove waste products more extra work will be thrown on other organs of the body, *viz.*, the lungs and the kidneys. Water is the great remedy to clean the skin, but soap should always be used to remove grease and dirt. Care should be taken that good soft soap is used, as hard coarse soaps are apt to cause cracking and chapping of the skin. Especially where the skin is tender, as in the case of babies and very young infants, soft soap containing more fat is always to be preferred.

A daily bath should always be taken early in the morning or in the middle of the day before but not after a meal. Young, healthy people should always use cold water for a bath as it is vigorating and refreshing, but if one feels chilly after the bath, one should use tepid or warm water. Children and old people also should use tepid or warm water, as they are liable to get chill with cold water. The temperature of cold water should vary from 55 deg. to 65 deg. F., and that of warm water from 94 deg. to 104 deg. F. Even those who take a cold bath daily should occasionally take a hot bath with a temperature varying from 104 deg. to 110 deg. F., as hot water has a more solvent action on dirt and oily matter than cold or tepid water.

The ordinary way of Indian bathing, of pouring a few *lotas* of water over the head and back, is not at all good.

Soft soap should first be applied to the skin, and then there should be vigorous rubbing over the whole body, and lastly, it should be washed with sufficient water. During sickness when a bath cannot be taken, it is always healthy to rub the body with a towel wrung out in tepid or warm water. Massage or shampooing of the muscles is a very good practice specially when the muscles are flabby and in the case of people who have a poor physique.

**Hair.**—The hair of the head should be kept thoroughly clean, and should always be combed and dressed. If the hair is not properly looked after, several troublesome diseases, such as ringworm and dandruff may arise, while frequently lice also make their appearance. It is necessary to wash the hair once a week with a yolk of egg, soap and water, or with soap-nuts or myrobalans soaked in water. Oil should not be used too frequently, as is the custom among Indians, because it mats the hair together and harbours dirt. Nature has provided the scalp with oil or grease, which keeps the hair soft and pliant. If oil has to be used, it should only be used once a week, after washing the hair with soap, to replace the natural grease.

**Teeth.**—It is essential that the teeth should be thoroughly and regularly cleaned, for good digestion depends upon the thorough mastication of food, which cannot be done without strong teeth. They should be cleaned once in the morning after getting up, and a second time before going to bed. The Hindu custom of using a green *neem* or *babul* stick for cleaning teeth is very good from a hygienic point of view, but it is really a matter for regret that this stick is being replaced by tooth-brushes, which are not very sanitary, as there is always a difficulty in keeping them clean and the same brush is used for a long time. If the tooth-brush has to be used at all, it should be kept in a carbolic lotion when not in use, and should be kept in boiling water for some time after use. It should also be frequently changed.

Tooth-powder is generally used with the brush. Several varieties are being sold in the market, but nothing can be better than charcoal and common salt powdered and mixed together or powdered chalk and borax. After the brushing is over, the mouth should be rinsed out with warm water containing a little borax. The teeth should be well cleansed after every meal ; food particles are liable to remain lodged between them and so they should be removed by a tooth-pick or by a piece of string passed between two teeth. If there are cavities in the teeth, they should be filled up, but if they are very carious, they should at once be removed lest they may spread decay to other teeth. When the teeth fall away, artificial teeth should be used, if one can afford them.

**Nails.**—The hands and nails should be kept scrupulously clean specially as most of the Indians eat with their hands, and do not use spoon and fork. This is particularly necessary for those who nurse the sick. The poison and the dirt lodge under the nails and so they should be pared down with a pair of scissors and a stiff nail-brush should be used to cleanse them. Cuts and scratches received on the hands during work are likely to get infected, if they are not kept clean. The hands should always be washed with soap and water before and after meals. The fingers should never be introduced into the mouth and the nose. Some disinfecting lotion must be used for washing the hands while attending on persons suffering from infectious diseases.

**Feet.**—The feet should be kept clean by frequently washing them with hot water and soap. In the summer they become offensive owing to free perspiration. The perspiration, if not removed by properly washing the feet, dries up on the surface, undergoes fermentation, causes irritation and skin diseases, such as impetigo and eczema. The toe-nails should not be allowed to grow too long, as they would crack and break off leaving ragged ends. They should, therefore, be kept fairly short by cutting them down. They should always be cut straight across, and not rounded off at the corners. If they are cut away at the corners, they tend to grow at these places into the skin by pressure of the narrow-toed boots, and to produce what is known as an ingrowing toe-nail, which is most painful.

## EXERCISE.

Exercise is necessary for the growth and development of the body and the perfect maintenance of health. Bodily strength is essential for success in life, as much in the case of an individual as in the case of a nation. A strong man can work in life with great vigour, and can stand the worries better than another who is weak in constitution, and a weak nation is always ruled by a strong one. The British soldier is so much known for his daring and power to sustain hardships, simply because he has a love for sports and takes delight in manly games. Even on the battle-field he does not forget his football, if he gets some respite.

Without exercise the muscles become pale and flabby, and begin to waste. The appetite is lost, and indigestion and constipation are the result. The man who does not take exercise feels greatly depressed, cannot take interest in anything in life and becomes a prey to the attacks of diseases, while by exercise the voluntary muscles are brought into active play and grow harder and firmer. The frequency and force of the heart's action are increased and the blood circulates more freely through the whole body. The number of respirations is increased. There is a considerable increase in the amount of oxygen inhaled and carbon dioxide and watery vapour exhaled. Hence the oxygenation of the blood is very much accelerated. There is a marked increase of perspiration owing to the increased action of the skin, and consequently the quantity of urine diminishes, though the amount of urea and uric acid remains unaltered. The appetite is improved and the action of the bowels is stimulated. The mind is also refreshed, and the powers of observation, precision and tolerance are developed.

Exercise should be taken in the open air, and this is much more essential to brain-workers, such as lawyers, doctors, clerks, teachers and students, who have to work all the day in closed buildings. It should also be such as would give recreation and relaxation to the brain. There are various kinds of exercise, such as gymnastics, wrestling, dumb-bells, games of football, hockey, tennis, cricket, cycling, riding, walking, running and gardening. But walking is the best of all, as by it all the muscles of the body are brought into play, and it does not require any special apparatus or any expenditure of money. An adult who does not take any other exercise should walk at least five miles morning and evening. It should be impressed on the mind of parents that exercise is equally necessary for young girls, who ought to devote some of their time to outdoor games. As the mothers of the future race, they ought to be strong, vigorous and healthy.

Whatever exercise is taken it should be in moderation, for severe and prolonged exercise is harmful to health. It causes breathlessness, palpitation and hypertrophy of the left ventricle and renders the pulse small, frequent and irregular. The voluntary muscles become exhausted owing to overwork, suffer in nutrition and naturally begin to waste. After exercise the body should be well washed with soap and water, and should be carefully rubbed dry with a towel, so that the skin should not remain damp and dirty owing to the increased action of the sweat glands. The time of exercise should be early morning or evening. One should not eat too soon before or after exercise.

To calculate the amount of exercise needed for an individual it is necessary to remember that a healthy individual can perform in a day ordinary physical work equivalent to 300 foot-tons without losing weight or suffering any inconvenience. A very hard day's work equivalent to 500 foot-tons cannot be performed for long without losing muscular vigour and weight, even if the diet was considerably increased. According to Hangton the work performed by an individual walking on a level road is equivalent to raising his body plus the kit he carried to a certain fraction of the distance walked. This fraction, which is known as the *Co-efficient of traction*, varies according to the rate of speed in walking. Thus, for a speed of 2, 3, 4 and 5 miles an hour, it is 1|26, 1|20, 1|16 and 1|14 respectively. The formula for estimating the work done in walking is $\frac{W \times W^1 \times D}{2,240} \times C =$ foot-tons, where $W$=weight of the body in pounds, $W^1$=weight carried in pounds, $D$=distance walked in feet, $C$=co-efficient of traction, and 2,240=number of pounds in a ton.

## CLOTHING.

Clothing is used to maintain the normal heat of the body and to protect it from cold, heat, rain, wind and external injuries; the purposes of decency and decoration are also served by it.

The materials used for clothing are derived from animal and vegetable kingdoms. Those derived from animals are wool, feathers, fur, leather and silk, while cotton, linen, and india-rubber are derived from vegetables.

**Wool.**—Wool is a bad conductor of heat and a great absorbent of moisture. Being a bad conductor of heat, wool is warm and is worn in winter, as it does not allow the body heat to escape to the outer air, which is cooler than our bodies. The natural tendency of heat is to run from a higher to a lower level ; hence if we do not wear woollen garments, our body will give up its heat to the surrounding cooler air and we shall feel cold. Similarly, in summer it helps us in preventing the sun's heat from being conducted to our body, if it is worn next to the skin. Owing to its property of absorbing moisture, woollen garments should be worn immediately after hard exercise when the body has been perspiring, to avoid chills caused by lowering of the temperature owing to the evaporation of perspiration. The disadvantage of wool is that its fibres shrink, and become harder on washing, and thus they lose their hygroscopic power. The woollen cloth should, therefore, be first soaked in water, before it is made into a garment, and it should then be washed in soft cold or tepid water with mild soap, and should be dried without wringing out. Woollen garments being rough may cause skin affections when worn next to the skin, but they can be tolerated by habit. Flannels, blankets, shawls, worsteds, merino, cashmere, alpacca, etc., are manufactured from wool.

**Furs.**—These are very warm and afford protection to the body against cold and wind. They are very much used by European ladies as personal adornment. Fur is also used to make felt.

**Feathers.**—These are used by rich people for stuffing quilts and pillows, and by ladies as decorations to their hats.

**Leather.**—This is used as a clothing in very cold countries to protect against cold, bleak winds and rain; but it cannot be used for underclothing, as it prevents the ventilation of the air next the skin owing to its being non-porous.

**Silk.**—Silk is a bad conductor of heat and absorbent of moisture, though it is less so than wool. It is a non-conductor of electricity. Owing to its soft and fine texture it would be a useful article for underwear but for its cost. It does not shrink on washing so much as wool, and does not irritate the skin. Satin, plushes, velvets, ribbons, crape, etc., are manufactured from silk.

**Cotton.**—This is durable and cheap, and does not shrink on washing. It rapidly conducts away heat and does not absorb moisture ; therefore it is not a good material for underclothing, for, in the case of perspiration, it becomes wet and causes chill. In what is called "cellular" cotton cloth, there are large interspaces between the fibres, which hold air ; and air being a bad conductor of heat, this cloth is warmer than ordinary cotton cloth. Various fabrics of cloth are manufactured from cotton, *viz.*, jean, calico, twill, etc. It is mixed with wool to form merino, and is mixed with silk to make the cheaper kinds of silk goods.

**Linen.**—Linen is manufactured from the flax fibres. It is, in no way, superior to cotton, for like it, it is a good conductor of heat and a bad absorbent of moisture. On account of its smoothness and gloss it is used for making cuffs, collars and shirt fronts. Bed sheets made of linen are very cool and comfortable.

**India-rubber.**—This is elastic and impermeable to water, and hence is largely used in making water-proof coats, that are worn during the rainy season.

**General Remarks on Clothing.**—The clothes should be made of such materials as would preserve the body heat in winter as well as in summer, and should be so designed as would maintain the uniform temperature of the whole body. They should be white or grey in colour to protect the body from the direct rays of the sun. Black and blue colours absorb heat very readily, and so the outer garments made from these colours should never be worn in the summer when going out, but they can be worn under the shade as the sun's rays have no effect on them under shade.

The clothes should always be adapted to the different seasons of the year. They should be light and loose so as not to interfere with the functions of any of the organs. They should not press so tightly at the neck, chest, belly or waist as to impede the circulation of the blood or to change the natural contour of the parts, but should allow free movement to the muscles. They should be porous, and should not interfere with the normal functions of the skin. People should be very careful in using coloured clothes, which are generally made with aniline dyes containing arsenic. They irritate the skin, cause skin affections, such as eczema, and sometimes poison the system. It is much better, therefore, to avoid gaudy colours.

The same clothes should not be used for the day and the night. Even the poorest man should have at least two sets of garments. The clothes worn during day should not be kept in the sleeping room at night. Clothes, especially those worn next to the skin, should always be kept clean, and neat, and should be frequently changed. Dirty underwears stink horribly, and are infested sometimes by pediculi, which set up irritation to the skin, and cause great inconvenience.

In a tropical country like India a suitable head dress should always be worn while going out, to avoid the effects of the sun's rays. The turban is very good for such purposes but, if a hat has to be used, it should be so made as to cover the temples and the nape of the neck in order to protect the medulla oblongata from the direct action of the sun's rays. It does not matter much for women as the long hair that they wear is quite enough to save them from sunstroke.

**Boots and Shoes.**—Except during rains shoes are preferable to boots, as they allow the ankle more room to move. Whichever are used, they should fit the foot accurately, but at the same time all the toes should have free movement, the big toe should be in a straight line with the instep and the sole should be broader than the foot, and should be soft and pliant, though strong and durable. The heel should be broad and low. High heels cause a great inconvenience to the wearer in walking even a little distance. Most of the common deformities of the feet are due to badly fitting boots.

Children should be allowed to play about in the house without any shoes or boots, so that their feet may fully develop without any deformities or without any corns or bunions caused by badly fitting shoes. They are also better able to stand cold if properly nourished.

If socks or stockings are used, they should be made of wool or merino—a mixture of wool and cotton. They should not be fixed by garters, but suspended by elastic suspenders. They should properly fit the feet and not form any folds or creases.

# CHAPTER XV.

## INFECTION, IMMUNITY AND PREVENTION.

### INFECTION.

It has been proved beyond doubt that there are several diseases, such as typhoid, cholera, syphilis, small-pox, malaria, plague, tuberculosis, etc., which are communicable between men and men, and between men and animals. This communicability of diseases is based on the "germ theory of disease," which teaches us that the infection or poison in each case is due to the living micro-organisms which are capable of independent life both within and without the animal body. These micro-organisms, when they enter the human system, are capable of growth and multiplication and generate "toxins," which produce special symptoms peculiar to each disease. In some such diseases as diphtheria and tetanus they produce toxins at the seat of infection which are absorbed into the system, while in other cases, such as relapsing fever and anthrax, the micro-organisms invade the whole system, and multiply enormously in the circulatory system as well as in the internal organs. These poisons are then given off from the body along with the excretions, and are conveyed directly from the sick to the healthy.

Koch has laid down certain phenomena by the observation of which it can be proved that a particular micro-organism is the cause of a particular disease. These are as follows:—

(1) The micro-organism must be found in the blood, lymph or diseased tissues of man or animal suffering from or dead of the disease.

(2) This micro-organism must be isolated and cultivated in suitable media outside the animal body for any required number of successive generations.

(3) A pure cultivation thus obtained, must, when introduced into the body of a healthy susceptible animal, produce the same disease.

(4) In the blood or tissues of the inoculated animal the same micro-organism must again be found.

**Micro-organisms.**—These micro-organisms, which are also called bacteria or schizomycetes, are living organisms, consisting of a cell-wall composed of cellulose and protoplasm without chlorophyll or colouring matter. They multiply by fission or division or by the formation of spores or eggs. They are called by different names according to the forms, which they adopt. Thus **micrococci** are those which are round or oval shaped, while the rod shaped micro-organisms are called **bacilli,** and curved or spiral ones are called **spirilla** or **vibriones.**

These micro-organisms are very small, can be seen only under the microscope and vary in length from 1|50000 in. to 1|500 in. They are again divided into **parasites** and **saprophytes.** Parasites are those which obtain their nutrition only from the living animal or plant, and are mostly the disease-producing organisms, and hence are called pathogenic. Saprophytes are those which live only on dead tissues. They are also called **facultative,** when they so adapt themselves as to grow both on living organism and dead materials. They are again called **ærobes,** when they require oxygen for their growth and **anærobes,** when they can live without it. These bacteria are widely distributed in nature. They are met with in the atmosphere of the mountains, cities, as well as in that of the houses. They are present in water, as also in the soil.

The causation and spread of the infectious diseases can be compared to the sowing of a yeast plant in a saccharine solution. This plant sets up fermentation on being placed into a sugar solution by which sugar is split up into carbon dioxide and alcohol, and the plant which is only a vegetable cell grows and multiplies. Similarly a micro-organism of an infectious disease, when it gains an entrance into the human system, acts on the body by producing symptoms. At the same time it grows and multiplies, and the increased numbers are ever ready in their turn to infect other human beings, whenever they get an opportunity to enter their system. These organisms take up some time in growing and multiplying within the body and exhibiting symptoms by generating poisons, after they have attacked the human body ; and this interval between the infection and the appearance of the characteristic symptoms is known as **incubation** period, which is always different in different diseases. The full period of development of these micro-organisms represents the type and the course of the disease ; recovery means their decline and ultimate destruction, while death of the patient is the result of their toxicity or the lesions which they produce. It is necessary to know the period of incubation and the duration of the infectious diseases, for during those periods the sick individual is a probable source of danger to healthy persons.

**Disease Carriers.**—Moreover, there are persons who harbour pathogenic micro-organisms without developing any symptoms of the disease, but who are still able to infect other individuals. Such persons are called "carriers." They are of three kinds: acute, chronic and temporary. Acute carriers are those who discharge micro-organisms a few weeks after convalescence, chronic are those who go on harbouring the micro-organisms for a very long time, while temporary carriers are those who have never suffered from an infectious disease, but still harbour and discharge the micro-organisms for a short time only.

**Modes of Infection.**—The infectious diseases are carried from man to man directly by actual contact as in kissing or through soiled hands, infected towels, cups, spoons, or food and many other articles which may have been used by sick persons. In some cases the poison or virus is transferred indirectly through contaminated water, food, soil or air, while in other cases there is an intermediary host which carries infection from one individual to another. The intermediary hosts are, as a rule, insects and the chief insects concerned in the propagation of diseases are mosquitoes, flies, fleas, bugs and lice, and the diseases are called insect-borne diseases. These insects convey infection in several ways. The wings, legs, mouth parts and outer surface of the body may be smeared with the virus which is then transferred to the food and water used by men when these insects sit upon those articles ; or the virus may remain attached to the proboscis of a biting insect and may be transferred to man through circulation when it bites him. In some cases the micro-organisms are taken in the digestive tubes, as in the case of flies taking in tubercle bacilli, where they grow and multiply without affecting the insects. The germs are then deposited through the dejecta of these insects on to food or other articles, which become contaminated and then infect susceptible persons using them, or these poisons are introduced through salivary glands into wounds caused by bites.

**Classification of Infectious Diseases.**—The actual classification of infectious diseases is difficult but, according to the vehicles through which they are conveyed, they may be classified as follows :—

1. **Air-borne Diseases.**—These are carried through the agency of air, and are small-pox, chicken-pox, measles, whooping cough, diphtheria, influenza, mumps, scarlet fever, pneumonia, plague pneumonia, pulmonary tuberculosis, etc.

2. **Water-borne Diseases.**—These are carried through polluted water, and have been discussed elsewhere.

3. **Milk-borne and Food-borne Diseases.**—These have also been described.

4. **Insect-borne Diseases.**—These are the diseases which are carried by both biting and non-biting insects. The examples are malaria, plague, typhus fever, relapsing fever, sleeping sickness, yellow-fever, sandfly fever, cholera, dysentery, tuberculosis, etc.

The infectious diseases are also classified as (*a*) epidemic, (*d*) endemic, (*c*) sporadic, and (*d*) pandemic, according to the nature of their occurrence.

(*a*) **Epidemic.**—Epidemic diseases are those which spread rapidly, and attack a large number of persons at the same time from a common source of origin. In the case of these diseases the poison is imported from outside.

(*b*) **Endemic.**—Endemic diseases are those which are always present to a greater or less extent in a particular locality, *e.g.*, cholera in lower Bengal. These diseases are generally due to faults in local sanitary conditions, and are apt to flare up and become epidemic.

(*c*) **Sporadic.**—Sporadic diseases are those in which a few scattered cases occur in a locality now and then.

(*d*) **Pandemic.**—Pandemic diseases are those which spread in an epidemic form, and extend over a large area of the world. The best example of a pandemic disease is influenza.

## IMMUNITY.

The disease germs are present in the air, in water and in our food. Hence we are ordinarily exposed at all times to the sources of infection, and yet we notice that generally very few of us suffer from an infectious disease, and that many are saved from its attack. This is due to their insusceptibility or immunity to that disease. This immunity, according to Metchnikoff, is defined as a group of phenomena in virtue of which, certain living organisms possess the power of resisting attacks of disease-producing micro-organisms. It may be natural or acquired. Natural immunity is due to some inherent power of the body tissues by which the individual is able to successfully withstand attacks of an infectious disease. This power is present in men as well as in animals. This immunity is not absolute, but only relative ; for an individual who is immune to a particular disease may become susceptible to it under conditions which may help to lower the general vitality of the body, such as fatigue, starvation, indiscreet living, exposure, vitiated air and unhygienic surroundings.

Acquired immunity is of two kinds—**active** and **passive.** Active immunity is induced by recovery from a previous attack of the disease, or is produced by artificial inoculations, which are carried out in the following ways :—

(1) Inoculation into the blood or tissues of living micro-organisms of the disease;—but this method is always fraught with dangers, as the attack thus induced is as severe as the disease contracted naturally. This was practised as a preventive of small-pox before vaccination had been introduced.

(2) Inoculation into the system of the virus of a disease in a mitigated or weakened condition.—Mitigation or weakening of the virus can be brought about (*a*) by passing the organisms through the tissues of another animal as seen in calf lymph vaccination for small-pox, (*b*) by growing the cultures in a current of air as used in preparing anti-cholera vaccine, (*c*) by cultivating the cultures at a very high temperature sufficient to destroy them, as used for mitigation of anthrax bacilli, (*d*) by adding some weak antiseptic (such as carbolic acid 1 in 600) to the media in which the cultures are grown, or

by injecting such antiseptics along with micro-organisms at the time of inoculation, and (*e*) by drying the virus in air, as in the preparation of a vaccine against hydrophobia.

(3) Injection of dead cultures of bacteria as used in Haffkine's preventive inoculation against plague.

(4) Injection of the extracellular toxins of the organism as used in preparing curative sera to immunize lower animals against diphtheria and tetanus.

The individual who is rendered immune by any of these processes becomes more or less ill owing to his effort of fighting against and overcoming the organism or its toxin. Hence this sort of immunity is spoken of as active immunity.

Passive immunity is conferred on the body by the injection of anti-toxic or anti-microbic serum derived from an animal, usually a horse, that has already acquired artificially an active immunity against the disease in question. It is called passive, because the individual does not take any part in the formation of the serum. Thus the injection of some anti-toxic serum, from a horse rendered immune to diphtheria, into the body of a child produces passive immunity in that child. This sort of immunity does not, as a rule, last long.

## PREVENTION.

To suppress successfully the outbreak of any epidemic infectious disease it is necessary to acquire knowledge of the modes of transference and of the life history of any insect which may be an intermediary host in conveying the disease from man to man or from animal to man. The principal measures to be adopted to check the spread of infection of an epidemic are: (1) Notification, (2) Isolation, (3) Quarantine, (4) Education and (5) Disinfection.

## 1. NOTIFICATION.

In order to adopt prompt preventive measures against an infectious disease, the health officer of a municipality or the sanitary authority should immediately be informed of the occurrence of such a disease with full particulars by the medical practitioner treating him, or by one of the relatives of the patient, in the absence of a medical man. The health officer should be entrusted with full powers to take such steps as may be necessary to prevent the outbreak of such diseases. In England an Act for compulsory notification of dangerous infectious diseases to the sanitary authorities was passed in 1889 making it compulsory for every medical practitioner, under a penalty, to report a case of an infectious disease as soon as he has seen one. The advantages conferred by such notification are as follows :—

(1) Early information of all cases of a notifiable disease and therefore an accurate knowledge of the prevalence and the distribution of the disease in a district.

(2) Opportunity afforded of investigating into the probable cause of infection as to whether it is a local case or imported from some other place, whether it is connected in any way with bad water-supply or with insanitary surroundings of the premises, or whether it is conveyed by milk or other articles of food, etc. The causes of the outbreak can be detected only by thus comparing the data furnished by such enquiries, and proper measures can be adopted to check it by having recourse to isolation, disinfection, etc.

It is not possible to introduce this Act in India at present owing to want of education among the people and owing to the unwillingness of the people to consult qualified medical men for the treatment of infectious diseases, as most of the people imagine the occurrence of such diseases as being due to the visitation of a deity.

Much can be done, however, in this matter by taking in confidence the public and the Vaids and Hakims who form a large majority of the medical advisers to the people. Moreover in municipal towns of the United Provinces of Agra and Oudh, according to the orders of the Local Government passed in conformity with the United Provinces Municipal Act of 1916, a medical practitioner is bound to notify such infectious diseases as cholera, plague, small-pox, diphtheria, measles and scarlet-fever to the health officer or any other officer appointed by the Municipal Board for the purpose. For non-compliance with this rule he is liable to a fine up to Rs. 50. The householder is also responsible under a penalty to report such a case at once, if a medical practitioner is not called in for treatment.

## 2. ISOLATION.

As soon as information is received about an infectious case, the patient should be isolated, in a suitable hospital constructed for the purpose, though the patient should be given a choice of remaining under the treatment of his own medical attendant. The patient should not be removed in public conveyances which cannot be thoroughly disinfected, and which would thus become a source of transmitting infection. Besides, public conveyances, such as " ekkas, etc.," are not convenient for patients to be carried. It is, therefore, best to carry patients in ambulances with 2 rubber-tyred wheels usually driven by men or motor ambulances. They should always be kept ready for the purpose at police stations, municipal offices and hospitals in the town. They should be provided with an awning, and should be disinfected after use.

Owing to proper nursing, proper care about food, etc., and better sanitary arrangements in isolation hospitals, there are always better prospects of recovery there, than when the patient is being treated in his own house. Besides, the other inmates of the house and the community at large are protected from the disease by the prompt removal of the patient to the hospital. Isolation to the hospital has, however, not been regarded with favour in India either by the poor or the rich, the educated or the ignorant, owing to the inherent desire of relations to remain by the side of the patient. The next alternative is to isolate the patient in a separate room in the same house, though it is quite impossible to do so in the case of the poor, who have not got more than two or three rooms at their disposal.

Where possible, the room selected for keeping the patient should be situated on the top of the house, and no other room should be used by the inmates on that floor. It should be much better if it is detached from the rest of the building. The windows of the room should be kept open for free ventilation, but the door should remain closed, or a screen of some cloth soaked with some such disinfectant as carbolic lotion may be kept hanging in front of the door, especially in the case of air-borne diseases. No furniture should be kept in the room. A fire may be kept to burn waste matters and also to aid ventilation. No one except the person nursing the patient should enter the room, and he should not leave the room without thoroughly disinfecting his hands and changing his clothes. Food, utensils, clothes and dejecta of the patient should not be removed from the room without previous disinfection. It is better to use a spray of some deodorant all the time in the room. Isolation of the patient should be maintained from the day of infection to the day when the doctor pronounces him free from possible infection to others. The patient should then be given the necessary baths and allowed to mix with other people.

## 3. QUARANTINE.

This term is derived from the Italian "quarante" meaning forty, and refers to the detention of ships at seaports for a period of forty days as a preventive measure when arriving from infected countries or with cases infected by a dangerous disease, such as cholera. Quarantine is also imposed on travellers going from an infected district into another district or province. The travellers are detained in quarantine camps, where they are inspected and disinfected along with their baggage, and are allowed to leave the place after the incubation period of the particular infectious disease raging at the time is over. This practice is very objectionable, and has never been regarded with favour by the public, as it causes considerable hindrance to trade and travel. In the beginning of the outbreak of plague the Government adopted this kind of quarantine by having detention camps with a military cordon at several railway junction stations and at some places of pilgrimage as at Hardwar, where the travellers used to be detained for ten days and were allowed to leave the camps after their luggage and they themselves were thoroughly disinfected, but it did not prevent the plague from spreading throughout almost all India owing to the lack of supervision and honesty of the subordinate staff. The people, on the contrary, were put to a lot of hardship and inconvenience, and at some places even riots had broken out.

There would be very little need of adopting quarantine as a preventive measure, if all the communities were to rely on sound sanitation and were to place their cities and seaports in the best sanitary conditions, so that there would be little danger of the spread of an epidemic, even if it could gain entrance there. The only preventive measure in that case would be to inspect the passengers and crew on board ships and to remove the sick to hospitals and to disinfect them. In the case of an outbreak of an epidemic in the cities, the inmates of the house, where infection has occurred, must be kept under a certain degree of quarantine, if the case has not been removed to the hospital, until the last case has ceased to be infectious and the final disinfection has been completed; but if the patient is removed to a hospital and disinfection has been carried out, it is only necessary to keep the inmates under observation for the maximum period of incubation of the disease in question. During the quarantine period, the children from the infected house should not be allowed to attend school, though this is not necessary in the case of enteric fever. Tailors, milk-men, *dhobies*, sweetmeat sellers, etc., should not be allowed to carry on their business if an infectious disease has occurred in their household or on their business premises.

The people themselves have begun to realise the importance of this sort of quarantine, and therefore they never allow any shelter to people coming from infected villages or towns. Even in big cities cases have been known in which the inmates of a house were boycotted by the neighbours, because they allowed persons to live with them who had gone there from another infected street.

## 4. EDUCATION.

The people become panic-stricken when an epidemic breaks out, and so it should be the duty of the sanitary authorities to issue pamphlets and circulars regarding the disease in all the vernaculars of the district to educate them, while other measures should be carried out to combat the disease. The education of the community is essential for the sake of obtaining co-opèration, for it is not possible to eradicate an epidemic without the active support of the people. Press *communiques* should be issued in responsible vernacular papers, as was done some time ago by the Government of Bombay with regard to the outbreak of cholera. Lectures and demonstrations, with magic lantern slides, should also be arranged in different *mohallas* of the city. The Sub-Assistant Surgeons in charge of travelling dispensaries can help a good deal in this matter, if they were to start lecturing in the plain vernacular to the people in different villages on epidemic diseases, their causes, their spread and the measures taken to prevent and cure them.

## 5. DISINFECTION.

By disinfection is meant the destruction of the agents causing infection. A disinfectant is a substance or an agent which is capable of destroying the pathogenic germs, or the infective material. It is synonymous with the term "germicide" or "bactericide." An antiseptic is a substance which prevents decomposition, and inhibits the growth or activity of micro-organisms without destroying them. A deodorant is a substance which has the power of removing, covering and destroying the unpleasant odours arising from organic matter undergoing fermentation or decomposition. There is a great difference between a disinfectant and a deodorant. The former destroys the germs, while the latter neutralizes only the smell. Thus eau-de-cologne, eucalyptus oil, camphor, Sanitas, and tobacco smoke, are all deodorants, as they remove bad smell, but cannot be considered disinfectants, as they are powerless to destroy the germs causing ill-odorous gases; but we should aim at thorough cleanliness so as to remove the source of the nuisance, so that putrefaction may not occur rather than use the deodorizing substances to conceal the smell of offensive gases arising therefrom, just as the surgeon arms at thorough asepsis in his operations.

Persons undertaking the work of disinfection must be thoroughly conversant with the causes and modes of conveyance of infectious diseases, and they should personally supervise the work instead of leaving it to the irresponsible and inexperienced menial staff.

**Classification of Disinfectants.**—Disinfectants are divided into three kinds, *viz.*, (1) Natural, (2) Physical and (3) Chemical.

(1) **Natural.**—Fresh air and sunlight are the chief agents of nature, which always destroy infection, and thereby limit the spread of the communicable diseases. The poison of such diseases when exposed to fresh air is very much diluted and often destroyed; hence the importance of free ventilation of a sick-room during and after sickness. Besides, dryness, temperature and sunlight are very good agents in destroying micro-organisms, though their spores take more time to be thus destroyed; hence the tiles of the roofs of some houses used to be removed to let light in at the time, when plague broke out in Bombay in 1896 and 1897.

The oxygen of the atmosphere also plays an important part in chemically acting upon and thus destroying the infective materials adhering to articles exposed to the air.

On the outbreak of an epidemic of an infectious disease, people must use natural agents to remove infection by observing scrupulous cleanliness in their rooms, keeping them dry and keeping all the doors and windows open so as to allow free ventilation.

(2) **Physical.**—Fire and exposure to heat—dry or moist—are the physical agents used for disinfection.

Fire is the most efficacious of all the methods of disinfection, and it is the best and the safest thing to burn all the infected articles of little value. Cottages, which can easily be renewed, should be burnt, especially in time of plague. The litter of stables and the refuse of a town should be burnt, especially when some pestilence has occurred; and it is safer to cremate all bodies dead of a communicable disease. Small quantities of sputum and other discharges should always be burnt rather than disposed of in any other way ; but no article should be burnt against the will of its owner, and, as far as practicable, the owner should be compensated by the municipal board for his articles that are burnt.

**Dry Heat.**—Micro-organisms and even the spores are killed, when exposed for one hour at a high temperature of 115° C. in a hot-air chamber; but disinfection by dry heat is being given up now, as it is not capable of penetrating into bulky articles like mattresses, while woollen and similar other articles are always scorched and destroyed by it; it is, however, serviceable for articles of glass, leather, morocco, india-rubber, books, etc.

**Moist Heat:** (*a*) **Boiling.**—This is one of the readiest and the most effective methods of destroying infections of all kinds. Boiling for 20 minutes kills almost all non-spore-bearing micro-organisms. A few spore-bearing bacteria, such as anthrax and tetanus, are generally destroyed by boiling for one hour. Boiling is suitable for disinfection of bed-clothing, body linen, towels, etc. The albuminous stains of blood, pus and fæces on the articles should be first removed by soaking them in cold water and rubbing them with soap, before they are boiled since heat fixes the stains permanently on account of the precipitation of albumen. Metal utensils, wooden furniture, beds, and floors and walls of an infected room may be disinfected by cleansing them with boiling water. Sodium bicarbonate should be added if steel instruments have to be boiled.

(*b*) **Steam.**—This is a most reliable and quick disinfecting agent, and has the power of penetrating deeply in bulky articles, such as pillows, mattresses, etc. It rapidly destroys vegetating bacteria, and kills most of the spores in a few minutes. Steam may be saturated or superheated. Saturated steam is steam generated under pressure at a temperature higher than that of the boiling water (100°C.), and is at or near its condensation point. Superheated steam is steam heated above its natural condensation point by bringing it into contact with a surface at a higher temperature than 100° C. without increasing the pressure. For purposes of disinfection saturated steam is preferable, since it easily conveys heat and readily condenses to a liquid form on coming into contact with cooler objects. In so doing it gives off its latent heat to those objects, is reduced to $\frac{1}{1,600}$th part of its volume, and owing to a partial vacuum thus created, more steam rushes in and thoroughly permeates the objects to be disinfected. Superheated steam is practically a gas, and will not condense until it has lost all its superheat. Hence it has very little penetrating power, and acts by conduction. Its only advantage is, that it dries moistened objects.

Whatever be the condition of steam, either saturated or superheated, it is generally employed as current steam or steam under pressure. Current steam is steam escaping from a boiler, as soon as it is generated at the temperature of boiling water. It has the same disinfecting power as boiling water, and destroys infective agents from half an hour to an hour. Steam under pressure has a greater germicidal action than current steam at low or atmospheric pressure. Steam at high pressure means a pressure of about 15 to 20 pounds per square inch. The higher the pressure, the more thorough is the penetration, and the shorter is the time required for killing bacteria. Exposure to a saturated steam of 115° C. for 30 minutes is commonly considered quite sufficient.

Steam is used in disinfecting bedding, pillows and other articles of cotton; but it is injurious to silk and shrinks woollen materials, which lose their colours also. Leather, India-rubber, oil-cloth and varnish also suffer from steam.

Another drawback in using steam is the necessity of an expensive apparatus, to work which a skilled man is needed, and there should be provision also for a disinfecting station.

The air should be expelled from the apparatus before generating steam, for air being a bad conductor of heat prevents the steam from penetrating into the interstices of the articles.

The articles to be disinfected should be packed in gunny bags and sealed up before they are sent away to the disinfecting station.

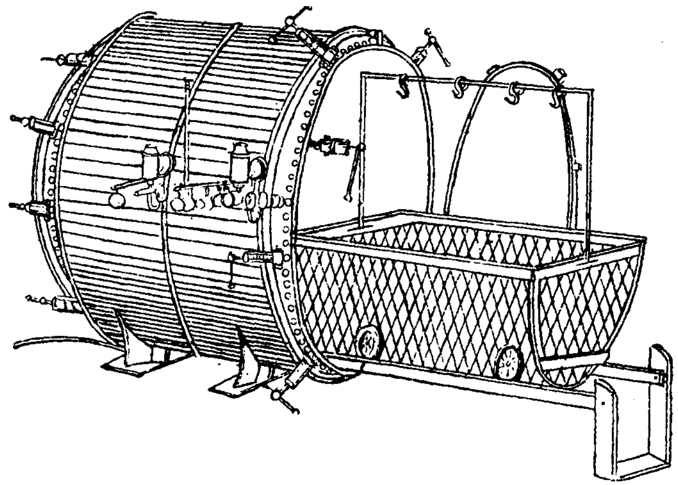


Fig. 30—Steam Disinfector.

**Steam Disinfectors.**—Several types of the steam disinfectors are employed for carrying on disinfection by steam, but those commonly used are the Washington Lyon, the Equifex and the Thresh.

The Washington Lyon's Disinfector is an apparatus, consisting of an elongated boiler having double walls and fitted with a closely-fitting, air-tight door at each end. The wall of the disinfecting chamber is surrounded by a jacket so as to prevent the loss of heat and to dry the articles after they have been disinfected. The apparatus is so placed in the partition between the two rooms, that one end opens into one room which is used for receiving infected articles, and the other end opens into the other room, which is used for receiving disinfected articles. The infected articles on wooden trays are introduced into the apparatus through one opening and when disinfected are taken out at the opposite door. There being no direct communication between the two rooms and the persons employed in both the rooms being quite separate, there is no possible risk of reinfection of disinfected articles. Steam is admitted into the chamber at a pressure of 20 to 25 lbs.; and its penetrating power may be increased by intermitting the pressure during the process of disinfection. When disinfection is complete, steam is cut off from the chamber, while it is continued in the jacket, and thus the articles are dried before they are removed.

The Equifex Disinfector has no steam jacket, but is provided with coils of hot steam pipes at the bottom and top of the chamber with a view to prevent undue condensation and to dry the disinfected articles. Steam is generated in a boiler quite separate from the apparatus, and is then intermittently admitted into the disinfecting chamber at a pressure of between 7 and 10 lbs. The process of disinfection is usually completed in about 20 minutes.

The Thresh's Disinfector is a low-pressure apparatus, and consists of a central chamber surrounded by a jacket boiler containing a solution of calcium chloride. The jacket boiler is heated by a small furnace placed underneath, and the steam generated is conducted into the central chamber. Owing to the presence of the salt the water boils at a temperature higher than its boiling point, and the steam is given off at about a temperature of 106°C. without the application of extra pressure. When this superheated steam has passed for a sufficiently long time, it is readily diverted and allowed to escape through a chimney. Hot air is now admitted, and at the end of an hour the articles may be removed quite dry and disinfected. This apparatus is cheap and suitable for small hospitals.

(3) **Chemical.**—Chemical disinfectants are used in all the three states, *viz.*, gaseous, liquid and solid. They act either by killing micro-organisms, or by preventing their growth and multiplication, or by weakening the microbes, so that they may lose their pathogenic action.

The ideal disinfectant must be cheap and easily obtainable. It must be very strong in its germicidal action. It must be stable in its composition and soluble in water. It must not lose its action in the presence of organic matter like blood, pus, urine and fæces. It should have no poisonous action on men or higher animals, and should be non-corrosive. It should not bleach colouring material, nor should it have any injurious action on any articles of wood, leather, paper, wool, etc.

**Gaseous Disinfectants.**—The chief gaseous disinfectants are formaldehyde (formic aldehyde), sulphur dioxide, and chlorine. Formaldehyde is soluble in water, a 40 per cent. solution of it being known as formalin. It is a very valuable germicide and is, therefore, one of the best gaseous disinfectants. It is also a good deodorizer, as it combines readily with the nitrogenous products of putrefaction and fermentation, and forms new odourless chemical compounds. It has no injurious effects upon wool, silk, cotton, linen or metals, and has no action on colours; and hence its usefulness in universal application. It acts most readily in dry atmosphere, but not in moisture.

The vapours of formaldehyde are obtained (1) by heating formalin with 20 per cent. calcium chloride in an autoclave; (2) by heating paraform tablets over a special lamp called the paraform lamp (25 tablets, each containing 1 gramme, are sufficient to disinfect 1,000 cubic feet of space); (3) by exposing formalin to a high temperature in a special generator; and (4) by the heat evolved by the chemical action between formalin and potassium permanganate.

Sulphur dioxide is obtained by burning flowers or rolls of sulphur, which are easily procurable in an Indian bazar. Three to four pounds of sulphur should be burnt for efficient disinfection of a room having a capacity of 1,000 cubic feet. Cylinders containing 20 ounces of the liquefied gas are sold in the market and are very convenient. Two such cylinders are sufficient for a space of 1,000 cubic feet.

Sulphur dioxide is a colourless gas having a peculiar suffocating smell. It is a powerful bleaching agent, and readily deprives silk, wool, and other articles of their organic colouring material. It tarnishes metals. It is highly poisonous to mammalian and insect life and, therefore, is very valuable as a disinfectant against diseases spread by rats, flies, fleas, mosquitoes and other insects.

Fumigation with sulphur dioxide is carried out by burning sulphur in some iron vessel, which should be placed in a bucket of water to avoid the risk of fire. The presence of water by its evaporation supplies the necessary amount of moisture required to render sulphur dioxide more potent in its action. It is better to place the bucket and the iron pot on a high stool or table for complete diffusion in a room as this gas being heavier than air has a tendency to settle down on the floor.

Chlorine is both a disinfectant and deodorizer. Its action is increased in the presence of moisture as it combines with hydrogen and liberates oxygen in its nascent state, which bleaches the vegetable colouring matter and prevents putrefaction by oxidizing organic matter; but great care should be observed in its employment, as it possesses a strongly irritating smell, and causes pain and even death if inhaled in larger amount.

It is generated by mixing together 8 ounces of sodium chloride, 2 ounces of manganese dioxide, 2 ounces of sulphuric acid and 2 ounces of water. The reaction can be represented by the following equation:—

$$2NaCl + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2.$$

It can also be obtained by decomposing 1½ pounds of chloride of lime with 6 ounces of sulphuric acid, or by the action of HCl on bleaching powder, or by slightly heating potassium bichromate with concentrated hydrochloric acid.

Ordinarily about 2 pounds of bleaching powder and 1 pound of strong hydrochloric acid should be used for every 1,000 cubic feet. The vessels containing these substances should be placed on high stools, as chlorine being a heavy gas is slow in diffusing. It is necessary that one per cent. of the gas should be present in the air of the room to be disinfected.

**Liquid Disinfectants.**—It must be remembered that the strength of a liquid disinfectant should not be lowered, when it is added to a fluid, which is required to be disinfected. An excess of it should always be added, so that the same strength might be maintained in the whole bulk of the fluid. To compare the strengths of the various disinfectants Rideal and Walker have proposed a method, which has lately been modified and improved. According to this method a 1 in 100 solution of carbolic acid is taken as a standard disinfectant, and the bacillus typhosus in a 24 hours' broth culture at blood heat is taken as the standard germ. Various dilutions of the disinfectant, whose strength has to be ascertained, are made, and the highest dilution, which destroys the typhoid bacillus in the same time as the standard solution of carbolic acid, is determined by making experiments. This dilution divided by 100 is known as the **carbolic acid co-efficient** of the disinfectant used.

The following are some of the liquid disinfectants in common use:—

**Mercuric Chloride or Corrosive Sublimate** ($Hg\ Cl_2$).—This is the most powerful and most convenient disinfectant. A solution of 1 in 1000 destroys non-spore-bearing bacteria, but a solution of 1 in 500 is necessary to kill spores. A warm solution is stronger than a cold one. It is colourless and highly poisonous and should, therefore, be coloured with indigo or aniline colours and kept in special poison bottles. It corrodes metals and so should be stored in non-metallic vessels. It must be used in excess as a large quantity of it is precipitated by organic matter as an albuminate. This can be prevented by the addition of hydrochloric acid or common salt to the solution. The following solution is generally used for disinfecting infected houses:—Mercuric chloride ½ ounce, hydrochloric acid 1 ounce, and water 3 gallons.

**Mercuric Iodide** ($HgI_2$).—This is less poisonous than $HgCl_2$, and is not precipitated by albumin to the same extent, while it is twice as strong as mercuric chloride. It is insoluble in water, but is soluble in excess of potassium iodide. It is used very much by surgeons to disinfect their hands.

**Mercuric Cyanide.**—This is as powerful as the chloride, but is not precipitated by any albuminous or organic matters. It is, therefore, suitable for disinfecting mud floors smeared with cowdung. An emulsion with kerosene oil and in the strength of 1 in 50 is used for disinfecting plague-infected houses.

**Carbolic Acid** ($C_6H_6O$).—This is used largely in disinfecting excreta, sputum, soiled clothing and bedding as it does not coagulate albumin. A 5 per cent. solution should be used to destroy the resisting organisms.

**Izal.**—This is non-poisonous, and forms an emulsion when mixed with water. It is extracted from an oil obtained from coke ovens. 1 in 200 destroys non-spore-bearing organisms in 5 minutes, and a 10 per cent. solution kills the spores of anthrax bacillus in 15 minutes. An emulsion of 1 in 100 is used to disinfect rooms and wooden furniture.

**Lysol.**—This is more powerful as a germicide than carbolic acid, and is used in 1 per cent. solution in surgical cases. It is non-poisonous, and forms a clear frothy soapy liquid when mixed with water.

**Cyllin.**—This is non-poisonous and very similar to izal in its properties. On account of its non-injurious effects on clothing, metals, etc., it is largely used now-a-days in disinfecting plague-stricken houses. It is used in 2 strengths, *viz.*, 1 in 160 for disinfecting stools, sputum, floors, etc., and 1 in 320 for disinfecting clothes, furniture, etc. A solution of cyllin and petrol mixed in equal quantities makes a very good disinfectant and insecticide.

**Hycol.**—This is 18 times stronger than carbolic acid in its germicidal action, but the disadvantage is that it has a tendency to stain clothes. 1 in 200 is used for disinfecting walls, and 1 in 400 for clothes.

**Formalin.**—This is a commercial name for a 40 per cent. solution of formaldehyde. In a 1 per cent. solution it is a powerful germicide. It is used in the proportion of 10 drams to a quart of water for disinfecting sputum, urine and fæces, and is used as a spray in the proportion of 6 ounces to a gallon of water. The chief advantage of formalin as a disinfecting spray is that it does not damage wall-papers, etc.

**Solid Disinfectants.**—These are potassium permanganate, lime, chlorinated lime (bleaching powder), ferrous sulphate and soap.

**Potassium Permanganate** ($KMnO_4$).—The chief use of this salt in India is to disinfect wells contaminated with cholera germs. It readily gives up its oxygen to organic matter, and hence becomes inert very soon. It stains articles of clothing, and therefore cannot be used for disinfecting them; however, its stains can be removed by oxalic acid, hydrochloric acid or lime juice.

**Lime.**—This is a cheap and valuable disinfectant, but it should always be fresh. It is largely used for disinfecting excreta. It is also used for white-washing the walls of rooms, but their surfaces should be scraped before they are white-washed. Quicklime has lately been suggested as a disinfectant of well water. 30 lbs. of lime are considered sufficient for a well.

**Chlorinated Lime (Bleaching Powder).**—This is an excellent disinfectant, but rapidly loses its strength in this country especially in hot damp weather, the whole of the disinfecting powers being lost in three weeks after a closed drum has been opened. To be efficient it should contain about 33 per cent. of available chlorine. It may be used as a dry powder or in solution. As a dry powder it is thrown about on the floors of sick rooms, and privies and acts as a deodorant. A 4 per cent. solution of chlorinated lime is used to disinfect the excreta of sick persons. One part of this salt in 200,000 parts of water is used to disinfect drinking water contaminated with typhoid or cholera bacilli. It is very unstable, and should always be kept in stoppered bottles. Chloros, which is sold in the market in a liquid form, contains 10 per cent. of available chlorine.

**Ferrous Sulphate or Green Vitriol** ($FeSO_4$).—This is used as a deodorant, and acts by its reducing action. It is used for disinfecting excreta and drains and gullies.

**Soap.**—This possesses disinfecting properties owing to the alkalies it contains; but medicated soaps are no good and should not be relied on.

## INSECTICIDES OR PULICIDES.

The insects that carry infectious diseases are mostly rats, fleas, flies, lice, bugs and mosquitoes. They are all killed by fumigation with $SO_2$, HCN, $CS_2$, or other irrespirable gases, but it is not possible to carry out thorough fumigation in most Indian houses. Hence we must use other agents that will kill these insects. These are as under:—

**Pyrethrum.**—This is a popular remedy for killing insects, as it is non-poisonous to man and higher animals. The pure powder stupefies flies, mosquitoes and other insects by acting through their breathing pores, when it is sprinkled on them. It is sold as "Persian insect powder." It is used as a dry powder or by its burning fumes. It ignites well, if a little alcohol is sprinkled over it. Two pounds of the pyrethrum powder are usually burnt for 1,000 cubic feet of air space.

**Phenol-Camphor.**—This is a liquid compound prepared by rubbing up equal parts of phenol crystals and camphor. On moderately heating the liquid, it gives off dense fumes, which rise rapidly and diffuse slowly, and kill mosquitoes, flies and other insects by stupefying them. Care must, however, be taken that, it is not over-heated, or else it will take fire and will have no action on the insects. Four ounces of phenol-camphor are considered sufficient for every 1,000 cubic feet of air space.

**Pesterine.**—This is crude petroleum and instantly kills fleas, bugs and other insects that come into direct contact with it. Rats are killed by pouring it into rat holes.

The solution of pesterine made with soap and water is either sprayed to the walls or applied to the floors and walls by means of a brush with a long handle.

**Petrol.**—This kills fleas on mere contact, and its fumes kill them in about one minute. Equal parts of cyllin and petrol are used to disinfect houses where plague cases have occurred.

A mixture of petrol, benzene and crude petroleum in the proportion of 1 : 2 : 3 forms an excellent pulicidal agent.

**Kerosene Oil Emulsion.**—This is used according to the following formula :—

Common soap 3 parts, water 15 parts, and kerosene oil 82 parts. Soap and water are first boiled and when all soap is dissolved, the soap mixture is placed in a wooden tub and kerosene oil is slowly poured into it, slowly stirring it until all the oil is absorbed into it. Captain Gloster, I.M.S., found by experiment that fleas were killed in 2 minutes by a 1 in 1000 solution of this emulsion. The emulsion should be used diluted with 20 parts of water for earthen floors.

**Kerosene Oil and Cyanide of Mercury.**—Two parts of cyanide of mercury and 100 parts of kerosene oil are used for killing fleas and other insects in Indian houses; but it is costly, and so its use is limited.

## METHODS OF DISINFECTION.

**Excreta and other Discharges.**—Fæces and urine in typhoid fever, bowel discharges and vomits in cholera, stools in dysentery, sputum in tuberculosis and pneumonia, discharges from the throat and nose in diphtheria, measles, whooping cough and influenza are very dangerous as a source of conveying diseases from the sick to the healthy, and so they should be properly disinfected before they are finally disposed of.

The infected stools, urine, sputum, etc., should be received in vessels made of glass or some other impervious material containing any one of the following disinfectants:—

Acid carbolic solution 10 per cent., izal 5 per cent., cyllin solution 1 in 160, chinosol 1 in 500, solution of formaldehyde 4 per cent., solution of bleaching powder 4 per cent., and equal quantities of fresh quicklime and water. Whatever disinfectant is used enough should be added to the material to be disinfected so as to maintain the necessary percentage of strength for disinfection; both should then be thoroughly mixed together, and should be allowed to stand covered up for one to three hours. They should then be discharged into a sewer, or in villages and towns where there are no sewers, should be buried deep in the earth far away from a well, or any other source of water-supply. It is still better to burn them after adding enough sawdust.

**Articles of Clothing.**—Articles, such as towels, napkins, handkerchiefs, blankets, bedsheets, mattresses, and underwear clothing should always be disinfected, if they have been exposed to infection of any communicable disease. They should be subjected to steam disinfection, if there is an arrangement of a suitable steam disinfecting apparatus. In the absence of this, they should be soaked in carbolic acid 5 per cent., or formalin 10 per cent., or perchloride of mercury 1 in 1000, or izal 1 in 20, or cyllin 1 in 320 for at least 12 hours, then boiled for half an hour and washed. The articles that are soiled with such discharges as pus, blood or excreta should be first washed with soft soap and water, before they are immersed in a solution of mercuric chloride or boiled, as both mercuric chloride and boiling precipitate albuminous matter contained in those discharges, and thus render the stains permanently fixed to the clothes.

Silk fabrics which are apt to be injured by boiling should be placed in the sun for three periods of eight hours each. Leather goods should be carefully wiped over with formalin.

**Dead Bodies.**—Before they are removed to the burial ground or the burning ghat, the bodies of persons dead from infectious diseases should be carefully wrapped round with a sheet soaked in a strong solution of mercuric chloride, carbolic acid or izal.

**Houses.**—Infected houses are disinfected either by fumigation or by means of sprays. The nature of disinfection depends also upon the nature of the disease. Thus in the case of cholera particular attention should be devoted to disinfection of the fæces, vomit and urine and articles soiled by them; in the case of plague we should direct our attention to destroy rats, mice and fleas together with destruction of the plague bacillus; and in the case of malarial fever the chief aim should be to kill anopheline mosquitoes. Another important point to note is that no parts of the house such as privies, staircases, etc., should be left without being disinfected. In the case of bungalows the servants' quarters and stables should always be disinfected.

Thorough disinfection cannot be carried out unless houses are evacuated, and so the first essential thing is their evacuation by the inmates. Rooms should then be specially prepared for fumigation with either formaldehyde, sulphur dioxide or chlorine. The rooms should be made as air-tight as possible, so that the gas that is generated inside might not be lost through leaks by diffusion; all the windows, chimney and orifices should be closed tightly, and pasted with thick paper and all the chinks and crevices should be closed by pasting paper or by applying some impervious material. The almirahs, drawers and boxes should all be opened, and kept away from walls and clothing and other articles contained in them should be hung on strings, so that the gas might freely enter and diffuse through all the corners. The rooms should thus be fumigated for at least six hours. The doors and windows should then be opened, but no one should be allowed to enter until the smell of the gas is driven off.

The clothes and other articles should then be separately disinfected, all wooden furniture, such as bedsteads, etc., should be washed with mercuric chloride lotion, or formalin, or with soap and hot water. The floor should be well scrubbed, the walls and ceiling should be lime-washed and the rooms should then be allowed to be occupied.

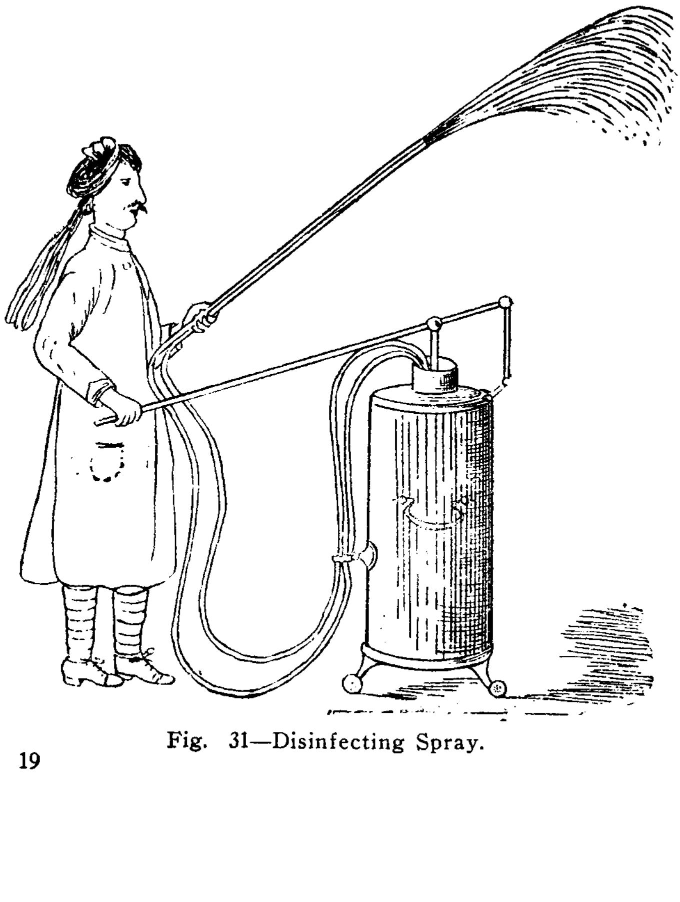


Fig. 31—Disinfecting Spray.

In *katcha* houses, or those houses where it is not possible to render the rooms air-tight, disinfection can be carried out by means of disinfecting sprays. Two gallons of a solution should be used for every 1,000 square feet of surface. In the absence of the sprays the surfaces of walls and floors can be disinfected with garden syringes filled with mercuric chloride solution, cyllin or formalin solution, or pesterine in the case of plague. The persons engaged in using these sprays or syringes should wear boots, putties and overalls, which they should leave behind on leaving the house. Disinfection by sprays should be carried out in the morning so that the rooms might dry by the evening, or it might be necessary to dry them by burning fire in big *angithes*. The walls of the rooms should always be white-washed before they are occupied.

Privies and bath-rooms should be disinfected by izal, carbolic or cyllin lotion, and should be kept thoroughly clean. The walls, seats, and the *gumlas* should also be disinfected. Drains and gullies should be disinfected with a solution of ferrous sulphate in proportion of 1 lb. to 1 gallon of water, or with a solution of hycol or cyllin; or should be sprinkled over with carbolic powder, Sanitas powder, bleaching powder or lime.

# CHAPTER XVI.

## MALARIA, YELLOW FEVER AND DENGUE.

### MALARIA.

THIS is a very widely prevalent disease, and is spread over almost all the parts of the globe. Broadly speaking, the disease is more prevalent in tropical and sub-tropical countries, and becomes much more prevalent as the Equator is approached. However, even among such countries certain districts are far more malarious than others, while some enjoy a complete exemption in this respect. Similarly in India the Presidency of Madras suffers much less than the Presidencies of Bombay and Bengal, while in Bengal itself it is much more malignant in Lower Bengal and Assam. Jasalmir State is said to be non-malarious.

The incidence of the disease is greatest, when the atmosphere is hot and moist. It is also largely to be seen along the banks of the rivers, canals, and in marshy, low-lying regions.

The season has a great influence over the occurrence of the disease. In temperate climates it is active only during the warm season, and in the tropics it is most prevalent in the wet season. In India it is less prevalent in the first half of the year up to June, but the epidemic as a rule breaks out in August or September and reaches its maximum intensity from October to December.

### CAUSATION.

The disease is caused by a microscopic amœboid parasite called the plasmodium of malaria belonging to the class "sporozoa." It is a unicellular organism consisting of protoplasm, a neucleus and a neucleolus. It has the charcteristic of living at the expense of other cells, and hence is called an endocellular parasite. It possesses amœboid movements, grows and multiplies by fission or spores. This parasite infects birds, sheep, cattle, dogs and man. In man there are three distinct species of this parasite—two of the mild or benign type, *viz.*, tertian and quartan, and one of the malignant or æstivo-autumnal form which is supposed to form crescents. That these three species of malaria parasites are quite distinct from one another is demonstrated by inoculating the malarial blood from a diseased man to a healthy man. The inoculation of a drop of malarial blood will reproduce the same type of the fever and the same type of the parasite which is inoculated.

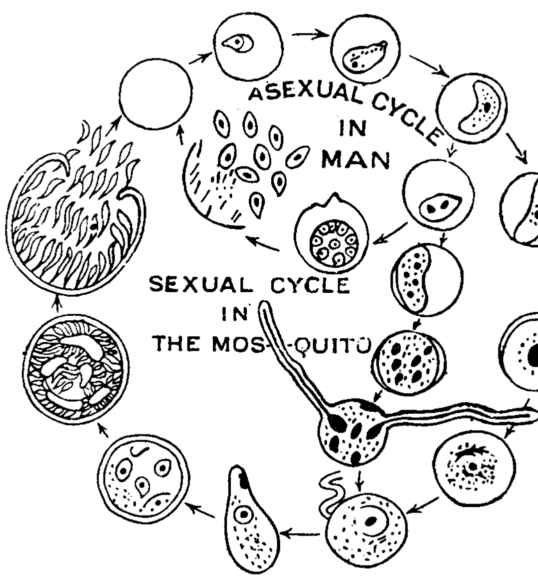



Fig. 32—Malarial Parasite.

It was first discovered by Dr. Laveran, a French army surgeon, but it was left to Sir Patrick Manson and Major Ross to find out that the mosquitoes playec a very important part in the propagation of this disease. In 1895 Major Ross found out that both man and the anopheles mosquito were necessary to complete the life cycle of the malarial parasite, the former being the intermediate host, which harbours the asexual phase, and the latter is the definitive host harbouring the sexual phase of its life cycle. In man it inhabits the red blood corpuscles; and in the mosquito it is parasitic in the tissues of the stomach wall and in the salivary glands.

**Life-history of the Malarial Parasite.**—The young form of the parasite called **Schizont** enters the red blood corpuscles of a man's blood. It is seen under the microscope as a small unicellular mass of protoplasm, undergoing amœboid movement and occupying but a small portion of the whole corpuscle. It gradually grows larger, feeding upon the substance of the red blood corpuscle and converting the hæmoglobin into dark granules of pigment **(melanin)** which can be seen in the parasite. When it has grown to its full size so that it nearly or quite fills the corpuscle, the grains of pigment collect together into a mass, and the parasite begins to divide up into a number of small parts or segments called spores, each of which is capable of becoming a new parasite identical in all respects with the original. These parts or spores remain in contact with one another for some time and then burst through the red blood corpuscles and become free in the blood stream. Each of them now seeks out and enters a red blood corpuscle, in which it begins to grow in the same way as the original did, finally reaching its full size and dividing up into a number of embryo parasites which again enter other corpuscles and go through the same cycle. This is the asexual method of multiplication by division called **schizogomy.**

After this multiplication has gone on for a number of days, some of the parasites in the red blood corpuscles instead of further multiplying and dividing up, commence to form sexual forms called **gametocytes.** There are two kinds of these sexual forms, *viz.*, male forms called **micro-gametocytes** and female forms called **macro-gametocytes.** Having attained their full size, they appear as coarsely pigmented round or crescent-shaped bodies enclosed within the thin shell of the red blood corpuscle. They undergo no further development in the blood of man and gradually die off. At this stage of their life-history it is necessary for them to enter the anopheline mosquito to complete their development. When such a mosquito bites a person with these sexual forms in his blood, some of them are carried into the mosquito's stomach with the blood which it extracts, and undergo further development. On account of the action of the digestive juices in the stomach, the thin shell of the red blood corpuscle, which was protecting the parasite while in human blood, gets disintegrated and sets free the parasite in the fluid of the mosquito's stomach. The female sexual form now becomes a granular spherical body. The pigment of the male sexual form becomes agitated violently, and three or four long filaments called **microgametes** are suddenly protruded from the periphery. These filaments then break off and float about in the fluid in the mosquito's stomach. They are the true male element in the sexual process. When one of them meets a female sexual form, it enters it, and fertilizes the true female element called **macrogamete** contained in it. After this fertilization the female parasite changes its shape and becomes ovoid with a pointed end which is named **ookinet.** It then moves about, and rests between the epithelial and muscular layers of the stomach after entering its inner wall. Here it begins to grow and in a few days attains a large size, when it is called **zygote.**

By a process of division called **sporogony** a large number of embryo parasites called **sporozoites** are formed in the full-grown **zygotes.** After some time the capsule of the zygote bursts, and the sporozoites are set free into the lymph sinuses which surround the outer surface of the stomach. They are then carried to the salivary glands through the circulation and deposit themselves into the gland cells and the salivary duct, which opens into one of the piercing stylets of the proboscis. These parasites are inoculated into the blood of man, when the mosquito bites him, when they at once attack the red blood corpuscles and commence the human phase of the parasite. The mosquito phase of the parasite's life occupies ten to twelve days for its full development.

## INCUBATION PERIOD.

This varies with the type of the fever. In the tertian it is from 6 to 12 days, and in the quartan 11 to 15 days.

## MOSQUITOES.

Mosquitoes belong to the order of insects known as Diptera and to the family group called the Culicidæ. They can be distinguished from other insects of the same order by a long piercing and sucking proboscis and by having two wings, one on each side with its veins covered with scales.

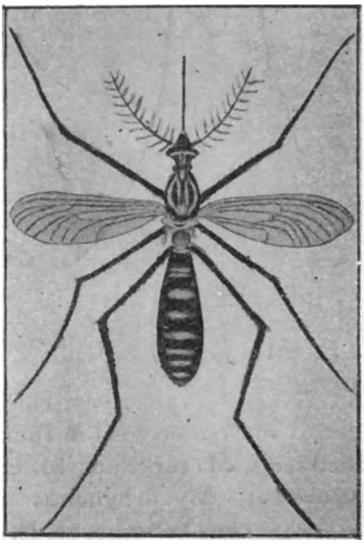


Fig. 33—Anopheline.

Three principal genera of mosquitoes are important to medical men in the tropics.

They are culex, stegomyia and anophelina. Culex are concerned in carrying **Filaria bancroftii** and the carrier of dengue fever. One variety of stegomyia propagates the yellow fever and anophelina consist of more than 100 known varieties, out of which some carry malaria. The

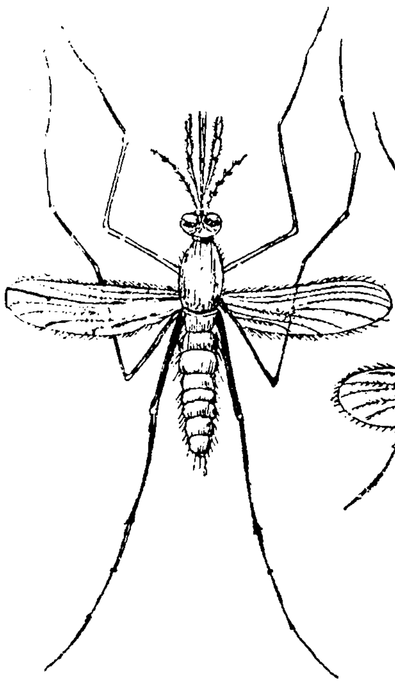


Fig. 34—Stegomyia.

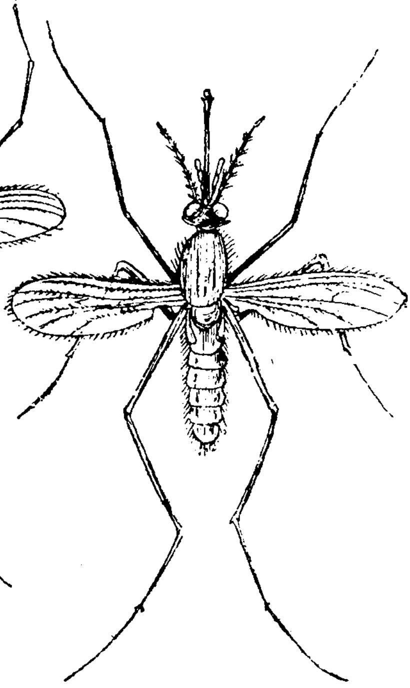


Fig. 35—Culex.

chief of these met with in India are **Myzomyia rossii, M. culicifacies, M. turkhudi, M. christophersi, Pyretophorus jeyporensis, Myzorhynchus sinensis, M. barbirostris, Nyssorhynchus fuliginosus, N. maculipalpis, N. stephensi, and N. theobaldi.**

**Life-history.**—Mosquitoes pass through four stages of development, *viz.*, (1) the egg or embryo, (2) the larva, (3) the pupa or the nympha stage, and (4) the imago or the adult insect. The first three stages are passed in water and the fourth stage is mainly passed on the wing.

**Eggs or Ova.**—The eggs of mosquitoes, before they are deposited by the female on to the surface of the water, are collected together into a sort of a receptacle

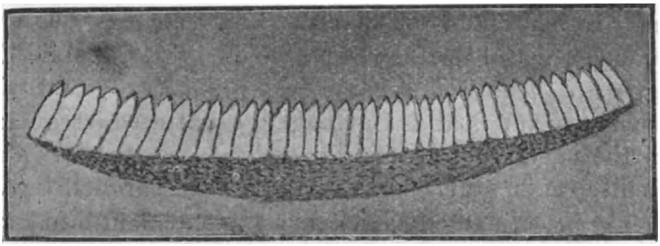


Fig. 36—Culex Eggs.

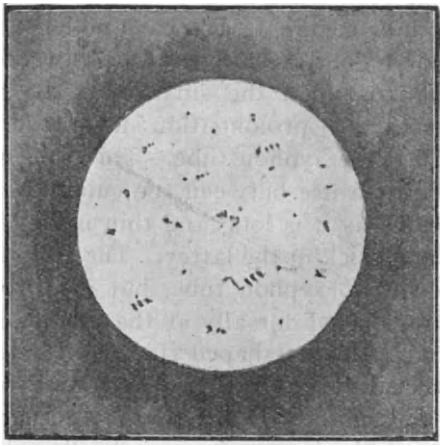


Fig. 37—Anopheline Egg.

made by crossing her hind legs, so as to form a sort of a raft containing several hundred eggs and held together by a gelatinous material surrounding them.

The eggs of the culex are thus massed vertically together in irregular raft-like masses, and can be seen without the aid of the lens. They are broad and oval in shape and in some cases are elongated. The eggs of the stegomyia float separately on their sides and are more or less oval in shape. They are cream coloured when laid, but rapidly become jet black.

Those of the anopheles cannot be seen without the aid of the lens. They are about 0.7 to 1.0 mm. in size, and are black and rod-shaped. Each egg has two oval air cells placed on each side, which act as floats. The eggs are deposited separately without any cementing substance, and float as isolated eggs scattered irregularly on the surface of water. In some cases they arrange themselves in star-shaped patterns or in parallel rows.

**Larvæ.**—In about 3 days the eggs hatch out into larvæ which can be seen quite easily with the naked eye. The larvæ consist of the head, the thorax and the abdomen divided into nine segments, but have no legs. The larvæ of culex and stegomyia hang head downwards and with the tail upwards upon the surface of the water, and breathe through a prolongation from the abdominal segment called the syphon tube. This tube serves as a distinguishing feature between the culex and stegomyia larvæ inasmuch as it is long and thin in the former and very short and thick in the latter. The anopheline larvæ have, however, no syphon tube, but are provided with two apertures placed dorsally at the 8th segment of the abdomen and little cup-shaped structures called palmate hairs on the dorso-lateral surface of certain of the abdominal segments. Owing to the presence of these two structures, the larvæ of anopheles float horizontally beneath the surface of the water.

The anopheline larvæ feed chiefly at the surface, but if the puddle, in which they are living, is only a few inches deep, they sink slowly by their own weight to the bottom to feed amongst the mud or stones and then come up to the surface by making darting and jerky movements in a backward direction by alternately curving the tail round to the head, first on one side and then to the other.

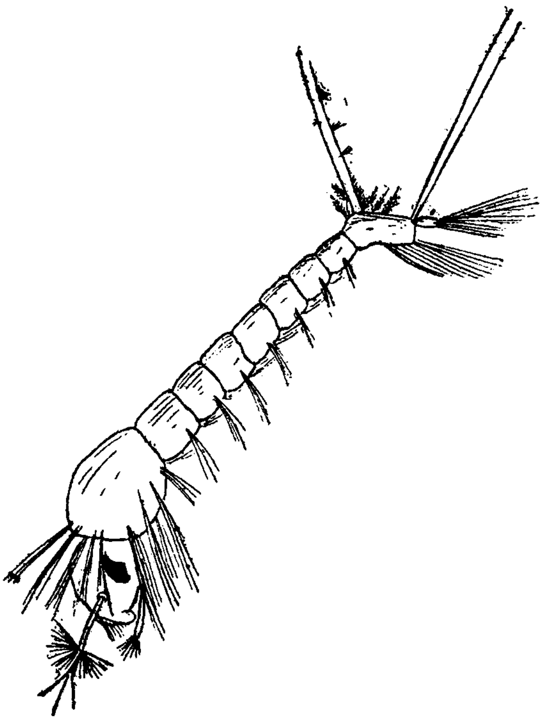


Fig. 38—Larva of Culex.

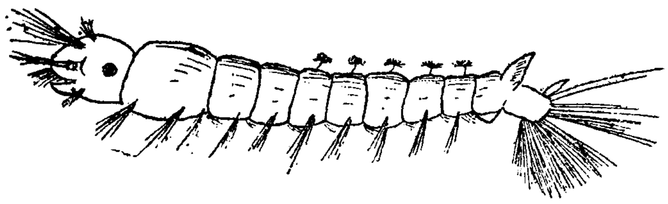


Fig. 39—Larva of Anopheles.

They feed on algæ or green weeds, and hence are found in puddles and slow-running streams or in those pools of water which are not likely to dry up or be scoured out by rain. Culex larvæ are very active in the water, and if disturbed, wriggle at once to the bottom and often remain there for a long time, if the disturbance is continued; but they do not possess the jerking movements like anopheline larvæ. When feeding, they are seen to be continually moving forward by the action of their mouth parts. Sometimes they go to a depth of several feet in search of their food. They are not particular about their diet and feed voraciously on anything that comes in their way, though they seem to prefer animal matter and sewage. They attack the body of a drowned mosquito even before it is quite dead, and devour the anopheline larvæ and smaller and sickly ones of their own species also. They are found in pots, tubs, broken bottles, ponds or ditches, or any place where a little water collects.

**Nymphæ or Pupæ.**—The nympha or pupa stage is almost identical in appearance among all the species of the mosquitoes. The larva casts its skin two or three times, and attains its full size in from 8 to 20 days or more. At this stage the larva becomes irritable and swims about in a fitful way and lastly comes to rest. Then quite suddenly a slit appears in the back and after a few kicks and wriggles a comma-shaped pupa creature emerges from the skin. This is called the nympha or pupa. It has no mouth, as it does not require any food to eat. It is very active and swims rapidly by lashing the hinder part about. When disturbed it darts to the bottom of the pool, but soon rises to the surface owing to its buoyancy. It does not breathe through its tail like the larva, but does so by means of a pair of trumpet-shaped tubes which project from the dorsum of the thorax. These tubes serve as a distinguishing mark between anopheline and culicine pupæ. The tubes of the anopheline pupæ are short, stumpy and funnel-shaped, while those of culicine pupæ are longer, more slender and trumpet-shaped.

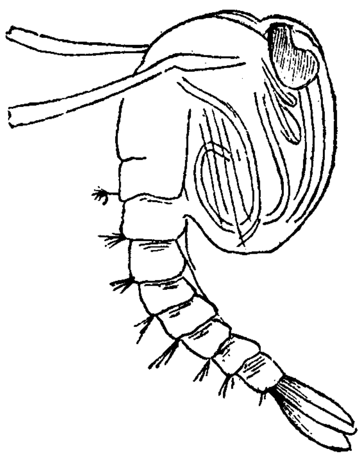


Fig. 40—Pupa of Culex.

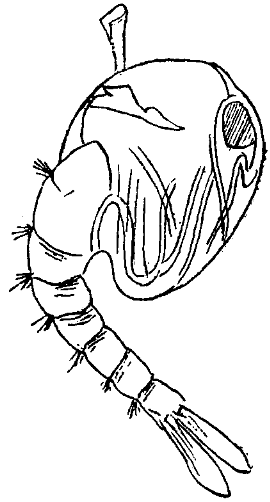


Fig. 41—Pupa of Anopheles.

This pupal stage usually lasts two or three days, and then an adult winged insect (imago) emerges from its case through a rent in the region of the breathing tubes. The imago remains standing for an hour or two on the empty pupal case acting as a rafter, until its legs harden and wings unfold when it flies away in search of its food.

**The Adult Mosquito or Imago.**—The adult mosquito possesses the head, the thorax and the abdomen.

The head, which is rounded, contains organs of sense and brain. To it are attached two large eyes, two antennæ, two palpi and the proboscis by which the insect pierces its victim and sucks its blood. The antennæ are seen arising anteriorly to the eyes on each side. They are covered with long prominent hairs in male mosquitoes, while in female mosquitoes the antennæ are almost bare without these hairs. Next to the head is situated the thorax of about the same size. To its under-surface are attached six long jointed legs, three on each side and a pair of beautiful membranous wings. The wings are studded with veins, which are covered with scales. The abdomen, which is segmented, is attached to the thorax.

The anopheline mosquito can be recognised by the following features :—

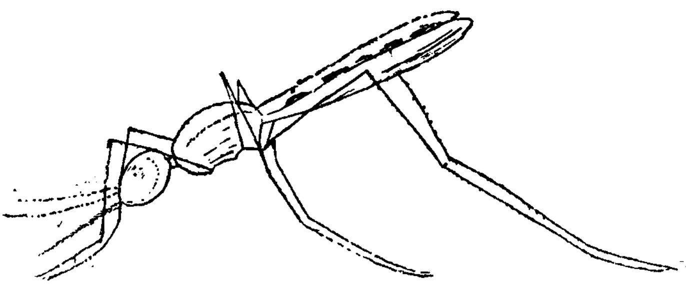


Fig. 42—A Female Anopheles.

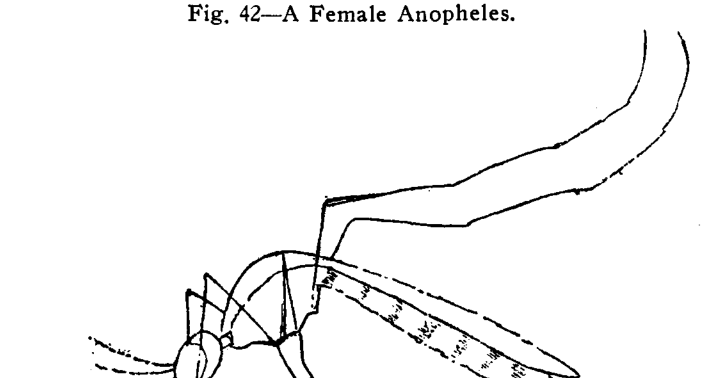


Fig. 43—A Female Culex.

The proboscis is thick and straight. The palpi are as long as the proboscis. The body is slender. The legs are long and exceedingly slender, and the wings are small and light coloured, but marked by dark brown spots on their anterior margin. While resting on a wall or any flat surface, it is inclined almost at right angles to the surface and is nocturnal in its habits.

In culex and stegomyia varieties the palpi are short, proboscis thin and curved, and the head is at a lower level than the thorax, which happens to be larger. The wings are unspotted and are brown, grey or greenish black in colour. When resting on a wall it is parallel to its surface, and has a hunchbacked appearance. The stegomyia is active chiefly during the day; but as it is not able to distinguish between artificial light and sunlight, it sometimes bites even at night in the electric light. Culex very often bites in the evenings.

**General Remarks.**—The anopheline female feeds on blood, and lays eggs two or three days after the feed. Ordinarily a mosquito can live on vegetable matter, such as juices of fruits, but the female does require a meal of blood both for fertilization and for the development of its ova. The female, after laying eggs, frequently dies, if it has not been again fed on the previous night. It is believed that mosquitoes return to the spot in which they were born, and hence the places probably remain permanent breeding haunts.

In summer, from May to October, the anopheline is very active, and capable of producing four generations in one season, 40 days being the time occupied from ovum to imago. It has been calculated that if the average number of eggs laid by a female be 150, the number of descendants by the fourth generation would amount to 31 millions, but, fortunately, bats, birds, fish, insects and spiders are their natural enemies and devour them or their larvæ and thus diminish their number.

During the winter months the mosquitoes become torpid, quiescent, hide in sheltered cellars or dark nooks or hibernate in out-of-the-way places. With setting in of the hot season, they become lively again, and generally wake up from their winter sleep in a state of considerable hunger. In fact, they are favoured by heat, plenty of water suitable for their larvæ, and by abundance of food.

They lay their eggs in rice fields, in the weedy margins of rivers, streams, lakes and ponds, in small sluggish streamlets, in pools of rain-water lying on grass, in pits hollowed out near the railway embankments, in cisterns and pits used for watering gardens, in hollows, in rocks and in water at the bottom of boats. They shun light, and so during the day they prefer to live in dark almirahs, dark corners in the rooms, rafters of the roof, or in stables or under the shade of trees and bushes; and, with the onset of night, they being blood-suckers leave their hiding places and come out to attack man and other animals. They usually bite after sunset or in the early morning. It is only the female that bites, and she may bite several persons at a time, and if she is carrying malarial parasites, she will infect several people at the same time and thus help in propagating the disease. On account of this noctural habit of the mosquitoes, malaria is, as a rule, contracted in the evening or at night, and hence a healthy man may escape the disease, if he visits the malarial place only during the day and does not sleep there at night.

The anopheles do not like white colour, but have predilection towards dark colour and so will be found during the day sitting on smoky walls of a room or on dark dadoes, if the walls are white-washed. Again they will sit on dark coloured clothes, if any are hung in the room. They can, therefore, be easily caught in these places. When a mosquito is seen resting on any of these places, the mouth of a dry test tube is placed very gently over it. It will fly into the tube, the mouth of which can then be easily closed with a plug of cotton-wool. This can then be transferred into a large glass bottle. These captured mosquitoes have to be fed on banana and water, and are thus kept alive from two to five weeks. Even though they avoid the diffused light of the sun, they are very much attracted by the concentrated light of a lamp, and so one can avoid mosquitoes at night by keeping one's room dark and placing a light in the adjoining room, where they will all be lured away.

People wearing dark thin socks are bitten more by mosquitoes than those who wear white ones. Negroes and Indians are bitten more than white races. It has been lately noticed that anophelines suck blood from a dead body. While flying some mosquitoes make a noise, with which every one is familiar, but anophelines do not make any noise. The bite of the female is not very painful, and very often people are not aware of having been bitten by them.

Anophelines cannot fly more than half a mile in a horizontal direction, but they may be carried away to distant places in trains, boats, and even in ocean-going steamers. They may also be carried along the currents of the streams and canals. They are blown away by winds but, as a rule, they dislike winds, and conceal themselves in their hiding places. It is, therefore, quite safe for people to sit outside without being annoyed by mosquitoes in the evening when the wind is blowing. Again trees, plantations, bushes and jungles hinder their flight. They cannot also fly very high in a vertical direction from low-lying places, and hence the necessity for people to sleep in topmost storeys of houses.

## IMMUNITY.

Truly speaking, no human race is naturally immune to malaria, though certain races and certain individuals are less susceptible to its influences than others. Thus, negroes in Africa do not get the fever so frequently and so severely as Europeans living there. Again, the Chinese, the Malays, and some other dark-skinned races also appear to enjoy a comparative immunity—an immunity considerably less pronounced, however, than that enjoyed by the African and West Indian negroes. The cause of this immunity has been explained by Koch, who says that the men in those regions, where they are constantly exposed to the infection, go through it very often in their childhood and those, who do not succumb to it, acquire a greater or less complete immunity. Owing to the same reason, European children in malarial districts, even though they live under better sanitary surroundings, suffer more from malaria and appear to be of weaker constitution than those born of the local inhabitants who have been immune. One attack does not render a man immune from other attacks, but on the contrary subsequent attacks may be more severe than the first. The new arrivals from non-malarious districts suffer more severely, probably owing to the fact that they do not take the same amount of care and precautions as old residents. They expose themselves to chill and do not take any precautions against the bites of mosquitoes. The old residents, owing to their previous experience, take better care about themselves, and do not act in such a way as their vitality may be lowered and thus may be a prey to malarial infection. People indulging in alcohol, opium and other intoxicating drugs suffer more than people who are sober in their habits. People who burn wood and cowdung in their houses, anoint their bodies with oil and close their doors and windows at night, so that mosquitoes may not enter their houses, do not seem to suffer from malaria so much as others do.

With the growth of prosperity and civilisation, people learn to live in good, well-ventilated, *pucca* houses of two or more storeys and use mosquito nets, and also place themselves under the treatment of qualified medical men, who are, as a rule, found in almost all towns and, therefore, these people are less affected by this pestilence than poor coolies, labourers and cultivators who suffer from poverty and are housed in badly constructed huts. Besides, famine also helps to increase the disease very much.

## ESTIMATION OF MALARIA.

The prevalence of malaria in a locality or district can be ascertained by (1) examining the statistics in hospitals and dispensaries, (2) by ascertaining the proportion of people suffering from enlargement of the spleen, and (3) by examining the blood of a number of people to find out how many of them are infected by malaria parasites.

No reliance can be placed on the first method, as most of the fever cases, whatever their nature, are returned as cases of malaria for want of enough material for correct diagnosis; and in places where there is a facility for correct diagnosis, possibly there is no will on the part of a medical man to take all that trouble to arrive at a correct diagnosis, or that there is not enough time at his disposal owing to his manifold duties.

The second method is useful in places, where kala-azar and other diseases, which, in addition to malaria, cause enlargement of the spleen, do not occur and can be followed by any intelligent person other than a medical man provided he knows where to feel for the spleen in the body. Children between 2 to 10 years should be examined for estimating the enlarged spleen, for enlarged spleens become much less common among persons as age advances, owing probably to the establishment of a toleration or partial immunity produced by long exposure to malarial infection. For this method the best thing is to examine children attending a village school. The percentage of enlarged spleens found among children of these ages is called the "Splenic index of malaria."

The third method is the most reliable, but is not practicable everywhere, for it requires the aid of a man specially trained in microscopic work and at the same time with plenty of leisure. Owing to the same reason as mentioned under the second method, the blood of infants and children under ten years should be examined. The blood films from 30 or 40 children should be taken, and should be examined after proper staining for the presence or absence of malaria parasites. The percentage of such children who have malaria parasites in their blood is called the "Endemic index of malaria." When the blood of a sufficiently large number of children has been examined, the fifigure affords a true index of the degree to which malaria prevails in a place, and affords the most satisfactory means of comparing the amount of malaria in different localities.

## MORTALITY.

Malaria is a benign and protracted disease, which is complicated and terminated by such inter-current diseases, as pneumonia, cirrhosis of the liver, dysentery, infantile diarrhœa, anæmia, etc. Hence in the event of death it is oftentimes not possible to say definitely whether death has been due to malaria or to any of those inter-current diseases. Besides, the great majority of malaria deaths occur among the children of the poor, who are never treated by medical men, and the cause of death in such cases is therefore never confirmed. Again, the so-called registrar of deaths, who is merely an illiterate chowkidar of a village, always attributes malaria as the cause of death in those cases where he does not find prominent symptoms as those of cholera, plague, small-pox, etc.

Thus the so-called death-rates are not at all reliable, but one fact is evident, that malaria enfeebles the constitution, and saps away the virility of a nation, and that in India millions of people not only suffer from malaria every year, but are so much enfeebled, that they are unable to follow their usual avocations. The average life of the people in malarious districts is shorter and the infant mortality higher than in healthy places and so labour and cultivation suffer most. In such districts, owing to the epidemic of malaria enough labourers cannot, very often, be had for reaping the harvest, and the same is the case in tea estates. It has also been observed that people from Lower Bengal migrate to northern India, which is not so malarious as the former. On the whole there is a great economic loss to the community in a country where malaria is very prevalent as in India, and hence all possible measures should be adopted to minimise the incidence of the disease.

## PROPHYLAXIS.

For proper and rational prophylactic measures to be adopted, the first step should be directed towards the correct diagnosis of malaria by microscopic examination of the patients' blood, as there are many other morbid processes which simulate the malaria infection.

In adopting the preventive measures the watchwords ought to be (1) protection against mosquito bites, (2) destruction of the mosquitoes, (3) quinine treatment, and lastly, (4) education.

**(1) Protection against Mosquito Bites.**—Houses should be built on an elevated place, and far from marshes and swamps, so that the mosquitoes do not reach there. A row of tall trees if planted near the house will screen it from swamps, but the trees must not be too close, or else they will serve as shelter to the insects.

The houses should be encased in wire netting. To do so successfully the netting should be applied to the verandahs, and in these should be doors made of light wood frames covered with netting and provided with spring hinges so that they are self-closing. Bedrooms if possible should be on the second floor, and should be devoid of much superfluous furniture, such as curtains, etc., which may harbour mosquitoes during the day-time. There should be no lamp in the bedroom, if the windows and doors are open and unprotected, because such a light attracts these insects. The beds should be provided with mosquito-proof nets, but without holes.

The people should not sleep in the open, and should not leave their houses between sunset and sunrise. They should not even sit on the verandahs during that time, unless they have on thick woollen garments, which will protect the chilling of the body—a predisposing cause of malaria—and also the mosquitoes will not be able to bite through the thick cloth, though they can do so through thin cloth, when they are very hungry. The face and neck may be protected by wearing thin veils over the head, gloves should be worn to protect the hands, while thick socks or stockings or putties and boots should be worn to protect the ankles and feet; but all these precautions are not practicable during the summer of India. People whose business carries them to malarious localities should take care not to sleep there at night, but should go back to their places after they have finished their work, during the day-time. Cultivators, who work in their fields during the day-time, should not remain there at night, but should go and sleep in houses built on elevated spots. If their houses are situated in low-lying localities, and if the subsoil water is very much near to the surface, eucalyptus, palms and other quick-growing trees should be planted, so that they will absorb a large quantity of water and render the soil dry.

At bed time the body should be anointed with any one of the following preparations, called culicifuges, which would drive away the mosquitoes:—

Ointments or liniments made with eucalyptol or camphor, oils of eucalyptus, lavender, sandalwood and peppermint, lemon juice, vinegar, petroleum, ammonia, a mixture of tar and oil, and vaseline and many other patent fluids sold in the bazar. A few drops of any of these substances may also be sprinkled on pillows at night, or a cloth sprinkled over with a few drops may be hung over the head of the bed; but all these cannot be very efficacious and lasting till the morning, as on account of their volatility their action can only be transitory.

Fans of palm leaves are very good to drive away the mosquitoes and to keep the body cool at the same time. Punkhas and electric fans, wherever they can be afforded, are the best means to drive them away, as they avoid strong currents of air.

Military camps should always be pitched on high elevated spots. They should never be laid near marshes or the banks of rivers, particularly where the water is stagnant, and in the neighbourhood of swamps. In preparing a camp the soil should be disturbed as little as possible lest malaria should break out. In the camp men should not be allowed to sleep on the ground.

**(2) Destruction of Mosquitoes.**—For the destruction of anopheline mosquitoes the most effective measures are those which aim at destroying their breeding-places, and thus prevent their multiplication. To obtain the best results both individual and communal efforts are necessary.

Natural collections of water, which may serve as breeding-places, should be filled in or drained. Hollows and pits in the ground should be filled up with inorganic refuse, such as pieces of stones, tiles, cinders and ashes, and the ground should be so made that no water should collect, or they can be filled by earth dug up from a neighbouring hill or mound, but care should be taken that in removing earth no depression capable of holding water should be made. Low marshy lands adjoining the rivers, lakes or the sea may be filled by pumping silt or sand.

When filling is not practicable, nullahs, pools and marshes should be drained into neighbouring running water-courses by constructing ditches. These ditches should have a sufficient fall, so that no water should stagnate in their course. They should have straight sides, and should be inspected frequently to see that they do not become choked. There should be proper arrangement for under-draining of the soil, so that it may remain dry in the neighbourhood of villages and towns which are irrigated from canals.

Mosquitoes breed in water barrels, cisterns and tubs used for storage of water; towns and cities should, therefore, be provided with the modern closed system of water-supply, so that there may be no necessity for storage of water within the premises of the houses. But where it is not possible owing to enormous costs involved in the system, all cisterns, tubs, reservoirs, etc., must be well covered with tightly fitting wire-gauze coverings, so that mosquitoes may not breed in them and at the same time there may be enough aeration of water. In villages and towns where water is chiefly taken out from wells, they should be provided with lifting pumps, and should have closely fitting lids. The streets in the cities and towns must be all paved and their drains should be made *pacca*, and should always be brushed and kept clean. If there are any cesspools, they should be done away with, or should be connected with drains.

Broken bottles and crockery, empty broken tins, flower pots and old buckets, which are likely to harbour mosquitoes, should not be allowed to lie about in the compound of the house but must be collected in suitable dust-bins.

If efficient drainage cannot be carried out to check the breeding of mosquitoes, the next best thing is to wage a war against the larvæ in water and the mosquitoes in the air.

The larvæ come up to the surface of water to breathe, and so they can be killed very easily by pouring some substance on its surface which will asphyxiate them. The substance that is generally used for this purpose is kerosene oil or crude petroleum. Approximately an ounce of the oil to every fifteen square feet of surface is sufficient, and ordinarily the application need be made only once a month. The entire surface of the water should be covered with a thin film of oil. For small pools a piece of cloth should be tied to a long stick and dipped into kerosene oil, which should then be spread over the water surface. For a big lake a rope sufficiently long to reach its sides should be taken and in its centre a big piece of cloth dipped in kerosene oil should be tied. Two persons should then hold the two ends of the rope standing on the opposite sides of the lake, and should move the cloth about on the surface of the water, so that the whole surface will be evenly oiled. Tar is also used instead of kerosene. There are many other larvicides, *viz.*, sulphuric, hydrochloric and other acids, potassium permanganate alone or mixed with hydrochloric acid, sulphate of copper, perchloride of mercury, carbolic acid, aniline dyes, leaves of strong tobacco, and powders from unexpanded flowers of chrysanthemums, but all these being poisonous, should only be used in water not meant for drinking purposes, and should be used in large quantities to be thoroughly efficacious.

Another method of destroying larvæ is by cultivating small fish in pools and lakes, where larvæ are to be seen, as fish are their natural enemies. The chief of these fish are gold-fish, minnows and millions. Water weeds should always be removed, as they protect the larvæ from being consumed by fish.

The substances that are used to kill mosquitoes are called culicides. They are divided into odours, fumes and gases. Among the odours which cause death are oil of turpentine, iodoform, menthol, nutmeg, camphor and garlic. There is a custom among the people of hanging small bags containing garlic or camphor round the necks of sick patients, especially the children, with an idea that the evil spirits may be warded off. It is doubtful whether these spirits will be thus kept at a distance, but in malarious places mosquitoes will certainly avoid biting such people.

Among fumes, the smoke of tobacco is very efficacious, as it kills mosquitoes in two or three minutes. Ordinarily people burn green neem leaves and horses' litter with cowdung cakes in stables and huts to drive away mosquitoes. Smokes of pyrethrum powder, chrysanthemum flowers, fresh eucalyptus leaves, quassi wood and simple wood are also beneficial. Among the gases the most practical and efficacious is sulphur dioxide obtained by burning sulphur. The other gases that can be used are sulphuretted hydrogen, coal gas and formaldehyde.

Bats, birds, lizards and dragon-flies are the natural enemies of mosquitoes, but they themselves are a nuisance if introduced into dwelling houses to kill mosquitoes and in that case, the remedy will be worse than the disease. Large numbers of mosquitoes can be destroyed in houses by a small hand-net as suggested by Major Ross. Mosquito traps of wooden boxes painted black or lined with black cloth on their inside may be placed in the rooms to catch mosquitoes, which may be killed by pouring benzene or petrol through the small hole on the top, and may then be removed. The hole should be closed with a cork, so that mosquitoes may not fly away.

During the breeding season of mosquitoes, it should be the duty of every municipal board in malarious districts to employ gangs of coolies called *mosquito brigades*. Each gang should consist of three or four men and a headman, who should be responsible for the work of the gang. All the gangs should be placed under a medical man or a sanitary inspector. The duties of these gangmen should be to keep street gutters, surface drains, road-side ditches and channels, margins of ponds and streams clear of weeds and obstructions, to fill up breeding pools or ponds or to oil them, to inspect the compounds of houses at least once a week and to destroy all the breeding-places.

**(3) Quinine Treatment.**—As the source of infection, *viz.*, the malarial parasite, resides in the blood of man, it is necessary to treat the malarious patient effectively, so that he may not be a source of danger to others. The best way to do this is to disinfect the blood by administration of quinine which is the specific disinfectant for amœboid organisms, and consequently for the malarial parasites in the amœboid stage. The best time to give quinine to patients is the sweating stage, when the greater number of amœboid forms of the parasite are present in the circulation. These will be killed by quinine, and thus the recurrence of another paroxysm of fever will be prevented. Several preparations of quinine are used for this purpose, but acid hydrochloride of quinine seems to be quicker and more efficacious in action than sulphate or bisulphate, and a comparatively smaller dose is required as it is rapidly absorbed in the blood. The malarious patients should be treated free of charge. For this purpose five-grain packets of quinine are sold at a nominal price at all post offices, and quinine pills are distributed gratis among the people in the villages.

Quinine acts also as a prophylactic and should, therefore, be given to every one in a locality where malaria breaks out, but it is very difficult to persuade healthy people to take it, as it is a very bitter medicine. Again poor and ignorant people, who are, as a rule, averse to allopathic treatment, will object much more strongly to a routine treatment of quinine, when they are apparently healthy; however, this treatment is nowadays adopted in jails, schools, barracks and police lines, wherein the number of malarious cases has diminished to an appreciable extent.

There are three principal methods of administering quinine as a prophylactic : (*a*) five grains every day after breakfast, (*b*) ten grains on two successive days in a week, or (*c*) 15 grains once a week. Those who have an objection to taking of powders or solutions which are bitter should be given freshly prepared pills or tabloids. Children can be persuaded to take pills more easily than bitter solutions, but the old dried pills should not be used, as they are not liable to be absorbed, but pass out unchanged along with the fæces.

**(4) Education.**—All the sanitary measures described above to eradicate malaria cannot be effectively carried out without the co-operation of the people for whose benefit they are intended; it is specially so in India where people are steeped in ignorance and superstition. Co-operation cannot be secured, unless the rationale of these measures is thoroughly understood. The sanitary authorities should, therefore, try to educate people in malarious districts on the mosquito-malaria theory by issuing pamphlets in vernaculars from time to time, and by organizing popular lectures on this subject, illustrated with magic lantern slides, if possible.

## YELLOW FEVER.

This is a disease of the tropics, and is endemic in the West Indies and West Africa. From these places it spreads in an epidemic form to other areas, where conditions more or less tropical exist. In most cases the disease is conveyed by means of shipping.

**Ætiology.**—The cause of yellow fever is not known, but the virus is ultramicroscopic, and is capable of passing through a Berkfeld filter. It is present in the peripheral blood of the patient only during the first three days of the disease, and is destroyed by an exposure to a temperature of 55°C. for ten minutes.

**Incidence.**—It is chiefly a disease of the sea-coast towns, the banks of rivers and flat delta country, and for its development it requires an atmospheric temperature of over 75°F. It never spreads when the temperature is below 68°F. Both sexes of all ages are susceptible to the disease, men possibly more than women.

**Incubation Period.**—The average period is 3 to 5 days. It rarely exceeds this period, but may be under 24 hours.

**Mode of Infection.**—The disease is conveyed through the bite of an infected mosquito, the *Stegomyia calopus*. The mosquito becomes infected only if it has sucked the blood of yellow fever patients during the first three days of the fever. Further it is capable of transmitting the infection to other persons after at least twelve days have elapsed since feeding on the infected blood. During this period the disease germ, whatever it may be, undergoes its cycle of development in the body of the mosquito. The infected mosquito remains infective during the rest of its life, which may extend to four months or more; only the female mosquito transmits the virus, and may transmit it to a new generation of mosquitoes developed from its eggs.

**Immunity.**—No race is immune to this disease, inasmuch as Europeans, Indians, Chinese and Negroes suffer from the disease, though dark races are popularly believed to be less susceptible than white races. One attack of the disease confers immunity against a subsequent attack, and this acquired immunity is very strong, and lasts throughout the life-time of the individual.

**Prophylaxis.**—This consists in isolating the patient suffering from yellow fever and screening him from mosquitoes for at least the first three days. Mosquitoes in the infected house and the surrounding houses should be destroyed. Ships leaving infected sea-ports should be thoroughly fumigated with the object of destroying mosquitoes, which may have been carried on board in baggage or otherwise. Sailors and other crew of ship coming from infected ports must not be allowed to disembark, on shore, unless medically examined. Anyone found suffering from yellow fever should be at once placed under a quarantine.

## DENGUE.

This disease, which is also known as Dandy fever and Breakbone fever, is very similar to yellow fever, inasmuch as it is prevalent along the coastal towns, and in the valleys and deltas of large navigable rivers, and that its virus is filtrable, but like influenza, very often spreads in a pandemic form over large areas along the trade routes, and attacks almost everyone in the community.

**Incubation Period.**—The incubation period is usually one to three days, but it may extend to five or seven days.

**Immunity.**—One attack does not confer immunity. Very often persons are known to have been affected at the occurrence of each epidemic. However, fatal cases are very rare.

**Mode of Infection.**—The virus resides in the peripheral blood of the patient from the second to the fifth day, and the disease is conveyed from the sick to the healthy through the bite of the mosquito, *Culex fatigans*, which has fed on the infected blood. The disease has been conveyed by the mosquito immediately after its meal of the infected blood, but the poison may survive in it for 8 to 27 days.

**Prophylaxis.**—This consists in screening patients against mosquito bites, and destroying the mosquitoes and their breeding-places.

# CHAPTER XVII.

## PLAGUE.

THIS is the " Black Death," or " Pestilence " of the Middle Ages, and " Mahamari " or " Pali plague " of India. It is endemic in Garhwal, in the valley of the Yunan, on the eastern slope of the Himalayas, in Mesopotamia and in the interior of Africa near the source of the White Nile in Yuganda. From these places it has often spread in an epidemic form over Asia, Africa and Europe from very early times.

The present epidemic of plague has been raging in India for the last twenty-four years. It first broke out in Bombay in 1896. It is not settled as to how plague was introduced into Bombay, though the following theories have been advocated by medical men working into its epidemiology :—

1. There was plague in Hongkong and in China in 1894, 1895 and 1896, and so it is possible that it might have been imported from Hongkong or southern parts of China.
2. It might have been conveyed from the Persian Gulf, the disease being endemic in Mesopotamia.
3. The pilgrims from Kumaun and Garhwal might have brought the infection to Bombay.

In 1896-97 the disease was practically limited to the Presidency of Bombay, but during the subsequent years it spread to the other presidencies and provinces, particularly Bengal, Punjab, United Provinces and Central Provinces. In 1906 the disease also broke out virulently in Burma, and during 1907 a few cases had been reported west of the Indus. Up till now fortunately the plague has not got its hold on the Presidency of Madras, and Provinces of Eastern Bengal and Assam.

**Mortality.**—This is generally very high, varying from 60 to 80 per cent. of those attacked. In India, in the twenty years 1898—1918 rather more than ten and a quarter million deaths from plague were recorded, the years 1903-04, 1904-05, and 1906-07 contributing over a million each and 1917-18 contributing about eight hundred and twenty thousand. The mortality usually reaches its height in the month of March, but in April it very closely approximates that of the former month. February, May and January come next. June and July are the months of minimum plague mortality as a whole.

## ETIOLOGY AND EPIDEMIOLOGY.

The disease is due to the *Bacillus pestis* isolated by Yersin and Kitasato at Hongkong in 1894. The parasite is a very minute cocco bacillus with rounded ends. It has one terminal flagellum. It has also a capsule which is seen specially in the bacilli present in the blood. It is readily stained by aniline dyes, the extremities taking stains better than the central part. The bacilli are found in the tissues lying singly or in pairs, and sometimes in chains.

The bacillus is easy of cultivation, is non-sporing and very soon loses its vitality on exposure to sunlight, drying and other external agencies. It does not exist in nature outside an animal body either in the soil or upon the floors of the houses, and so there is very little danger from these sources.

The plague bacillus gains admission through an abrasion of the skin, except in cases of pneumonic type. In plague cases, the bacillus can, in most cases, be found in the buboes, in the blood, in the sputum, and in the internal organs. In a very few cases it is found in the urine, and then even in a very small number; but the fæces are, as a rule, free from this bacillus.

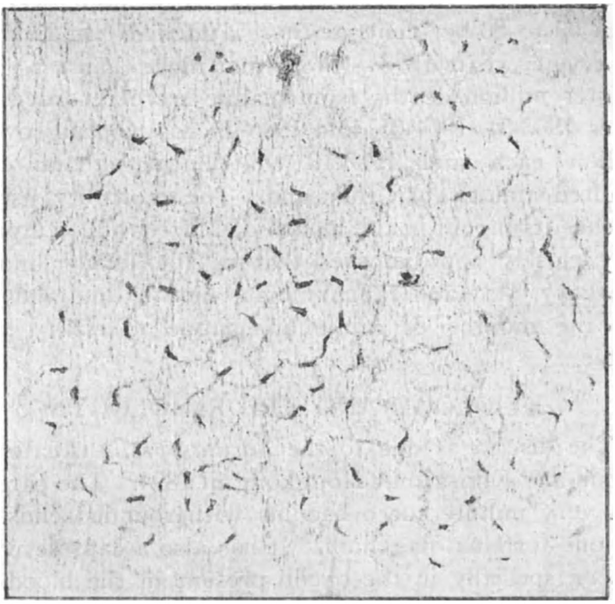


Fig. 44—Bacillus pestis in the human blood.

It has been proved by recent researches by the Indian Plague Commission working in Bombay that plague is primarily a disease of the rat, and secondarily of man; and that it is transmitted from 'rat to rat' and from 'rat to man' through the agency of the rat flea. It is apparent from the history of the plague that the rat has always been associated with the disease.

Besides rats, there are other animals, *viz.*, mice, guinea-pigs, rabbits, squirrels and monkeys, which suffer from plague, but they are not of much importance, as they are not concerned in propagating the disease in man, though on seeing them dying of plague, people should take necessary precautions against it. However, it has been noted by Major Tucker, I.M.S., that a child got plague after it was bitten by a plague-infected squirrel.

Horses, goats, cows and sheep are immune against even artificial inoculation according to Haffkine. The German Plague Commission has found that pigeons, fowls, geese and pigs are absolutely refractory, and dogs almost so. The opinion is divided as to whether cats are susceptible to plague, but certainly they are refractory.

**Rats.**—There are two chief varieties of rats in India, which are concerned in spreading the disease. These are *Mus decumanus* and *Mus rattus*. The former has a longer and sharper snout, smaller ears, less bristly fur

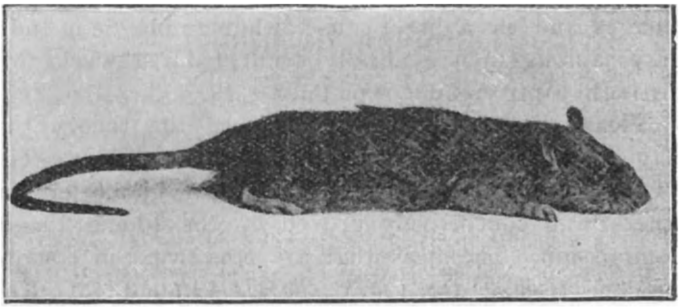


Fig. 45—*Mus decumanus*. The Sewer Rat.

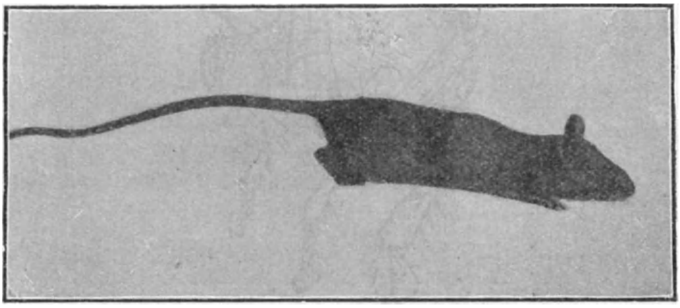


Fig. 46—*Mus rattus*. The House Rat.

and a more hairy bi-coloured tail, the dorsal surface of which is darker than the ventral, and is found only in

Bombay and some other seaport towns in India. In Bombay it inhabits stables, outhouses and sewers, and enters houses only for food. The latter, *Mus rattus*, is of small size and of dark colour. The body is shorter than the tail and the ears are pointed and large. It is found in all the villages in India, and is a true companion of man, inasmuch as it lives and breeds in human dwellings. It lives in cupboards and under boxes, and makes burrows in the muddy floors and walls of huts in Indian villages. It breeds and multiplies with great rapidity, feeding upon the grain and other materials stored in the house. It is mostly concerned in spreading plague in villages, and it is a direct cause of human plague in India. Cases among men generally occur from a week to a fortnight after rats die of plague.

**Fleas.**—Simond, in 1897, advanced the theory that plague was transmitted from rat to man by fleas. This theory was developed by J. Ashburton Thompson and others, and conclusively proved by the Indian Plague Commission. The fleas that are concerned in conveying the disease are *Pulex cheopis* (Indian rat flea),

Fig. 47—Male Pulex Cheopis.

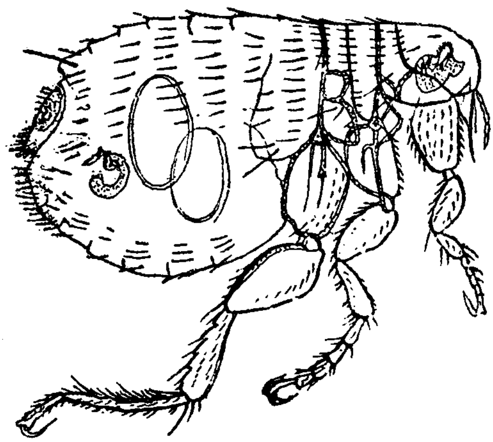


Fig. 48—Female Pulex Cheopis.

*Ceratophyllus fasciatus* and *Pulex irritans*, the human flea; and other fleas infecting dogs and cats may also carry the plague.

Fleas are flat, wingless insects and pass through four stages, *viz.*, embryo, larva, pupa and imago. The adult female flea deposits her eggs, about 12 in number, among the hair or fur of the host animal, but they fall freely to the ground as they are not fastened together. Sometimes, she lays her eggs in dust and dirt. These are oval, whitish, smooth and about half a millimeter long, and hatch out in 50 hours or more. The larvæ are slender legless, cylindrical creatures, whitish or yellowish in colour, each having a head and 13 segments. The larvæ feed on almost any kind of refuse. They usually crawl into cracks and crevices in the floors and walls of the houses. They live about 7 days and then spin cocoons in which they change to the pupal stage. The adult flea develops from the cocoon stage in from 5 to 8 days. It has a hard and strongly chitinized body, and its mouth parts resemble somewhat those of the mosquitoes.

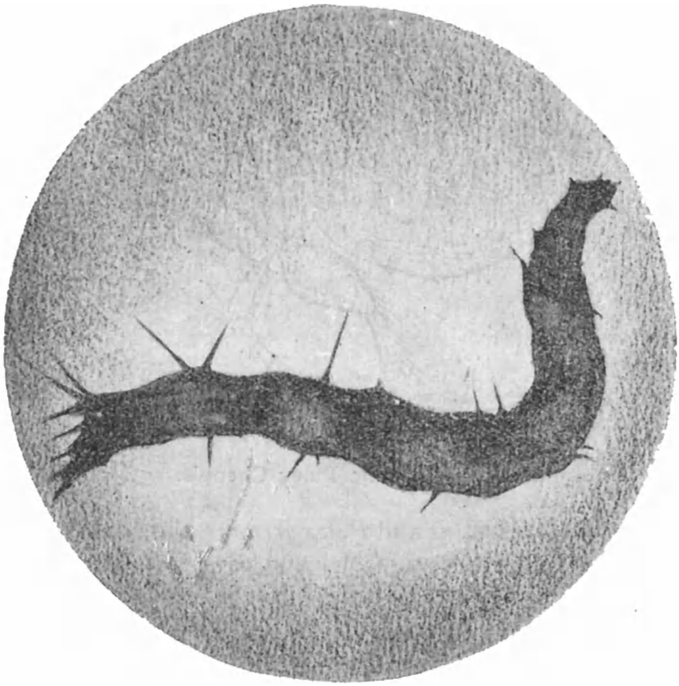


Fig. 49—Larva of a Flea.

These fleas cannot fly higher than 6 inches above the ground and avoid light. Fleas do not vary much in size. They are mostly about 2 to 3 millimeters long. Both the male and the female are capable of biting, and thus transmit infection. They do prefer certain hosts, but are not very particular in this regard, specially when they are very hungry, and that is the reason why they are dangerous so far as plague and other infections are concerned. The rat flea thus leaves the plague-stricken rat after its death, and being hungry attacks human beings in the house, as it does not find its own host, *viz.*, the rat; for rats leave the house when they find that some of their companions die of this disease.

The plague bacilli multiply in the stomach of the flea, and remain alive for seven or eight days, and are passed out in the dejecta and deposited on theh human skin near the puncture when the flea bites a man. Inoculation then takes place, when the skin is scratched with the finger nails to allay irritation of the bite. The bacilli also grow in masses in the flea's œsophagus, and block the entrance of the stomach. The starved flea makes violent efforts to get more blood, and the œsophageal contents regurgitate thereby infecting through the skin lesion the healthy person whose blood the flea is trying to suck. The bacilli thus inoculated, are carried by the lymphatic vessels of the skin to the lymphatic glands usually of the groins or armpits, as the legs and arms are most likely to be bitten by rat fleas. The people, who walk about in the houses barefooted, and who sleep on the floor not well protected with sufficient clothing, become the victims of infected fleas.

The pneumonic type of plague is contracted by the inhalation of dust containing the organism or by the direct inhalation of the germs contained in the sputum sprayed out into the air by the patient's cough. In some cases the bacillus infects the system through the tonsils and the mucous membrane of the mouth, when the resulting bubo forms in the submaxillary region, or at the angle of the lower jaw.

## CONDITIONS FAVOURING THE SPREAD OF PLAGUE.

The circumstances that favour the spread of plague are filth, overcrowding, poverty and a lowered tone of the general health. Owing to poverty and the filthy habits of the people of allowing grain and other eatables to lie about in dark ill-ventilated houses composed of one or two rooms in many cases and also allowing cattle, goats, hens and other domestic animals to live among them, rats are always found inhabiting such houses, which lead to the spread of plague, if once the locality is infected.

The plague is usually carried from house to house in a town or village by means of infected rats; but they do not carry infection from one locality to another, as rats are not found to be migratory in their habits, though they may be carried from one place to another in merchandise, *e.g.*, grain, cotton, hay, furniture, etc., but on the other hand, infected fleas are carried by persons in their clothes or other belongings, while going from an infected place to an uninfected area, where these fleas inoculate rats, their natural hosts, if they find them. Thus, the plague first breaks out among rats, and then later on among men.

The disease is most common among young people of both sexes who are in the prime of life, but women are more apt to be attacked than men, since, owing to their habit of remaining indoors they are more liable to be bitten by rat fleas. Infants and young children appear to enjoy a certain degree of immunity. The disease generally occurs during the cold weather. In India plague usually subsides during the hottest weather, and recrudesces with the onset of the cold season. Rainfall in defect of the normal is inimical to plague, while excessive rainfall is favourable to its spread. Humidity at certain seasons of the year in excess of the normal is beneficial to the rat flea in all the stages of its development, and a flea population in excess of the normal appears to be essential to plague epidemics of more than average intensity.

## VARIETIES OF PLAGUE.

There are three chief varieties of plague, *viz.*, the bubonic, pneumonic, and septicæmic. The incubation period of the bubonic variety varies from two to seven days, but that of the pneumonic and septicæmic types is much shorter and in some cases even less than 24 hours. Death frequently takes place within 48 hours of the onset of the symptoms. A fatal result is, as a rule, rare, after the 8th day.

## PROPHYLAXIS.

Isolation of the sick, placing the people of the infected locality under quarantine and their surveillance for ten days, specially when they had travelled from one place to another either by rail or by road, were the chief measures adopted by the Government in the beginning of the plague, but they had to be given up owing to the apathy of the people towards them. The principal preventive measures that are now adopted are a campaign against rats, evacuation, disinfection and inoculation.

**A Campaign against Rats.**—Plague is primarily a disease of rats, and it can safely be deduced that there would be no plague, if there were no causes existing, which would bring about association of rats with men. It is, therefore, very necessary to fight against rats, if plague has to be eradicated from a locality. This should be carried out by rendering the dwellings rat-proof and rat-free and by destroying or trapping rats.

In designing rat-proof dwellings it should be borne in mind that the *Mus rattus* cannot jump higher than 2½ feet, cannot circumvent a horizontal ledge of 9 inches, provided this be smooth on the undersurface, and cannot live on dry grain without some water to drink.

The dwellings should have the basement, floors and roofs made of such concrete material as would not harbour rats. The lower parts of the doors and windows, specially on the ground-floor, should be reinforced with strong iron or tin sheets to keep them from gnawing through. The open mouths of the house drains should be surrounded with concrete and screened with strong galvanized iron netting.

Rat holes should be closed with a mixture of cement, sand and broken glass, or sharp bits of crockery, bricks, and stone. Shops, warehouses, granaries, restaurants, markets and stables should be separated from human habitations.

The people should learn to keep their rooms clean and tidy, and should not throw waste food material and grains anywhere in the premises of houses or in streets, where rats might easily reach them. They should take proper steps to collect and dispose of house refuse. They should not store grains and corns in earthen *garahs* or sack-cloth bales, but in iron or tin pots or *pacca* masonry-built receptacles, so that rats may not have access to them.

In a country like India it will take many years to carry out these measures to completion, and so steps should be taken to destroy all the rats by using poison or disseminating bacterial disease among them. Phosphorus mixed with sugar and wheat flour is a poison which is commonly used to kill rats throughout the world but, from the interesting observations carried out in Poona, Dr. Chitre and Major Kunhardt, I.M.S., have proved that barium carbonate is by far the most efficient. It is cheap, fatal to rats in a dose of 1½ grains, and comparatively harmless to men and domestic animals. It is also one of the very few poisons that the rats fail to detect. Rats prefer the food grain, which forms the staple food of the human population of their place of origin. Hence barium carbonate should be mixed into dough with freshly ground flour made from the grain, which forms the staple food of the people of the locality, where rats are to be killed. One pound of barium carbonate should be mixed with 3 pounds of flour in an enamelled basin, and the mixture with the addition of sufficient water should be made into a thick paste to be divided into 2,400 round baits of uniform size, each containing 3 grains of the poison. The baits should be set towards night in such places as are accessible to rats and not readily accessible to children or domestic animals. All sources of food supply usually available for rats should be kept covered up so as to make them hungry. About 20 baits are sufficient for every thousand cubic feet of space. The baits are only attractive to rats when fresh. Hence they should be made fresh each day, or at most every second day. When barium carbonate is not available, the Punjab Rat Exterminator, which is equally efficient, may be used; 3 grains of the exterminator is fatal to a *Mus rattus* of average size.

The rats should also be attacked in their hiding burrows by fumigation with carbon monoxide, carbon dioxide, sulphur dioxide or hydrocyanic acid gas or potassium chlorate candles. But this method of reducing the number of rats in a locality has been found quite impracticable for want of co-operation on the part of the people, for a large majority of them, owing to their religious beliefs, will not assist in taking away lives of insects and animals, however destructive they may be to life and property.

The rats have been found very resistant to bacterial infection; and so an effort to destroy them completely by spreading some infectious disease among them has not so far met with any success.

Lastly, the number of rats should be kept down by advising the people to keep cats or to trap them alive and to send them to depôts, where they should be subsequently destroyed.

The dead rats found in the house should not be handled or thrown about in gullies or streets, but must be burnt on the very spot.

It is also necessary to examine bacteriologically trapped or killed rats to find out whether they are infected by plague and to find out the locality where plague is raging.

As fleas are the carriers of the disease-germs, attempts should be made to destroy them as well. The larvæ should be attacked in the cracks and crevices of the floor by sprinkling a thin coating of naphthalene on the floor, and leaving the room tightly closed overnight. In the morning the naphthalene may be swept up and what remains used again. Adult fleas are generally killed by the same poisons as are used to kill their hosts. Formalin, pesterine, mercuric chloride, tincture of green soap, chloroform and ether are efficient poisons for killing fleas. The gases employed are $CS_2$, $SO_2$ and HCN.

Another method of destroying fleas, as suggested by Lieutenant-Colonel D. T. Lane, I.M.S., Chief Plague Officer of the Punjab, is by using cresol vapour. The method of using it is as follows :—Put two ounces of cresol on smouldering fire of four or five cowdung cakes in a cup of iron in a closed room, or put a cup containing an ounce of cresol over the fire of any material which is not in flame. In the former case the cresol will be completely burned in two hours; and in the latter case it will vaporize in an hour. The advantage of using cresol is that it is fatal to fleas, but harmless to men and animals. It should be remembered that cresol to be efficacious should be vaporized and not ignited.

To avoid the bites of fleas it is much better that people should anoint their bodies, especially the exposed parts, such as the arms, legs and necks, with mustard oil as is the custom in Bengal. This should be done at least two or three times in a day. Kerosene oil and citronella oil may be mixed with mustard oil.

**Evacuation.**—As soon as rats are found dying in a house, in a *mohalla* or in a village, all the people living in that house, *mohalla* or village should at once evacuate their houses and live in camps in the open. The rats should then be destroyed, and the houses should afterwards be thoroughly disinfected chiefly by pesterine; but the people should not go to live with their friends in uninfected villages or towns, for thereby those places are liable to be infected through their agency. The people should not be allowed to go back to their houses to fetch any articles, after they have once left them, as they are liable to be bitten by infected fleas there, and thus carry infection to the camps. As far as practicable, Municipalities of towns and District Boards in rural areas should provide the people with materials free or at nominal costs, with which they can build huts in the open outside the town or village. There should also be proper arrangement for a pure water-supply, scavenging and chowkidary, as well as for lighting at night.

The fleas are generally carried in the clothes, bedding and such other articles when carried from one village to another, and are thus likely to convey infection. They should, therefore, be unfolded and exposed to the sun for an hour or so on some hot sandy place away from trees or houses outside the village, before persons carrying such clothes are allowed to enter the village. The fleas, if there are any, will thus be killed by this exposure, and then there will be no danger of conveying infection to the inhabitants of the village.

**Disinfection.**—The plague-infected house should be disinfected by cyllin, formalin or pesterine, and should be whitewashed before it is re-occupied by the inmates. All articles used by the patient should be burnt, if possible. If not, they should be thoroughly disinfected by steam after being first well soaked in a disinfecting solution. Discharges, such as fæces, etc., should be burnt. Dead bodies should be burnt, where possible; but they should not be disposed of, if a medical certificate as to the cause of death is not forthcoming.

**Inoculation.**—The last but not the least important measure is inoculation by Haffkine's vaccine made from dead plague cultures to which 5 per cent. carbolic acid is added. The vaccine is prepared under the direct supervision of experts in Parel Laboratory and sent out in

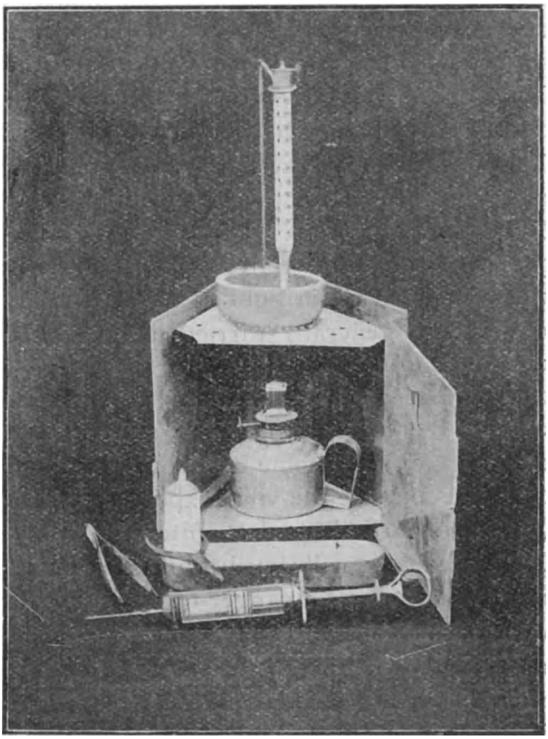


Fig. 50—Inoculation Outfit.

hermetically sealed glass bottles. Each bottle contains 20 cubic centimeters of the vaccine, sufficient for 5 full doses. Inoculation reduces the incidence of plague cases, diminishes mortality to a very great extent, and instils into the inoculated persons that confidence which is so very necessary in averting a panic. It confers immunity for from 6 months to a year, and therefore it is much better to be inoculated at every season of the plague. Frequent inoculations are not known to have caused any harm.

**Method of Inoculation.**—It is always best to collect as many men as possible before the operation of inoculation is started. Those, who hesitated in the beginning, might volunteer to be inoculated when they found that the operation was simple, easy and quite painless. Before starting the operation, one should provide oneself with an inoculation outfit consisting of two 20 c.c. Roux syringes, Kapadia's lamp, a stand, an aluminium dish, a thermometer, a pair of dissecting forceps, pure carbolic acid, vaseline and some bowls.

Kapadia's lamp should be lighted, and vaseline, olive or cocoanut oil should be heated in a dish over the lamp after the thermometer is adjusted in the vaseline or oil. The needles should then be put in the dish after having seen that their points are sharp and clean.

After ascertaining that the syringe is air-tight, it should be filled with the heated vaseline when its temperature has reached 90°C. and again emptied into the pot, so that moisture may be got rid of. Moisture at temperatures above 100°C. is immediately converted into steam, and this causes the vaseline to crackle and splash and may, perhaps, fracture or burst the glass barrel.

The syringe should again be completely filled and emptied twice with the hot vaseline when the temperature has reached 160°C. The syringe is now completely sterilized. A temperature higher than 160°C. injures the india-rubber plunger and a temperature lower than 160°C. is not so efficient in effecting sterilization.

Pick up a needle from the dish with a pair of dissecting forceps, and adjust it firmly to the nozzle of the syringe.

Draw up and eject the hot vaseline from the syringe with the needle *in situ*. The syringe may now be carefully laid on one side, preferably supported on the lid of the syringe box, and allowed to cool. The needle should, under no circumstances, be allowed to come into contact with any article or surface.

A bottle of anti-plague vaccine is then taken in hand. The neck should be examined for any cracks or flaws. Faulty bottles should never be used but rejected, and the contents thrown out. The bottle should be well shaken, so that the sediment at the bottom should be well mixed up. This sediment consists of the dead bacteria, and is, therefore, an essential part of the vaccine.

To open the bottle, the neck should be held in a flame, and a little jerk should be given to the fluid, when the neck will crack, if it has become hot. The tip may then be knocked off by a sharp blow from a pair of sterilized forceps.

Now take up the syringe, draw into it a small quantity of hot vaseline, and again eject it while the needle is still hot, draw into the syringe two or three cubic centimeters of the anti-plague vaccine. Place the bottle on its side on the table. Then draw out the piston of the syringe to its full extent, and shake up the small quantity of the vaccine within the barrel of the syringe. Eject the contents of the syringe. This is done to get rid of some of the excess of vaseline which adheres to the interior of the syringe.

Again dip the needle in the hot vaseline, pass the point of the needle through the flame, and then fill up the syringe. Get rid of excess of air by adjusting the piston. Note the graduation marks on the shaft of the piston, and read off four marks counting from the outside of the barrel of the syringe. Screw up the disc to the point noted. The syringe is now ready to deliver 4 cubic centimeters or one dose of the vaccine.

The inoculation is done at the insertion of the deltoid muscle on the left arm. The skin should be well scrubbed with 1 in 20 carbolic lotion. The dose should then be injected by entering the needle only in the subcutaneous tissue, and care should be taken that it does not enter the muscles, big vessels, or nerves. A pad of cotton-wool soaked in 1 in 20 carbolic lotion should be applied for a few seconds over the puncture. The needle of the syringe should be sterilized by dipping it into the hot vaseline every time the inoculation is performed. After all the inoculations have been finished, the syringe should be thoroughly washed out with 1 in 20 carbolic lotion, and the needles should be covered with vaseline.

The following are the doses to be given to persons in good health at various ages, the usual adult dose being 4 c.c. :—

0.2 c.c. or 1|5 of full dose for an infant of from 10 days to 1 year.

0.8 c.c. or 1|5 of full dose for an infant of one to two years.

1.6 c.c. or 2|5 of full dose for a child of two to five years.

2.4 c.c. or 3|5 of full dose for a boy of six to eleven years.

3.2 c.c. or 4|5 of full dose for a boy between twelve and fifteen years.

4.0 c. c. or full dose for a person between sixteen and fifty years.

N.B.—3 c.c. may be given as a full dose if the vaccine is to be used within three months of its preparation.

Persons over 50 years should be given 1|10th less for each decade above that age. Women of all ages over 14 years should be given 1|10th less than men of corresponding ages. Pregnant women may be inoculated up to the end of the 7th month with the usual dose. After that month the dose should be given in two instalments separated by an interval of a week or so. Miscarriage has never been known to result from inoculation, but inoculation should be insisted on pregnant women as plague among parturient women is ordinarily fatal.

The symptoms caused by inoculation commence, as a rule, in three to five hours, and consist chiefly of a swelling and pain at the seat of inoculation and of a rise of temperature. The arm should be kept at rest in a sling as any kind of movement enhances pain. Alcohol should be avoided after inoculation. There is a general discomfort and slight malaise accompanying fever, which subsides after 24 to 36 hours, but the pain lasts for 3 to 4 days and disappears gradually, though some induration remains for some time at the seat of inoculation. In some cases there is no fever. The presence or absence of temperature is no criterion to the protection acquired by inoculation.

# CHAPTER XVIII.

## THE HOUSE-FLY AND THE DISEASES CONVEYED BY IT.

**The House-fly.**—The house-fly, or the *Musca domestica,* as called by entomologists, belongs to the order Diptera. It is found everywhere in the world, though it is more frequent in warm climates than in cold. The chief breeding-place of the house-fly is found in stable

Fig. 51—House-Fly.

manure, but in India it has been found to breed in human excreta, excrement of dogs, cowdung, decaying and fermenting vegetable and animal matter, in carcases and in putrefying filth.

The female hibernates in dark corners and roofs of the houses in winter. It lays from 4 to 6 batches of eggs with the setting in of warm weather, and at each time deposits from 100 to 150 eggs. The eggs are pure white and present a highly polished surface due to the clear, viscous substance with which they are coated. The larvæ or maggots hatch out from the eggs from eight to twenty-four hours under favourable conditions. The larva is a white slender creature without any legs, but tapering towards the head, and possesses a pair of breathing holes or spiracles; and its body is much stouter towards its hinder part. It requires warmth and moisture for growth. It grows rapidly, and is fully developed in 4 or 5 days; it then becomes a pupa in a hard brown barrel-shaped case, the puparium, which requires warmth and dryness for its development. During this stage many of its organs undergo disintegration, and are re-formed; and in the course of 3 or 5 days the pupal case opens, and the adult lively fly appears, which seeks sunlight as well as the companionship of man. After leaving the pupa case the fly stretches its wings, the integument of the body hardens, and within an hour or two takes wing.

Flies become sexually mature in a week or ten days, and are able to deposit eggs four days after mating. A fly can live six weeks or even longer in a favourable season. It travels with the wind, and is known to have travelled half a mile in an hour.

The mouth parts of the fly are so constructed that it can only suck in liquid food. Hence it first dissolves solid food, such as sugar, by depositing some saliva on it, and then sucks up the sugary solution. It very frequently regurgitates its food in a spherical drop, which it generally re-absorbs.

**The Mode of Carrying Disease.**—Unlike fleas and mosquitoes the house-flies do not bite, and so cannot convey disease by direct inoculation into the circulatory system, nor do the specific micro-organisms undergo developmental changes in their alimentary canal. They, however, mechanically carry infection on their legs, wings and mouth parts from infected human excreta, etc., while walking on them, and then contaminate food articles, milk and water, when they alight on them to feed themselves.

The diseases that are thus conveyed by house-flies are typhoid fever, cholera, and infantile diarrhœa. Tuberculosis is also spread by flies feeding on tubercular sputum, as they are very fond of feeding on saliva. Another disease that is carried through flies, is purulent ophthalmia of the Egyptians. The house-flies have also been associated with the transmission of erysipelas, anthrax, glanders, small-pox, measles, leprosy and some skin affections.

Besides the house-fly, there is another variety of flies smaller in size and called generally "the lesser house-fly." It lives among decaying vegetation and fruit, and also amongst fermenting animal matter and dejecta. It is found sometimes in rotting grass. It frequently passes into the human alimentary canal. The blue-bottle fly

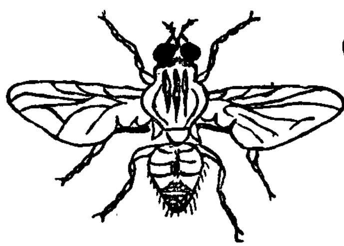


Fig. 52—Lesser House-Fly.

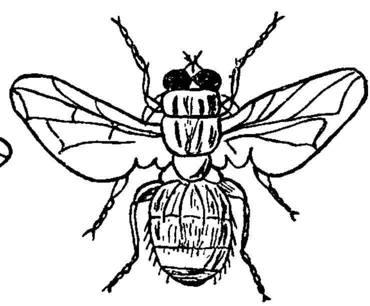


Fig. 53—Screw-Worm Fly.

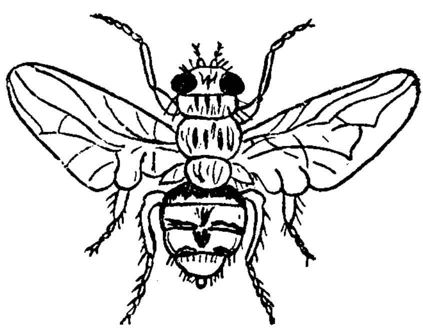


Fig. 54—Blow Fly or Blue-Bottle Fly.

or the "blow fly," or "meat fly," as it is commonly called, lays her eggs in fresh or decaying animal tissues, and so is a great source of nuisance in case of big wounds exposed for some time, especially in time of war.

In the warmer regions there is yet another group of flies, whose larvæ have the capacity to penetrate under the skin of human beings, and produce definite subcutaneous troubles. These troubles are grouped under the term " Myiasis," which, as defined by Graham Smith, signifies the presence of dipterous larvæ in the living body, whether of man or animal, as well as the disorders, whether accompanied or not by the destruction of tissue, caused thereby.

Some flies, such as the screw-worm, deposit their ova and larvæ in the cavities of the body, such as the ears and nose, and cause great inflammation and necrosis until they can be discharged and removed.

Fig. 55—Tse-tse Fly.

**Biting Flies.**—Besides the flies mentioned above, there are some other biting flies which carry micro-organisms of specific diseases, and inject them under the skin when they bite the human beings or animals. Thus the tse-tse fly called *Glossina palpalis*, which is found in equatorial regions of Africa, is concerned in transmitting the disease called sleeping sickness or trypanosomiasis. This fly carries trypanosomes along with its mouth parts which are inoculated into the human skin during a bite, and are then carried to the lymphatic glands by means of lymphatic vessels. There is another theory that the parasite undergoes a sexual evolution within the fly, which then transmits it to a human host. Thus it plays the part of an intermediary host between the parasite

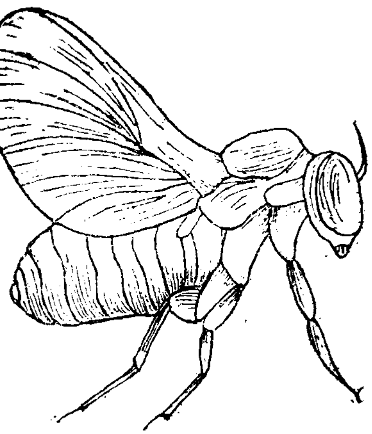


Fig. 56—Sand-Fly.

and the man. The sand-fly, called *Phlebotomus*, produces a five days' fever known as sand-fly fever which, in some cases, is followed by weakness and prostration. It is only the female that bites, just like anopheline mosquitoes.

**Prevention and Control of Flies.**—Towards the close of the breeding season most of the flies are carried away by a fungus disease, and centipedes and beetles also destroy a large number of them; however, owing to their great fecundity, flies can never be controlled and prevented, unless the following measures are taken against their breeding-places:—

1. Stables must be kept clean, and there should be no crevices in their walls or floors, which should be made *pacca* with concrete, and should be washed daily with phenyle or some other disinfectant.

2. Manure should not be allowed to collect in open heaps, but must be kept in tightly fitting closed barrels and should be carried for disposal far away from cities and towns.

3. House rubbish and refuse should be collected in closely fitting iron bins, but should not be allowed to lie near the premises of houses.

4. Latrines should be kept scrupulously clean, and human excreta should not be allowed to rėmain for any time in privy pans or *gamlas* which should at once be emptied into iron receptacles with tightly fitting lids. Kerosene oil should be used in latrines to destroy the eggs of parasitic intestinal worms and larvæ of flies.

5. In famine camps and fairs, trenches in which night-soil is buried, should be sufficiently deep and should be well covered with dry earth, so that if eggs are laid underneath the earth by any chance, they may not be able to emerge therefrom.

6. To destroy flies latrine screens, bushes, straw, etc., should be sprayed with water containing a little sugar, and one ounce of sodium arsenite to the gallon. Arsenious acid with sodium carbonate or washing soda may be used.

7. "Tangle-foot" papers (fly papers) coated with a sticky mixture of various forms should be used to catch flies in houses. Sticky mixtures can be prepared by heating 4 pints of castor oil and 9 ½ lbs. of crushed and powdered resin until the resin is dissolved without boiling it, or by heating 5 parts of raw linseed oil and 12 parts of powdered resin.

8. Doors and windows should be screened to keep flies away.

9. Flies being thirsty insects are always attracted towards water or liquid, and so if all sorts of liquids are removed from a room and a 2 per cent. solution of formaldehyde is placed in saucers containing some milk and

sugar, flies will drink from this liquid, and will be killed in a short time. Arsenic, potassium bichromate or infusion of quassia may be used instead of formaldehyde.

10. A clock-work mechanical fly-trap is very convenient to catch flies. It consists of a slowly revolving cylinder coated with gum. The flies are trapped by a ledge projecting on the cylinder and diverted into a box underneath.

# CHAPTER XIX.

## CHOLERA (ASIATIC CHOLERA), DYSENTERY, TUBERCULOSIS AND TYPHOID FEVER.

### CHOLERA.

THIS is a disease particularly of man, and for several centuries has been known to be endemic in the delta of the Ganges in the lower part of Bengal, from where it has spread in an epidemic form to other parts of India and in a pandemic form over wide areas of the earth's surface. In all epidemic and pandemic outbreaks cholera has always travelled along the routes of trade, such as caravan routes, railways, navigable rivers and sea-route. Again, the big outbreaks have always been traced to large fairs and gatherings and subsequent dispersions of pilgrims, as at Hardwar and Mecca. Thus it has spread to Afghanistan, Persia, Turkey, Russia and other countries of Europe, America, China and Japan. There is hardly any country in the world which has not been visited by cholera.

The incubation period of cholera is very short, a few hours to 5 days. One attack confers a mild grade of immunity, which is not lasting.

**Ætiology.**—Koch discovered the Comma bacillus or the cholera vibrio as the specific micro-organism causing cholera, first in Egypt in 1883, and then in Calcutta in 1884. It was found by him in the intestines and the stools of patients suffering from cholera. It is a very minute organism having the form of a slightly bent rod, which is thicker but not more than about half the length of the Tubercle bacillus. Sometimes it assumes distinctly a cork-screw like shape. On account of the flagella at one or both ends it has got mobile powers.

Comma bacilli grow well and luxuriantly between 17° and 40°C. on almost anything,—paste, boiled egg, turnip, cucumber, cabbage, bread, meat, butter and various fruits. They grow best at 30° to 40°C. in alkaline media. Their growth is arrested below 15°C. or above 42°C. and they are killed by a temperature above 50°C. They do not grow well in the absence of oxygen. They cannot grow in acid juices of the stomach and, therefore, there is less danger from ingesting them during active digestion than upon an empty stomach. It is only in the alkaline juices of the intestines that they find favourable food for their growth. It has been found by experiments that cold water taken on an empty stomach passes through the pylorus and enters the intestines quickly, where cholera vibrios, if contained in water, will find a suitable medium to grow, and the person drinking such water will probably get the disease.

Warmth and moisture are favourable for the incidence of the disease, which generally increases in April, reaches the maximum in July and August, and almost subsides in November with the onset of the cold weather.

It affects persons of all ages. Those, who are intemperate, weakened by want of food and live in unhygienic surroundings, are more prone to the disease. It is more common in low-lying localities situated near the banks of the rivers than in dry places at high altitudes.

**Modes of Infection.**—Cholera is principally a water-borne disease. Water of wells, tanks, canals or rivers gets contaminated on account of bowel discharges of sick patients being thrown in their vicinity, or on account of soiled linen and other articles being washed there. In cities where there is artificial water-supply, water mains are liable to be contaminated by leaky sewers passing underneahh the ground near them. Cholera vibrios are capable of living and multiplying in water, and persons using such infected water are liable to get the disease.

The Broad Street pump outbreak in London and the Hamburg epidemic are very good instances in favour of the disease being carried through water. Cholera is known to have been contracted even by using plates and dishes washed in water infected with cholera vibrios.

Vegetables, such as lettuces and radishes, which have been washed in infected water and have been eaten raw may convey the disease.

Flies also play a prominent part in disseminating the disease. They sit on evacuations teeming with cholera germs, and then sit on milk and other articles of diet, to which they transfer these germs, which they carry on their legs, wings and in their mouth parts. People partaking of these infected articles are liable to fall a prey to the disease.

The germs, when dried, die rapidly, and so infection through air is not possible in this case.

Cholera is not highly contagious, for physicians, nurses and other attendants of patients are not affected by the disease, provided they are very clean in their habits, *i.e.*, if they disinfect their hands after handling the patients or their soiled linen, and if they do not take water or food in the same room.

Cholera carriers play an important part in spreading the disease. The cholera vibrios usually disappear from the fæces of patients after the fourth to the fourteenth day, but the healthy persons living in the infected locality may continue passing vibrios for a period of two months, a gall-bladder infection having been established.

**Preventive Measures.**—1. To control its spread, persons suffering from cholera should at once be isolated to infectious hospitals, where they can be well cared for. It is therefore necessary that all cholera cases and even suspected ones should at once be notified.

2. As it is carried by pilgrims, they should be

thoroughly inspected at the railway stations before they are entrained, and the suspected cases should at once be kept under segregation.

3. These pilgrims, as a safe precaution when they reach their destination, should be kept in segregation for at least five days or should be kept under surveillance for that period; and should be compelled to report themselves to the medical officer there every morning or evening for five days.

4. The cholera germs are passed in stools, and in some cases in vomits. Hence the stools and vomits should be disinfected with 10 per cent. of formalin, 5 per cent. of carbolic acid, 5 per cent. of cresol, 1 in 100 of cyllin, 1 in 200 of hycol, 3 per cent. of fresh chlorinated lime or equal parts of quicklime and water, or evaporated to dryness in the *gamla,* into which they are passed, over an ordinary *chula* especially kept for the purpose. They should then be mixed with saw-dust and burnt, or should be buried deep in the earth far away from water-supplies or should be thrown into sewers if there is a drainage system in the town.

5. During the epidemic of cholera private and public latrines should be kept scrupulously clean, and disinfected with phenyle, formalin or milk of lime. The surface drain of a street, if it communicates with a drain of the private latrine of a house, in which a cholera case has occurred, should be disinfected daily, as although the latrine may not be used by the sufferer, the inmates of the house will probably throw infected matters into it.

6. As soon as the patient dies or recovers, the *pacca* floor and walls of the room occupied by him should be thoroughly disinfected with solutions of formaldehyde, mercuric chloride or cyllin. In case the floor is *kutcha,* either the earth should be removed to a depth of four inches, quicklime sprinkled on the ground, and four inches

of fresh clean earth substituted, or the floor should be thickly covered with quicklime or with grass which should be burnt.

7. Upon the death or recovery of the patient, all the clothes worn by him should, if possible, be boiled or disinfected, or if likely to be spoiled by boiling or disinfection, be exposed to the sun for eight hours. When necessary to overcome opposition, compensation may be paid and the clothes burnt. All rags and articles of no value which have come into contact with the patient should be burnt. The *charpoy* upon which the sufferer has been lying, as also any other furniture with which he has come into contact, should also be washed down with a cyllin solution.

8. Utensils, *lotas*, cups, glasses, saucers, dishes, and spoons used by patients should be thoroughly disinfected, and then scalded with boiling water. They should be kept separate as long as the patient is convalescing, or till he is dead.

9. Persons coming into contact with cholera patients should thoroughly disinfect their hands with phenyle or $Hg\ Cl_2$ lotion, which should always be kept ready in the sick-room.

10. Persons dying of cholera should be thoroughly cremated, but not near a water-supply. If they have to be buried, they must be buried 6 feet under the ground and away from water-supply.

11. As soon as one or two cases of cholera have occurred in a village or town, the water-supply of that village or town should at once be attended to. The wells should be disinfected with potassium permanganate. If there is a private well in the compound of a house where a case of cholera has occurred, the well should be disinfected and closed for a month. If, however, further cases occur in the same house, it should be

closed for a month after the recovery or death of the last case.

Even the wells of the neighbouring villages and towns should be permanganated, as some people infected with cholera are likely to carry the disease to those places, as they may leave the infected village out of panic, and go to the neighbouring villages.

12. People, as a further precaution, should be advised to drink water after it is boiled. In the absence of boiled water, it is safer to drink water after a grain or two of potassium permanganate is added to a tumbler of water, or it may be acidulated with dilute hydrochloric acid in the proportion of 30 drops to every ounce of water.

13. All kinds of food should be thoroughly cooked and eaten hot, but on no account should be eaten when cold or stale.

14. Bazar sweetmeats should not be eaten under any circumstances, as they are liable to be contaminated with cholera virus by flies owing to their being kept in open saucers in shops.

15. All the articles of food should be well screened, so that flies may not sit on them.

16. Milk should be boiled before use.

17. Butter should be made from boiled milk, and should not be purchased from the bazar.

18. Raw vegetables and fruits should be avoided.

19. Vessels used for cooking and other purposes should be washed with boiled water.

20. People should be temperate in their habits and moderate and regular in their meals, so that they should not suffer from indigestion; for this is a predisposing cause of the disease, as more attacks of cholera have been noticed after some feasts. Municipalities should, therefore, not allow caste dinners to be held in streets as is very common in summer at marriage festivities, etc., especially in the Presidency of Bombay.

21. Digestive derangements and diarrhœa should at once be treated by opium, acetate of lead or bismuth.

22. Purgatives should be avoided.

23. As a prophylactic measure anti-cholera inoculation is very valuable. It was first introduced by Haffkine into India. The cholera vaccine, which is prepared at Kasauli, consists of sterilized pure cultures of the cholera vibrios. The vaccine may be injected into any part of the body where the subcutaneous tissue is loose, the convenient situations being the back and the outer surface of the upper arm, or the front of the chest about 3 inches below the clavicle. At first half a c.c. is inoculated, and then 10 days later 1 c.c. is inoculated. The immunity thus artificially acquired usually lasts from four to six months or a little more. Hence inoculations should be performed just prior to the cholera season. As a precautionary measure individuals should undergo cholera inoculation when the disease is anticipated, or an epidemic exists, and when they are about to proceed on active service in cholera-infected areas.

The following is a table showing the doses of anti-cholera vaccine to be given to different periods of age :—

| Years. | 1st dose. | 2nd dose. |
|---|---|---|
| 4 to 6 | 0.15 c.c. | 0.3 c.c. |
| 6 to 8 | 0.2 c.c. | 0.4 c.c. |
| 8 to 10 | 0.25 c.c. | 0.5 c.c. |
| 10 to 12 | 0.3 c.c. | 0.6 c.c. |
| 12 to 14 | 0.4 c.c. | 0.8 c.c. |
| 14 to upwards | 0.5 c.c. | 1.0 c.c. |

Children under 4 years of age are usually not inoculated. Persons suffering from fever and bowel complaints should not be inoculated.

## DYSENTERY.

This is a disease met with in the temperate and tropical countries. There are two varieties of the disease. One is caused by an *Amoeba coli* and the other by a *Bacillus dysenteriae* isolated by Shiga in 1897. This bacillary dysentery occurs in an epidemic form in jails, asylums, schools and famine camps. It is very prevalent in the autumn and in the rainy season, when the temperature is high and the atmosphere is saturated with humidity.

The germ is contained in the stools, and enters the body by the mouth, chiefly through water, in the same manner as in cholera and enteric fever, and so dysentery is considered to be a water-borne disease. Moreover, it is carried directly from man to man through soiled linen and food. Flies also play an important part in conveying the disease from the sick to the healthy by infecting food articles.

Badly cooked or uncooked and irritating food, overcrowding, unhygienic conditions, chill and mental depression are predisposing causes that spread the disease.

Its incubation period varies from 2 to 10 days.

**Prophylaxis.**—(1) In jails and asylums, suspected cases of dysentery should at once be isolated and should be promptly and properly treated. They should not be allowed to mix with other persons during the convalescing period or even some time after they are cured, as they pass germs in their stools for a considerable time, but should be kept under segregation after they are discharged from the hospital.

(2) As a precautionary measure the prisoners and

under-trials, when first admitted into jails, should be considered " bacillus carriers," should be treated as a routine method with mercuric chloride and *bael* fruit and should be kept under segregation for at least ten days.

(3) Water-supply should be attended to. Wells should be permanganated, and water and milk should not be used, unless they are boiled.

(4) It should be seen that food is properly and well cooked; for very often badly prepared food has given rise to epidemic dysentery.

(5) Raw vegetables should not be eaten, but they should be washed with hot water, and then well cooked.

(6) Latrines should be kept perfectly clean and neat, and the stools should be disinfected with phenol, or with any other disinfectant, and then buried or burnt.

(7) Filth should not be allowed to be collected anywhere, especially near latrines, and there should be no cattle sheds in their neighbourhood, so that flies may not collect there. Every precaution should be taken to prevent flies from coming near the latrines.

(8) Sick people should not use the same *lota* for drinking purposes as they would take to latrines for purposes of ablution.

(9) The germs of dysentery are killed by exposure to sunlight in half an hour, but remain active for some time if left in the folds of linens, blankets and bedsheets. These soiled articles should, therefore, be unfolded and exposed to sunlight, and should be thoroughly disinfected and washed with boiling water, before they are given to healthy persons for use.

## TUBERCULOSIS.

This is a disease caused by the Tubercle bacillus discovered by Professor Koch in 1882, and occurs in the human system in different clinical manifestations, as acute general tuberculosis, phthisis (pulmonary tuberculosis), tuberculous meningitis, tabes mesenterica, tuberculous glands, etc.

All warm-blooded animals appear to be susceptible to this disease, though some are known to suffer more than the others. Thus bovines suffer most. Goats are said to be immune. Apes and monkeys do not suffer from it in the wild state, but suffer most when in confinement.

The disease is prevalent both in temperate and tropical countries, and is more prevalent in large over-crowded cities and towns than in open and scattered villages. Of late it has been on a great increase in India. It is very rare in the sandy deserts of Rajputana, but lately cases have been noticed there also, possibly owing to the people of that province migrating to the big cities such as Calcutta and Bombay, being infected there and then carrying infection to their own villages and towns on account of facilities in railway travelling.

**Predisposing Causes.**—These are badly ventilated, dark and dirty houses, which are rarely visited by the sun during the day, general poverty of the people, scantiness of food, alcoholism and consequent lowered vitality, early marriages, frequent child-bearing and *purdah* system, especially in Northern India.

**Tubercle Bacilli.**—These occur usually as short, fine rods, often slightly bent or curved and on an average are half as long as the red blood corpuscles. They are contained in the sputum of phthisical patients and in discharges from all other open tuberculous lesions, wherever they may be situated in the body. Sometimes they are swallowed along with sputum by phthisical people, and are then discharged with the fæces; but sputum is the chief source of danger in very many cases.

**Modes of Infection.**—The sputum, when not properly taken care of in the way of disinfection, gets mixed up with dust in the rooms, which is then stirred up by sweeping or walking on the floor and is inhaled by persons living in the room, who consequently get infected. People get affected by direct inhalation of fresh sputum droplets containing bacilli, which are sprayed out by sick persons during the act of coughing, sneezing or any other violent expiratory action. This is much more liable if the room is stuffy, ill-ventilated and dark, and hence the danger of sleeping in the same room as a phthisical patient.

Infection may also occur by handling injudiciously sputum and other discharges, and then contaminating food or water by means of fingers, or it may be inoculated into an abraded skin by scratching with infected fingers.

Flies are also known to spread infection first by sitting on sputum and then on food, water, milk or fingers, or even on lips. Ingestion of diseased meat is known to have produced the disease.

Lastly, the disease is contracted by direct contact as by kissing or indirectly through infected tobacco pipes or hookahs, spoons, glasses, cups, pencils and toys.

**Human and Bovine Tuberculosis.**—At the International Medical Congress held in London in 1901, the medical profession was very much surprised to hear from Dr. Koch, the eminent German bacteriologist, that human and bovine tuberculosis were different and that man would not contract bovine tuberculosis from cattle. As most of the other famous medical men did not agree with his views, this question was referred to a Royal Commission by the British Government in 1907. The conclusions that they arrived at after great deliberation are as follows :—

There can be no doubt but that in a certain number of cases tuberculosis occurring in a human subject, especially in children, is the direct result of introduction into the human body of the bacillus of bovine tuberculosis and there can also be no doubt that in the majority at least of these cases, the bacillus is introduced through cow's milk. Cow's milk containing bovine tubercle bacillus is clearly a cause of tuberculosis and a fatal tuberculosis in man.

It is, therefore, a settled fact that man is infected by bovine tuberculosis, but some physicians believe that in India this kind of infection is very rare on account of the custom of the people of using boiled milk, but at the same time, they conveniently seem to forget that milk is liable to be contaminated by flies coming from cowsheds after it is boiled, as vessels containing it are, as a rule, kept open. Besides, the cows and buffaloes are, in the majority of cases, stabled in the very houses which have been occupied by the owners, and children are also found playing about on the floor in the cowsheds scattered over with cowdung and urine, which may have been infected.

**Preventive Measures.**—The following measures should be adopted to check the spread of tuberculosis, which is rightly considered a white plague as it takes away so many young lives and bread-winners of families every year, and thus causes a great economical loss to the nation.

1. There should be need of early diagnosis of tuberculous cases, so that they may at once be notified to the sanitary authorities.

2. Tuberculosis being a contagious disease, it is better to isolate cases who pass bacilli in their sputum, and who are thus a direct source of danger to the community. For this purpose sanatoriums should be established in different districts and provinces. But sanatoriums are very costly and considered to be white elephants by some medical men; as sick individuals, when they are discharged from these institutions, do not find the same sanitary arrangements and facilities for treatment in their houses, and consequently fall ill again on reaching their homes. Hence both money and time are wasted on them. It is, therefore, much better to have

some cottages kept separate in villages and towns, where consumptives may be isolated and allowed to work in fields or gardens attached to them under the supervision of medical men in charge of travelling dispensaries. There is another advantage that the patients will be nearer their own relatives—a fact not to be disregarded in India.

3. Towns and cities should be remodelled, wherever possible. Congested areas should be opened up, and open squares with parks should be laid out, and streets should be widened out. Houses should be well ventilated on all sides, so that the sun should penetrate into each and every room.

4. The resisting power of the poor labouring class should be increased by housing them in cheap and well-ventilated houses and by increasing their wages, so that they may get enough to eat. They must be persuaded to give up alcohol and other intoxicating drugs which help to lower their vitality.

5. There should be systematic inspection of school children, so that those children who are found to be suffering from tuberculosis may be separated, and an arrangement should be made to school them in the open, under shady trees, if possible. The school buildings should also be roomy, spacious and well-ventilated.

6. Popular lectures by competent men on tuberculosis in all its aspects regarding the mode of infection and prevention should be frequently arranged in streets and *mohallas*, in towns and in prominent places of villages; and for this purpose anti-tuberculosis leagues should be organised in big cities. Printed leaflets written in easy local vernaculars should be distributed among patients attending dispensaries and hospitals.

7. There should be special tuberculosis dispensaries in every town and city, where out-door patients should be treated with tuberculin.

8. Cows and buffaloes should be examined for tuberculosis, and in case of doubt, tuberculin test should be tried. There should be efficient control of milk supplies as well.

9. In all big municipalities an arrangement for free bacteriological examination of sputum and milk should be made.

10. Veterinary surgeons should be appointed to inspect meat and animals to be slaughtered for human consumption.

11. Consumptives should be advised to hold a handkerchief to their mouth while coughing and to spit only in a spittoon or an earthen *handi*, provided with a cover, that contains some phenyle or other smelling disinfectant likely to drive away flies. Mercuric chloride should not be used to disinfect sputum, as it does not penetrate the albuminous mass. The sputum should then be burnt or buried far away from a water-supply as in the case of cholera evacuations.

12. They should be forbidden from promiscuously spitting in public halls, schools, theatres, public conveyances, tram cars and railway carriages. For their information notices " Spitting not allowed " should be put up in prominent places.

13. If they have to expectorate outside their houses, they should do so in linen handkerchiefs, which should then be disinfected and washed, or still better in paper handkerchiefs which may be burnt afterwards.

14. The rooms occupied by phthisical patients should be disinfected; the floors should never be swept with a broom, lest dust-laden germs be disturbed, but be wiped with a cloth soaked in phenyle or carbolic lotion.

15. Relatives should not sleep in the same room and much less in the same bed. They should not take food from the same dish, nor should they drink water from the same glass as used by patients.

16. Relatives and attendants should never receive sputum in their hands from the mouths of sick people.

17. The persons nursing them should observe perfect cleanliness in washing their hands, etc.

18. Persons with an inherited tendency to tuberculosis should not intermarry with persons of a similar constitution.

## TYPHOID FEVER (ENTERIC FEVER).

This disease is caused by a micro-organism called *Bacillus typhosus or Eberth's bacillus* with which the name of Gaffly has been associated.

This bacillus is rather short, thick, flagellated and motile with rounded ends. It is quite distinct from Bacillus coli, though in the beginning it was thought that it was the same as *Bacillus coli,* which underwent certain changes while growing in sewage, so as to be able to produce symptoms of typhoid fever, when introduced into the human system. It readily grows on various nutritive media and resists drying for months in thick layers, but when spread out in thin layers it dies in from five to fifteen days.

The bacillus is found in the blood, fæces and urine of patients suffering from typhoid fever, and in some cases in the sputum and even in sweats. After death it is found in the mesenteric glands, spleen, gall bladder and in various other organs. Besides this parasite, there are two more distinct varieties, *viz., Bacillus paratyphosus A* and *B*, which give rise to modified symptoms.

**Ætiology.**—It is met with both in temperate and tropical climates. It is more common in towns than in rural areas on account of the former being more filthy and overcrowded. European immigrants to the Tropics within the first three years of their arrival are more prone to the disease than residents of long standing. It was formerly supposed that the natives of India did not suffer from this disease, but Rogers has noticed these attacks among Indians as well as Europeans. However, if it is less common among Indians, it is due not to the fact that Indians as a race are immune, but because they suffered during their childhood and so got artificially immune owing to a previous attack, or they were acclimatised to it by living in constant contact with typhoid and similar toxic agents.

**Season.**—In the temperate countries it is more prevalent in the autumn, but in India it occurs more during hot and dry months, especially in Bengal and in the Punjab, though in Bombay it is met with during the monsoon months.

**Incidence.**—It is generally a disease of the young, who are most likely to be attacked between fifteen and twenty-five years of age. It attacks males more than females. The mortality is usually 10 to 15 per cent.

**Incubation Period.**—The average incubation period varies between twelve to fourteen days, but in some cases it may range from a few days to thirty. It appears to be much shorter, when the poison is introduced by water or by milk.

**Modes of Infection.**—The infection is conveyed from the sick to the healthy directly from the discharges of the patient, *viz.*, fæces, urine and sputum, or indirectly by means of water, milk, food, dust, fomites and flies. The convalescents and others, who harbour typhoid bacilli, and who are, therefore, called "bacilli carriers," play a very important part in spreading infection, especially if they happen to be cooks, bakers, sweetmeat-sellers and dairymen.

**Prophylaxis.**—The following measures should be carried out in order to check its spread:—

1. Correct diagnosis of the disease.
2. Its notification to the health authorities.

3. Isolation of the patient to an infectious hospital as far as possible.

4. If not possible, the patient should be isolated in a large well-ventilated room, much better if detached from the house, which should contain no unnecessary furniture. It should be kept thoroughly clean, but should not be allowed to be swept or dusted dry. Its door should always be well screened.

5. The stools, urine, sputum and other excretions should thoroughly be disinfected before final disposal.

6. The utensils used by the patient should first be dipped in izal lotion for some time, and then washed with boiling water.

7. The other inmates of the house should not be allowed to eat the remnants of food left by the patient, but they should be first boiled, and then discarded or burned.

8. Thermometers and other appliances used for the patient should be thoroughly disinfected by izal, carbolic or formalin lotion.

9. Bedding, towels, bedsheets, etc., used by the patient should first be disinfected, and then washed with boiling water. If possible, it is better to burn them.

10. The nurse and other attendants must protect themselves by first disinfecting their hands with mercury lotion and then washing them with soap and water, every time they handle the patient or his discharges. They should never eat or even drink water in the patient's room.

11. The room occupied by the patient must be thoroughly disinfected with 1 in 1000 mercury lotion after the patient has become convalescent or has died. It should then be whitewashed.

12. The floor, seat and walls of the latrines and the privy pans should be thoroughly disinfected.

13. On the occurrence of a typhoid case, wells in the

neighbourhood should be thoroughly disinfected, and the people should be instructed to drink boiled water as well as boiled milk.

14. They should not drink water or take other eatables sold on the station platforms during their railway journey.

15. They should protect their milk and food against the visit of flies.

16. Frequent bacteriological examinations of discharges (fæces and urine) of enteric convalescents should be insisted on, and they should be warned of being a source of danger to their relatives and to the community, if they are found to be "bacilli carriers." Their excrements should be disinfected. Such persons should, on no account, be employed in the sale of food stuffs or have anything to do with the preparation or handling of food, milk or drink supplies. If they happen to be students, they should not be allowed to live in the school boarding-house or hostel.

17. Sir Almroth Wright has introduced anti-typhoid inoculation in which the dead cultures of bacteria are used. It has been ascertained that two inoculations done at an interval of ten or fourteen days confer more or less immunity. This is mostly practised when a large number of people are to be exposed to a common danger as in war time. Before the introduction of this inoculation, more men in the army used to die from typhoid fever than from powder and shot, but now the incidence of the disease is very low, as has been proved in the South African and German wars.

# CHAPTER XX.

## RELAPSING FEVER, TYPHUS FEVER, KALA-AZAR, LEPROSY AND HYDROPHOBIA.

### RELAPSING FEVER.

THIS is also called famine fever, tick fever, and seven days' fever. It is a highly infectious disease, having a close relation to typhus fever. It is found in Europe, America, Africa and Asia. In Asia it is known to occur in China, Sumatra and India. In India it is largely met with in the Presidency of Bombay and is endemic in the north-west parts of the Punjab. It is present in the Kumaon Hills and the western districts of the United Provinces, while it is not known to have occurred in Bengal, Assam and Madras.

**Ætiology.**—The predisposing causes of relapsing fever are overcrowding, filth, scarcity and poverty. It is, therefore, very common among the poorer classes of the population; but the chief exciting cause is the presence of the spirochæta (spirillum) of Obermeier in the blood during the febrile stage, which disappears completely from it during non-febrile intervals. The spirochætæ are very thin and about 20 to 40 microns in length, their movement being that of rapidly progressing spirals. These have also been found in the sweat and in the tears, and have been proved capable of passing through the unbroken skin and intact mucous membrane. During the non-febrile stage they collect in the spleen and bone-marrow, where they may be undergoing germination and reproduction. These spirochætæ are also the causes of the African and European types of the disease though with morphological differences.

**Incubation Period.**—The incubation period is very short. It varies between five to seven days.

**Protection.**—Unlike other specific fevers one attack does not confer immunity against subsequent attacks.

**Modes of Dissemination.**—From observations made by Tictin at Odessa, he came to the conclusion that the bed-bug (*Cimex lactularius*) was the agent concerned in disseminating the disease from the sick to the healthy. In India, Mackie did not confirm this view by carrying out some investigations on monkeys and bed-bugs, but from inquiries made by him into an epidemic at a Mission Settlement at Nasik, he found out that the body louse or *Pediculus corporis* (*vestimentorum*) was the insect concerned in propagating the disease on account of its habit of easily passing from one person to another along with the clothes in which it lives. Infection takes place through the lice being crushed upon the skin, which is commonly excoriated by the self-inflicted scratches of the person harbouring them. The infective agent may, moreover, be conveyed on the fingers to the nose or eyes, and infect the system by absorption through the mucous membrane.

**Lice.**—Besides the body louse (*Pediculus corporis*), there are two more varieties of lice infecting man, *viz.*, *Pediculus capitus* or the head louse, the eggs of which remain attached to the hairs, and can be readily seen as white specks commonly known as nits; and *Pediculus* (*phthirius*) *pubis* or crab louse which is found on the parts of the body covered with short hairs, such as the pubes. More rarely it is found in the axillæ, eyebrows and eyelashes.

These lice are flat but elongate, wingless insects having a small head and stout thick legs ending in a strong claw, which is used as a pincer to cling firmly to the host. The mouth parts have in front a short

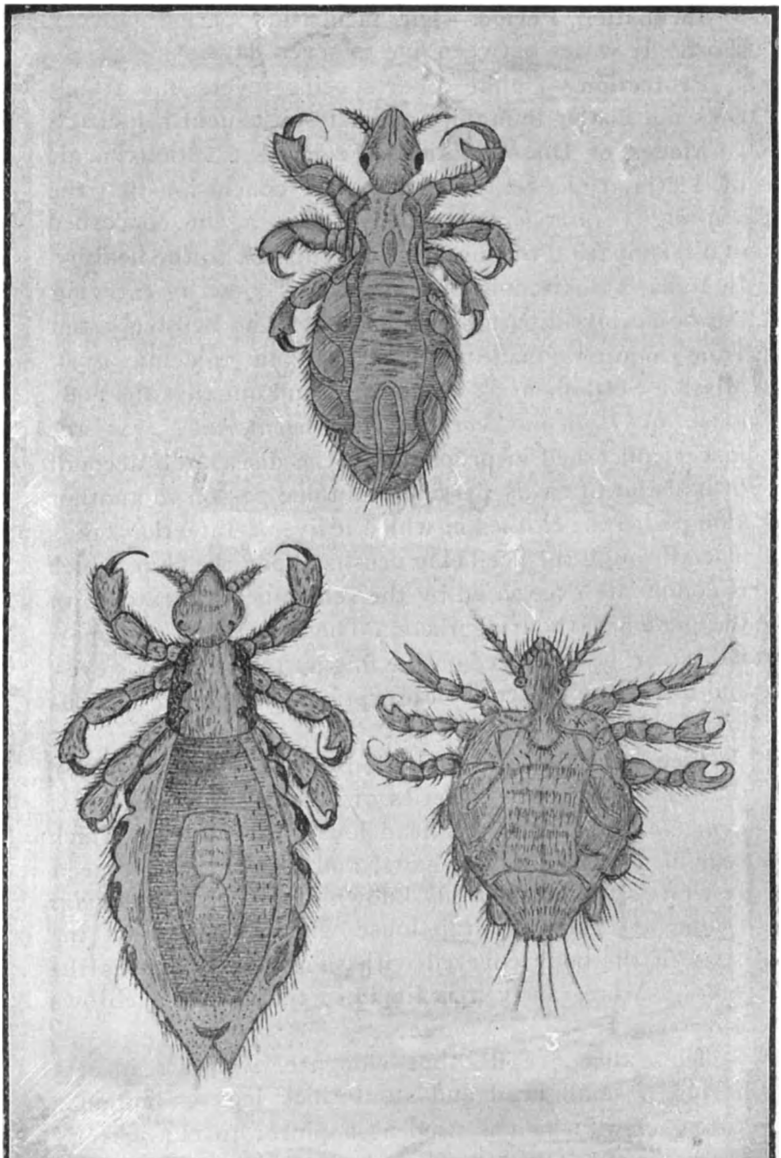



Fig. 57—1. Pediculus capitus; 2. Pediculus corporis;
3. Pediculus pubis.

beak or proboscis extending into a thin slender stylet, which is used to pierce the skin of the host and the blood is thus sucked up through the proboscis. The males are, as a rule, less numerous and smaller than the females. Their eggs are slightly elongated and remain fixed to the hair or clothes of the host. They hatch in about ten to fifteen days.

The African type of relapsing fever or tick fever is transmitted through the bite of the infected tick or of

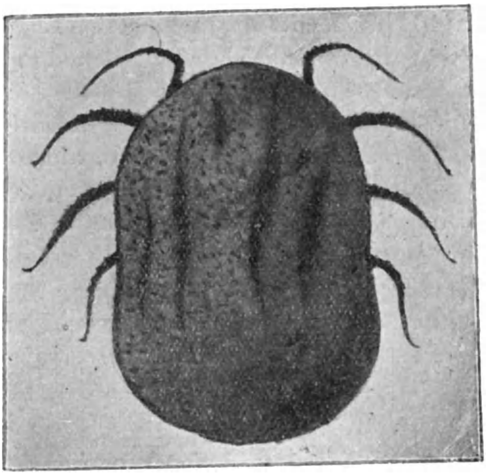


Fig. 58—Tick (Female).
Ornithodoros moubata.

tick born of infected females (*Ornithodoros moubata*), the horse tick. Ticks are met with in the houses of Arabs in the Congo Free State, in the dust, cracks in the mud floor, in and around the bed and in the bedding. In habits they resemble common bed-bugs. They attack human beings at night or during sleep, and it is the female tick that bites.

**Prevention.**—1. Early diagnosis of the disease and isolation of the patient suffering from relapsing fever. 2. Thorough disinfection of the room occupied by the patient, including destruction of vermin, *viz.*, lice. Lice and nits can be destroyed with kerosene, turpentine, dichlorethylene or tetrachlorethane. They are killed more easily by exposure to dry heat than to moist heat. They should never be killed with the nails. 3. Huts or houses of little value should be burnt, if possible. 4. Clothes infected with lice should be immersed for half an hour in a soap solution containing 2 per cent. of trichlorethylene or 10 per cent. tetrachlorethane. However, it is better that they should be boiled, baked or steamed. 5. Articles, likely to be injured by heat, may be subjected to sulphur fumes or dipped in carbolic acid solution. 6. Great attention should be paid to personal cleanliness, and underwear should be kept clean and neat. 7. Bites by ticks or bugs should be avoided, and for this purpose people should keep aloof from vermin-infected places, especially where the disease prevails. Other preventive measures of the first importance are those which combat poverty and overcrowding.

## TYPHUS FEVER.

This is also called spotted fever or jail fever. It is prevalent in Ireland, Russia and certain parts of Southern Europe, as well as in Mexico. It is not a disease of the Tropics, but is, sometimes, met with in the hills of India, as in Bhim Tal, near Naini Tal. It is entirely a disease of filth, overcrowding and poverty. Hence it is usually prevalent during the winter months, when the poor people huddle closely together in ill-ventilated rooms owing to want of proper clothing. The epidemic outbreaks very often follow wars and famines.

**Incidence.**—The adults of both sexes are attacked by the disease, but the mortality is much higher among the males between the ages of ten and fifteen years. The case of mortality is, on an average, about 20 per cent. and is higher in adults than in children.

**Incubation Period.**—This is usually 12 days, but may vary from 5 to 20 days.

**Mode of Infection.**—The causative micro-organism of the disease is not yet known. Some say it is an ultra-microscopic filtrable virus while, according to Plotz, it is an anærobic bacillus. The virus exists in the peripheral blood of the patient during the febrile stage, and possibly for thirty-six hours after the crisis. It loses its virulence, when heated to 55° C. for 15 minutes, but is not destroyed by freezing for eight days.

The disease is chiefly conveyed by means of the body and head louse, which sucks the virus from the blood of the sick and transmits it to the healthy.

**Preventive Measures.**—The patient suffering from typhus fever should at once be isolated to a hospital or a separate room. The hair of his scalp should be cut short, or shaved, and the hair of his face, axilla and pubes should also be shaved. Such hair should be collected and burnt. The patient should then be thoroughly washed with a soap solution containing 2 per cent. trichlorethylene or 10 per cent. of tetrachlorethane. It is also advisable to rub him all over with 10 per cent. camphor oil, or to spray him or to rub him down with kerosene, benzene or gasolene to destroy lice or their nits. The clothes of the patient should be immersed in boiling water, or should be steamed or baked. The room occupied by the patient should be thoroughly fumigated with sulphur dioxide or formaldehyde. Isolation of the patient should continue for five weeks.

Doctors and nurses, who have to attend on the sick, should protect themselves from the bites of the infected lice by wearing overalls fastened round the neck and wrist by adhesive plasters. They should also wear rubber gauntlet gloves, boots and leggings. The head should be covered by a closely fitting cap.

The contacts should be quarantined for 16 days.

## KALA-AZAR.

Synonymous with Dum-Dum fever, Burdwan fever and Kala-dukh.

This is a tropical infection characterized by an irregularly remittent type of fever, enlargement of the spleen, wasting anæmia and dropsy. It occurs in an epidemic form in Assam and in an endemic form in Madras and some other parts in India. Lately it has been noticed in the eastern districts of Oudh.

**Ætiology.**—The causal agent of the disease is a parasite which occurs in great numbers in the spleen and which, upon cultured media, develops into a flagellated organism resembling the trypanosomes. It was discovered by Leishman and Donovan in the spleen and liver and the epithelium of blood vessels. It is, therefore, called Leishman-Donovan body or Leishmanii-Donovani. This parasite is an oval and circular body about the size of a blood plate, with a spherical nucleus close against the capsule, and a short, rod-like body on the opposite side. It has been observed in the ulcerous mucous membranes of the intestines by Manson and Low, and Rogers cultivated the parasite from the spleen of patients suffering from kala-azar upon agar streaked with fresh human blood, when flagellate forms developed. The parasite passes through the asexual phase of its life in human blood, while its sexual phase is passed in an invertebrate intermediary host to complete its development, which happens to be a common bed-bug.

**Incidence.**—Kala-azar attacks both sexes and all ages, but unlike malaria, it shows a predilection for the acclimatised, the old residents; in them it is said to be as severe and fatal as in the case of newcomers.

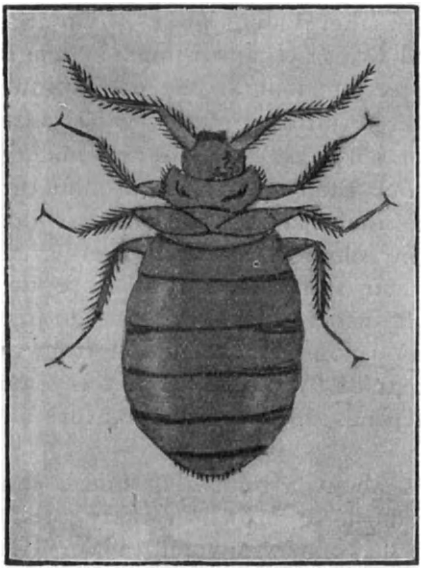


Fig. 59—The Bed-bug.

**Period of Incubation.**—The period of incubation is not certain. It may be under ten days.

**Mode of Conveyance.**—The disease is conveyed from the sick to the healthy through the bite of a common bed-bug (*Cimex rotundatus*) which plays the part of an intermediary host as observed by Patton and confirmed by Rogers.

This hypothesis appears to be quite correct, as the parasites are eliminated by the blood and, therefore, withdrawn from it by a blood-sucking insect (bed-bug).

**Bed-bugs (Cimicidæ).**—These belong to the order of the hemiptera. There are two species, which chiefly attack man. One is *Cimex lectularius*, common in the temperate climate, and the other is *Cimex rotundatus*, which is usually met with in warm climates. Both are accused of conveying bacterial diseases, but the latter is more dangerous than the former. Besides Kala-azar, it is supposed to be the carrier of relapsing fever, typhus, plague, tuberculosis, leprosy and anthrax; but evidence is still wanting to prove that the bug carries these diseases, especially relapsing fever and typhus.

After a good feed the female bug usually lays her eggs in batches of from six to fifty in cracks and crevices, which serve as her hiding places. The eggs are pearly white and oval, perhaps 1 mm. in length, and have a small projecting door at one end, through which the young emerge into the outer world after hatching for a week or ten days. They do not undergo any metamorphosis, but the young are in miniature forms very similar to their parents except that they are yellowish white in colour and nearly transparent. They have to shed their skin five times before they develop into the adult insect, and they have to feed between each shedding (moult). The period from the stage of the egg to that of the mature insect is about seven weeks, which depends upon the temperature and the amount of food.

The adult insect is about 5 mm. long and 3 mm. broad, and is of a reddish or brownish rusty colour, fading into black. It has no wings but a very flat body covered with hair, which enables it readily to pass through the narrowest chinks and crevices in walls, beds and furniture. It is also found behind the picture mouldings and under the mattings owing to warmth. During very cold season it becomes inactive, but can stand starvation for a very long time, even for a year. It is nocturnal in its habits, and can be carried from place to place into trunks and portfolios of travellers in railway trains, or on board ships. It bites its victim by piercing the skin with four thread-like filaments or setæ and causes irritation, redness and swelling at the site of the bite.

**Prophylaxis.**—Complete segregation of all recognised cases with their families, combined with thorough disinfection of quarters, clothing and furniture. In cases of coolies and other poor people living in huts and small houses, abandonment and destruction by fire of all their quarters and belongings seem to be the surest and quickest means of stamping out infection. Rogers has found this practice most successful on several tea estates.

Measures should also be taken to destroy bed-bugs, as they are believed to be the carriers of this disease. The most practical method to destroy them is a liberal application of gasolene, benzene, kerosene, oil of turpentine or a saturated solution of corrosive sublimate. These must be introduced into all crevices and cracks with small brushes or feathers, or injected with syringes. The use of boiling water is also efficacious. Another method is by fumigating the room with HCN, $SO_2$ or $CS_2$.

## LEPROSY.

This is one of the oldest of known diseases, and at present prevails widely, particularly in tropical and sub-tropical countries. In India it is estimated that there are some 300,000 lepers. It prevails extensively in China and Japan. In Europe, where it largely prevailed in the Middle Ages, it has become almost unknown, except in Norway. In America it exists in the Gulf States and in Mexico. It has been for long endemic in the West Indies.

**Ætiology.**—Bacillus lepræ discovered by Hansa of Bergen in 1871 is universally recognised as the cause of the disease. It has many points of resemblance to the tubercle bacillus, but can be readily differentiated. It is doubtful whether it is capable of growth in an artificial medium. The leprous bacillus is found in all the lesions of the disease, *viz.*, the tubercular nodules on the skin and mucous membrane, lesions of the liver, spleen, testicles and lymphatic glands. It leaves the body from any of the lesions that are broken down. It occasionally appears in the fæces and urine.

Leprosy attacks all classes and persons of all ages, but it is extremely rare before the 5th or 6th year, and generally does not attack people over forty. Uncleanly habits, squalor and poverty are probably the predisposing causes. It is not due to the eating of any particular food, such as dried fish as maintained by Jonathan Hutchison.

**Modes of Infection.**—There is no doubt that leprosy in all its stages is conveyed from the sick to the healthy by direct contagion.

It was formerly thought that heredity played the same important rôle in transmitting the disease as in the case of syphilis; but the Leprosy Congress in Berlin has decided against this view.

It is possible that leprosy may be an insect-borne disease, and flies, fleas, lice and bed-bugs may have been concerned in carrying the infection, but there is no positive proof of this theory.

**Prevention.**—The prevention of leprosy depends almost entirely upon isolation, care of the infected discharges, personal cleanliness, and sanitary surroundings.

For suppression of the disease, all lepers showing the disease in any stage should be compulsorily segregated in leper asylums or settlements, which should be so conducted as to prove attractive with arrangement for their treatment according to the improved modern methods. These should not be constructed in towns, but far away from them on a sufficiently isolated locality. Lepers ought not to be allowed to beg in the streets, to keep shops, to work as *dhobies* (washermen) or barbers, to handle food and clothes intended for sale, to wander about the country as pedlars or mendicants, to hire themselves out as servants or prostitutes, or to frequent fairs or public places.

Leprosy is not a hereditary disease. Hence the children of leprous patients should be removed from their surroundings, and should be kept in separate orphanages under favourable hygienic conditions.

In 1898 the Lepers Act was passed in India, by which a police officer is empowered to arrest, within a notified area, without warrant any pauper person suffering from any variety of leprosy in whom the process of ulceration has commenced, and to take him at once before an Inspector of Lepers, so that he may be segregated to a leper asylum for treatment. The law also empowers the Local Government to order that no leper within a notified area shall—

1. Personally prepare for sale or sell any article of food or drink or any drugs or clothing intended for human use, or
2. Bathe, wash clothes or take water from any public well or tank, or
3. Drive, conduct, or ride in any public carriage plying for hire other than a railway carriage, or
4. Exercise any trade or calling which may by such notification be prohibited to lepers.

Leprosy being contagious in all its stages, this act was defective. Hence it is amended this year, so that all the pauper lepers suffering from any stage of the disease can be arrested without warrant and segregated to a leper asylum.

## HYDROPHOBIA OR RABIES.

This is an acute specific rapidly fatal disease common to man and carnivorous animals, *viz.*, dogs, wolves, and cats. When it occurs in man, it is called "hydrophobia" from the dread of water, which is one of the chief symptoms; but owing to this symptom being absent among lower animals, it is commonly known as rabies.

At one time hydrophobia was supposed to occur chiefly in temperate climates, but this is not the case as it is common in India and Central Asia. The disease is more frequent in the hot season than in winter and spring.

**Mode of Infection.**—The specific virus is contained in the saliva of rabid animals, and hence the disease is transmitted to man by the bite of rabid dogs or more rarely of rabid wolves, jackals, foxes, and cats. The poison may also be conveyed by licking, provided there are abrasions or open wounds in the skin. Horses, cows and other herbivorous animals are liable to be infected if bitten by rabid dogs or other rabid animals. The virus enters the system through the broken skin or wound, and follows the nerve trunks from the seat of injury to the spinal cord, thence to the medulla and brain.

**Incubation Period.**—The incubation period varies from 14 days to a year or more.

**Prophylaxis.**—The prevention of rabies is considered under three heads—

(1) Treatment of wounds, (2) the Pasteur prophylactic treatment, and (3) the control of the disease in dogs.

(1) Wounds produced by the bite of an animal which is in the least suspected of rabies should at once be thoroughly cauterized with fuming nitric acid. The acid should be applied with a glass rod, and care should be taken that no pockets or recesses in the wounds should escape being treated.

(2) Pasteur elaborated this method of prophylaxis in 1883. The principle of the treatment consists in producing an active immunity by means of an attenuated virus. The virus is attenuated by drying. The fixed virus contained in the spinal cord of rabbits dead of hydrophobia is the material used for subcutaneous injection. The places, where this treatment is carried out, are called Pasteur institutes. In India there are

two such institutes, one at Coonoor and the other at Kasauli. Government pay all the expenses including railway fare to their low-paid servants and to all poor people. Similarly other public bodies also pay expenses for their own servants.

It should be the duty of medical men and health authorities to persuade people bitten by rabid dogs to go to any of these institutions for preventive treatment.

(3) Rabies can be stamped out by destroying all ownerless and stray dogs by drowning them or asphyxiating them in lethal chambers, and muzzling all known dogs for a sufficient length of time, but in a country like India, where the majority of people have great religious scruples against taking away life of any animal or even of an insect, however dangerous it may be to human beings, it is not possible to carry on wholesale destruction of dogs. The next best thing is to persuade people to collect and keep dogs and bitches quite separately in *pinjara pols* or at some other places to prevent their multiplication, to levy a tax on people who keep dogs on their premises, and to make a rule that these should be muzzled day and night.

# CHAPTER XXI.

## SMALL-POX, CHICKEN POX, MEASLES, WHOOPING COUGH, DIPHTHERIA AND INFLUENZA.

### SMALL-POX.

THIS is a highly contagious disease and though endemic in India, China, Egypt and many Eastern countries, it occurs in an epidemic form in all parts of the globe and affects the white as well as the coloured races.

**Incidence.**—Children are particularly susceptible. Previous to the introduction of vaccination children under five years of age suffered most, but since then the disease has become more prevalent among adults, children being apparently protected by vaccination.

The disease appears to be favoured by cold and retarded by heat. The rainy season puts a check on it. In Calcutta the greatest number of deaths occur in March, and in Bombay in April.

**Mode of Infection.**—Nothing is yet known of the exact method by which infection of small-pox is conveyed; however, the general belief is that it is an air-borne disease and enters the system through the respiratory tract. The virus of small-pox, whatever it may be, is contained in the skin eruptions and in the mouth and throat secretions of the patient, and is capable of being carried down the wind for considerable distances through the air in the dried epithelial scales and pus cells from the crusted pocks.

The infection may also be conveyed by beddings, towels, handkerchiefs, books, toys, spoons and articles of furniture, that may have come into contact with the patient. The poison remains active for a long time on such articles. It is also likely that the house-fly may convey the disease by carrying infection along its proboscis, feet and other portions of its body by first sitting on a sick person and then alighting on a susceptible healthy person.

**Incubation Period.**—The incubation period is nearly always twelve days, but may vary from nine to fifteen.

**Infectivity.**—The period of infectiveness begins with the appearance of eruptions and lasts till desquamation of all crusts has ceased. In some cases the disease is infectious in its initial stage before the eruptions have appeared and even during the stage of incubation. Ordinarily the duration is considered to be 5 to 8 weeks.

**Preventive Measures.**—Protection from small-pox can be acquired by (1) Isolation, (2) Disinfection, and (3) Vaccination.

1. **Isolation.**—Small-pox is a notifiable disease by the order of the Government. Hence a patient suffering from the disease should be promptly isolated to an infectious diseases' hospital, if there is no special small-pox hospital. In India it is pity that isolation is not strictly carried out. Those who come into contact with him must be kept under surveillance for at least 14 days. During this period they should certainly be vaccinated, unless not recently done. No harm is done by vaccination during the incubation period. On the contrary successful vaccination performed during the first three days of the incubation period prevents the attack of small-pox, and probably arrests or modifies the attack if performed on the 5th or even the 6th day. The children of an infected house must not be allowed to go to school, lest they might infect the other children of the school.

2. **Disinfection.**—The house occupied by the patient, and the bedding and other wearing apparels, as well as the furniture should be thoroughly disinfected. The clothing of the contacts should also be disinfected. The

patient himself is a great source of infection. Hence all his discharges, such as the sputum, urine and fæces should be disinfected with chlorinated lime, that has not lost its chlorine smell by prolonged keeping or with any other disinfecting solution, before they are finally disposed of. He should not be allowed to mix with other people, until desquamation has stopped. This may be favoured by the use of warm baths with soap, and by anointing the skin with vaseline or oil.

3. **Vaccination.**—Vaccination, *i.e.*, inoculation of cow-pox or vaccinia was introduced by Edward Jenner in 1796. He was led to make the experiment from the facts, long observed in dairy farms, that cows were liable to a pustular disease of the udder and teats, which was often accidentally communicated to men and women milking them, and that these persons enjoyed subsequent immunity from small-pox. Conversely, it was observed that those who had small-pox did not catch the disease from the cows. He demonstrated that cow-pox once implanted in the human subject could be continued indefinitely by inoculation from person to person which rendered the practice of vaccination possible.

**The Operation of Vaccination.**—It is usually performed on the outer surface of the arm at or about the insertion of the deltoid muscle, or on the forearm below the bend of the elbow. The operation can be carried out by a direct method from arm to arm, or from calf to arm, or from stored calf lymph. The skin at the site of the operation must be rendered surgically clean by scrubbing it with soap and warm water, or with warm water and alcohol ; but strong antiseptics should not be used lest they may destroy the efficacy of the lymph. Lately the tincture of Iodine has been very much advocated for painting the skin before the operation, and it was tried in the district of Agra, but with much less success, probably owing to its irritant nature. To render the operation successful, it is necessary to wash away the tincture of Iodine from the skin before lymph is introduced. The vaccinator must render his hands aseptic, and must also sterilize the needle, lancet, or Weir's scarifier, whichever he uses. It is best to pass it through the flame every time he operates. The lymph may be introduced by punctures, by scratches or by gently rubbing into an abraded surface. Scratching should be just sufficient to cause the exudation of a little blood-stained serum. Four scratched patches should be made, each patch being an inch away from the other. Care should be taken that the lymph is allowed to be dried and not wiped out. Dressings or bandages of any sort should not be applied, but some pieces of gauze may be placed over them as a protection.

**Age for Vaccination.**—Small-pox is a disease of children. It is, therefore, obvious that there should be no unnecessary delay in vaccinating children. The best time to vaccinate a child is within six months of its birth, before dentition has commenced. If small-pox be prevalent, children should be vaccinated within three days of their birth. In India vaccination should never be delayed beyond the first year of life. By the Vaccination Act of 1880, as amended by U. P. Act II of 1907, vaccination in the notified areas of the United Provinces is compulsory from the 6th month to the 14th year of age in the case of unprotected boys and to the 8th year in the case of unprotected girls. If the parent or guardian of a child during this period refuses to have it vaccinated without giving satisfactory explanation, he is liable to be punished with a fine extending to 50 rupees for the first offence and with simple imprisonment for a term extending to 6 months, or with fine extending to one thousand rupees or with both for further offences in respect of the same child.

According to this Act, if the superintendent of vaccination is of opinion that a child, which has been three times unsuccessfully vaccinated, is insusceptible of successful vaccination, he shall have to furnish a certificate to that effect to the parent or guardian of such child, who will thenceforth not be required to cause the child to be vaccinated.

**Phenomena of Vaccination.**—When the operation of vaccination has been successfully carried out on a healthy child, nothing is evident at the site of the operation for the first two days, but by the third day one or more papules appear which are round, flat, red, hard and superficial. On the fifth or sixth day a vesicle forms on the summit of the papule. The vesicle is at first clear and pearl-like, and becomes depressed in the centre as it enlarges. It then becomes surrounded by a deep, red, and swollen areola. On the eighth day the vesicle becomes mature. At this stage it is greyish in colour, tense, elevated and loculated, and contains a clear, viscid lymph, which exudes when the vesicle is pricked, and is used for vaccination purposes. On the ninth day the vesicle becomes pustular, and is surrounded by an inflammatory areola. Constitutional symptoms, *viz.*, malaise, loss of appetite, sometimes nausea and vomiting, headache, pain in the muscles of the back and a slight rise of temperature usually accompany this stage. On the tenth day the vesicle begins to dry up, and forms a dark-brown scab about the 14th day, which falls off usually about the 21st day. The scab should never be removed, as it forms the best form of a bandage. The scar left after the falling off of the scab remains depressed and pitted.

**Immunity.**—The immunity conferred by successful vaccination against small-pox does not last for life-time, but it wears off gradually with the lapse of time and, therefore, it becomes necessary to practise re-vaccination in order to have continuous protection. The time for re-vaccination is usually between 10 and 14 years of age. After this, it is unnecessary to vaccinate again for the rest of the life, unless the individual is particularly exposed to a danger of small-pox.

**Value of Vaccination as a Preventive against Small-pox.**—In Jenner's time, inoculation of healthy individuals with small-pox matter was freely practised. The disease obtained by inoculation was milder than true small-pox, and was never of confluent or hæmorrhagic type, while the pustules that appeared were rarely over two hundred.

Inoculation for small-pox was practised in India by Brahmans long before the Christian era. They used to inoculate people in the beginning of the cold season with dried small-pox scabs (attenuated virus) of the previous year. It was then introduced into China, Arabia and other Eastern countries. Lady Mary Westley Montague introduced the method into England in 1721, which was then adopted in America and the continent. The practice of inoculation had the following serious drawbacks:—

1. The disease acquired by inoculation was as highly contagious as true small-pox.

2. Persons coming into contact with those suffering from inoculated small-pox contracted the disease often in a serious or fatal form.

Inoculation, therefore, fell into disrepute, and in 1840 was prohibited by the law in England and other countries. By virtue of the Vaccination Act inoculation is also prohibited in India, and no person who has undergone inoculation is allowed to enter a notified area under the operation of the Act, before the lapse of forty days from the date of the operation, without a certificate from a recognised medical practitioner.

The value of vaccination as a preventive against small-pox was proved by Jenner himself by vaccinating a number of individuals, who did not suffer from the symptoms of small-pox, when they were subsequently inoculated with variolous matter. This value can also be ascertained by comparing the fatal and severe cases among the vaccinated and unvaccinated. In pre-vaccination times, children suffered most from the disease, and most of them proved fatal. The same is the case among unvaccinated people even at the present time. Among the vaccinated, children escape the disease, while adults are liable to be attacked by the disease on account of the fading away of the effects of vaccination performed in childhood, but most of these cases do not prove fatal. Besides, the incidence of small-pox has lowered very much in those towns and cities, where re-vaccination has also been compulsory.

**Objections urged against Vaccination.**—Antivaccinationists oppose vaccination on the ground that it causes several diseases, the chief of which are syphilis, tuberculosis, cancer, leprosy, tetanus, pyæmia, cellulitis, impetigo contagiosa and erysipelas. This allegation is only an exaggeration. If the operation of vaccination is properly performed, no other disease but vaccinia can be imparted. Again, in "arm-to-arm" vaccination, it should be ascertained that the child is healthy, comes from healthy parentage and that it does not suffer from hereditary syphilis or tuberculosis, before the lymph is taken from it. The lymph should be taken only from typical vesicles around which there is no conspicuous commencement of areola. It should also be remembered that a child should not be vaccinated, when it is very weak and ill-nourished, or suffering from any acute skin disease, from severe diarrhœa or bronchitis, or suffering severely from teething or any other ailment.

The question of syphilis becomes altogether nil, in cases where calf lymph is used, as calves are insusceptible to syphilis. As regards tuberculosis the calves should be watched for at least a week, and should be tested with tuberculin, before they are inoculated with vaccine lymph.

As regards the present reduction in small-pox incidence, anti-vaccinationists attribute it to general improved sanitation, but they are very much mistaken in this, for zymotic diseases, specially those that are air-borne, cannot be said to have been influenced by improved sanitary arrangements, inasmuch as whooping cough and measles have not yet been diminished in spite of improved water-supply, and good and efficient drainage in several big towns and cities.

**Varieties of Vaccine Lymph.**—These are human lymph fresh from the arm, human lymph dried on ivory points or preserved in capillary tubes ; or fresh lymph mixed with glycerine, lanoline or vaseline ; or fresh bovine lymph from the calf, bovine lymph dried on ivory points, or preserved in glass tubes, mixed with glycerine, lanoline or vaseline. Preserved glycerinated calf lymph is, nowadays, used very largely both in Europe and India. Vaccine is removed from the vesicular pulp five days after vaccination of the calf by means of a sterilized Volkman's spoon, and received into a weighed sterilized bottle. It is then rubbed and triturated in a sterilized glass mortar with a sterilized pestle with six times its weight of a mixture of 50 to 60 per cent. of pure glycerine in distilled water and lastly drawn into large tubes, the ends of which are hermetically sealed by means of a blowpipe. The glycerine has been found to retard or destroy extraneous septic microbes, but not to harm the efficacy of the vaccine. Lanoline paste is somewhat similarly prepared.

## CHICKEN-POX (VARICELLA).

This disease occurs in an epidemic form, but sometimes sporadic cases are also met with. It very often coincides with an epidemic of small-pox and adds to the difficulty in diagnosing mild cases of the latter. It is a disease of childhood, and most of the cases occur between the second and sixth years ; however, adults who have not had the disease in childhood are liable to be attacked. The specific germ of the disease has not yet been isolated.

**Incubation Period.**—The incubation period varies probably between fourteen and sixteen days.

**Mode of Infection.**—The infection is conveyed by direct contact or by means of fomites. The patient is infective from the appearance of the first symptoms to the time when all the scabs have dried up. The usual period of infectivity is about 4 weeks.

**Preventive Measures.**—

(1) Notification of the disease lest some mild form of small-pox may escape notice.

(2) Isolation of the patient.

(3) Thorough disinfection of the room occupied by the patient and his clothes and bedding.

(4) Prevention of children living in an infected house from going to school.

## MEASLES.

This is a widely distributed disease throughout the world, and occurs in India generally in cold months from November to April. It is a disease of childhood, but unprotected adults of all ages are sometimes attacked. It is very fatal to young children owing to pulmonary complications and sequelæ. Overcrowding, poverty and insanitary conditions mostly affect the mortality which is highest in the second year of life.

**Period of Incubation.**—The period of incubation varies from 8 to 20 days, the usual limit being about 11 days.

**Protection.**—One attack generally confers immunity against subsequent attacks.

**Modes of Transmission.**—The germ of the disease is not yet known. The virus is given off from the secretions of the nose, throat and lungs, and possibly from the skin eruptions. The disease is conveyed directly from the sick to the healthy by contact or indirectly through a third person or infected clothes or toys, as the poison is likely to cling to the clothes and garments. The pre-eruptive stage is most contagious, and the child is infective all throughout its illness, until cough and desquamation have ceased. Hence the period of infectivity may be laid down as 3 or 4 weeks after the symptoms of the disease have appeared.

**Preventive Measures.**—The patient should be isolated, and the body should be anointed with carbolised vaseline or glycerine. The nasal and buccal secretions should be wiped out with pieces of cloth, which should then be burnt. Clothes and bedding should be disinfected, and so also the room. The children of the house in which a case of measles has occurred should be kept under quarantine, *i.e.*, a strict watch should be kept on them to find out if any other case appears among them. They should not be allowed to mix with the patient, who should be kept separate in a well-ventilated room. They should also not be allowed to go to schools, or meet other children in streets, parks or on play-grounds for at least 3 weeks after eruptions have appeared in the last case in the family.

In order to reduce mortality in measles it is necessary to impress upon the parents that the disease has no bearing on any superstitious belief, and that the infected children should at once be treated on proper medical lines.

## WHOOPING COUGH.

This is a very frequent and widely spread disease, chiefly affects children under five, and is most fatal to infants, particularly females. It occurs in epidemics which are not, as a rule, influenced by climate or season, though it is more prevalent in cold and damp countries. Race has also no influence over the disease, as both

Indian and European children are known to be suffering from it. It generally follows the epidemic of measles.

It has now been proved that, as in other diseases like scarlatina and diphtheria, the cause of whooping cough is a small bacillus found in the secretions from the lungs.

**Mode of Transmission.**—The disease spreads from one person to another by direct contact or indirectly through clothes, toys, drinking cups, etc., as the virus may cling to them, though it is not carried to a long distance. It may also be carried to children through domestic animals, such as dogs and cats, as these are known to be affected by the disease. It is not conveyed through water, food or milk.

**Period of Incubation.**—The period of incubation varies from 7 to 10 days, but may be delayed up to 14 days, while the period of infectiousness is not less than six to eight weeks from the onset of symptoms.

**Protection.**—One attack generally affords protection. The second attack is very rare.

**Prevention.**—The disease can be controlled by isolating the patient in a separate well-ventilated room on the upper storey of a house, if possible, and by disinfecting all the secretions from the nose, mouth and lungs, as well as the articles of clothing and the utensils that may have come into contact with him. The patient should not be allowed to go to school, or to any other public assembly, where other children are likely to collect, and should not be allowed to ride in a public conveyance. The other children of the family should also be forbidden to attend the school, the theatre or any other public place or meeting. Dogs, cats, and other domestic animals should be kept away from the patient, remembering that these animals are susceptible to the disease which may, in their turn, convey it to other children in the street.

## DIPHTHERIA.

This is a widely distributed disease all over the world, and climate does not seem to have any influence over the disease, though it is more common in temperate and cold countries than in the tropical ones. In India it is more common in the hills than on the plains. It affects both sexes and all ages, but it is especially frequent in children between two and twelve years. It is said to prevail more in rural than in urban districts, although epidemic outbreaks in congested places, such as schools, asylums, jails and camps are more common.

The exciting cause of the disease is a micro-organism called Klebs-Lœffler bacillus, which is always present in the false membrane. At an autopsy it is found in the blood and internal organs in many cases.

The predisposing causes are lowered vitality due to overcrowding and insanitary surroundings and sore-throat, nasal catarrh, laryngitis and unhealthy conditions of the mouth and teeth.

**Period of Incubation.**—The period of incubation is very short, usually two or three days, but is liable to vary from one to six days.

**Period of Infectivity.**—There is no consensus of opinion as regards the period of infectivity, which is laid down between 14 days to 8 weeks ; though as a safeguard, diphtheria convalescents should not be allowed to mix with the healthy until at least two cultures taken from the nose and throat are proved negative.

**Protection.**—An attack of diphtheria is not known to confer immunity against subsequent attacks.

**Mode of Transmission.**—The disease may be transmitted from the sick to the healthy directly by coughing, speaking, sneezing or kissing, and indirectly through infected articles, such as handkerchiefs, toys, slate pencils, coins, etc. It is conveyed in some cases through contaminated milk and other articles of food. Bacillus carriers play a large rôle in spreading the disease. It cannot be carried to a long distance by air, as the diphtheria bacillus is frail, and soon dies, when dried or exposed to sunlight.

**Preventive Measures.**—The most important preventive measures are isolation of the sick and thorough disinfection of the clothing and of everything that has come into contact with the patient. The secretions from the mouth and nose should be received on a piece of cloth and burnt. During the convalescent stage the mouth, the throat and the nose should be repeatedly washed with a disinfecting lotion. The doctors and nurses should wash their hands with mercuric perchloride or formalin lotion, and should frequently gargle their throat and mouth with antiseptic lotions. Children from infected houses should not be allowed to go to schools. In the case of an epidemic outbreak, school children should be medically examined, and all cases of sore-throat or nasal catarrh should be segregated and forbidden from attending school until recovery. Those who have been exposed to infection should be rendered immune by injection of an anti-diphtheritic serum (anti-toxin). The dose for a child under two years is 500 units, and for older children and adults 500 to 1,000 units is the usual dose, which may be repeated in a few days, if necessary. This anti-toxic serum acts both as a curative and a preventive.

## INFLUENZA (*LA GRIPPE*).

This is a highly infectious epidemic disease, assuming a pandemic form after five, ten or thirty years, or some intermediate interval, and spreading over almost all parts of the inhabitable world in a very few weeks. The present worldwide outbreak of 1918-19 first started probably in Spain in April of 1918 and in a short space of time spread over all the continents. The military operations during the Great German War had to account for its rapid spread like a lightning spark. In India it first broke out in Bombay in about June 1918, and then travelled into the interior of the country and infected almost all the towns and villages. It caused a very high mortality of about 6 millions, and disorganized trade to a very large extent. The present pandemic was exactly like its predecessor of 1890-91, but the very high mortality during the present outbreak was due to the complications of pneumonia, broncho-pneumonia, etc., owing to the lowered vitality of the people on account of increased poverty and for want of proper clothing, especially during the winter season on account of an unprecedented high cost of cloth.

**Incidence.**—Persons of all ages are attacked by the disease, but males and the strong individuals appear to be more susceptible, perhaps on account of greater chances of exposure.

The disease does not seem to have any relation to season, climate, wind or telluric conditions, but it is much more severe during winter than during summer, as the people sleep indoors in overcrowded, and dark ill-ventilated rooms, and huddle closely together for want of clothing to protect themselves against cold.

**Incubation Period.**—The incubation period is very short, from 6 to 48 hours.

**Causation.**—The organism responsible for the epidemic of influenza has not been definitely identified. A large majority of authorities regard the Bacillus influenzæ of Pfeiffer as a specific micro-organism causing the disease, while others are of opinion that it is due to a filtrable virus. Whatever may be the initial cause of the spread of the disease, there is little doubt that the complications are obviously produced by different micro-organisms, the chief of which are the influenza bacillus, pneumococci, and hæmolytic streptococci.

**Mode of Infection.**—The disease, though spoken of as air-borne, is highly contagious, especially in the early stages. The virus is found in the secretions from the nose, throat, and respiratory tract. Hence it is directly spread from the sick to the healthy by " drop infection " as in coughing, sneezing and even in ordinary conversation. Freshly infected towels, handkerchiefs, cups and other objects also convey the disease. But the virus dies out readily outside the human body, so that infection is not carried to long distances by means of infected clothing. Bacillus carriers are numerous, who keep alive the infection during an inter-pandemic interval. It is possible that the disease may be conveyed through domestic animals, who also suffer from this disease.

**Immunity.**—No one seems to enjoy a natural immunity, at any rate when the virus is in its pandemic stride. One attack does not confer immunity, as subsequent attacks are common as a result of new infections or reinfections.

**Preventive Measures.**—It is very difficult to control the spread of the disease by suggesting any preventive measures, inasmuch as the disease spreads very quickly, the incubation period is extremely short, it is infective in its earliest stage, and many mild cases, though capable of conveying infection, may escape detection owing to the difficulties of diagnosis.

Notification of the disease is practically useless, except that it will furnish the statistical information to the health authorities. Isolation of patients, particularly those with pulmonary complications, is a measure worthy of adoption, but it is fraught with practical difficulties in a country like India, where a large population is still steeped in ignorance and superstition. However, it must be impressed that the patient should at once take to bed in a well-ventilated room or, if possible, on an open verandah, as soon as he finds that he is feeling out of sorts during the pandemic wave, and should remain there for a day or two after the temperature has become normal. The patient should always hold a handkerchief to his mouth when he is talking, sneezing or coughing, and the handkerchief should, then, be disinfected by boiling, or burnt, if made of paper. Expectoration should be received in a special disinfectant, its contents being subsequently disinfected or burnt. Clothing and other articles soiled by the discharges from the mouth and nose should be properly disinfected. It is hardly necessary to disinfect a house in which a case of influenza has occurred, but the room occupied by him should be disinfected. During the epidemic it is also advisable to disinfect public vehicles and railway carriages with a formalin spray.

As a personal prophylactic measure it is much better to avoid churches, crowded railway carriages, tram cars, theatres, cinemas and public meetings, where large assemblies of people congregate together. Fairs and markets should be stopped in villages, where they form a chief source of transmission of the disease. Similarly schools should also be closed.

The wearing by the people of masks of several folds of gauze covering the mouth and nose during the epidemic is a counsel of perfection, but it is not likely to be universally adopted. However, doctors, nurses and other attendants on the sick must wear them to prevent inhalation of infected material directly from the patient.

During the epidemic the people should gargle their throat and lavage the nostrils with mild disinfectants, such as solutions of potassium permanganate, resorcin, thymol, chlorinated soda, etc. A spray of a 1 in 1,000 solution of acro-flavine can also be used as a preventive. It has, however, been suggested that the natural resisting power of the mucous membranes of the nose and throat may be lowered owing to the vital injury caused by such lavage. Hence the Sanitary Commissioner with the Government of India recommends that the nasal cavities and throat should be douched with a salt solution four or five times daily as a preventive of influenza. The method of douching is as follows:—

1. Dissolve one teaspoonful of salt in a pint of warm water.
2. Gargle the throat with some of the solution.
3. Place the remainder of the solution in a basin.
4. Immerse the nostrils in the solution.
5. Sniff slowly some of the solution up the nostrils, until it is felt at the back of the throat.
6. Raise the head from the basin and allow the solution to flow from the nostrils into a bucket.
7. Repeat this process two or three times.

From investigations carried out in an industrial district, Dr. Alexander Gregor has proved that inhalation of $SO_2$ or $NO_2$ acts as a preventive of influenza. People working in an atmosphere containing either of these gases obtain a marked degree of immunity during the outbreaks of influenza.

The use of vaccines has been advocated both as a preventive and curative measure. A polyvalent vaccine consisting of killed cultures of the Pfeiffer's bacillus, pneumococci and streptococci, and a monovalent vaccine consisting of Pfeiffer's bacillus alone have been tried, but the opinion as to their efficiency is still divided.

Without the co-operation of the people it is impossible to cope with an epidemic, which is sudden in its onset and spreads quickly over a wide area. It is, therefore, necessary to organize associations, the members of which should volunteer to assist in the distribution of medicines. milk, and proper clothing to the poor patients, and also the food to afflicted families.

Lastly it is very essential to educate the people regarding the mode of infection and prevention of the disease by means of leaflets, posters, notices in the press, lectures in the schools and colleges and exhibition of magic lantern slides or cinema films.

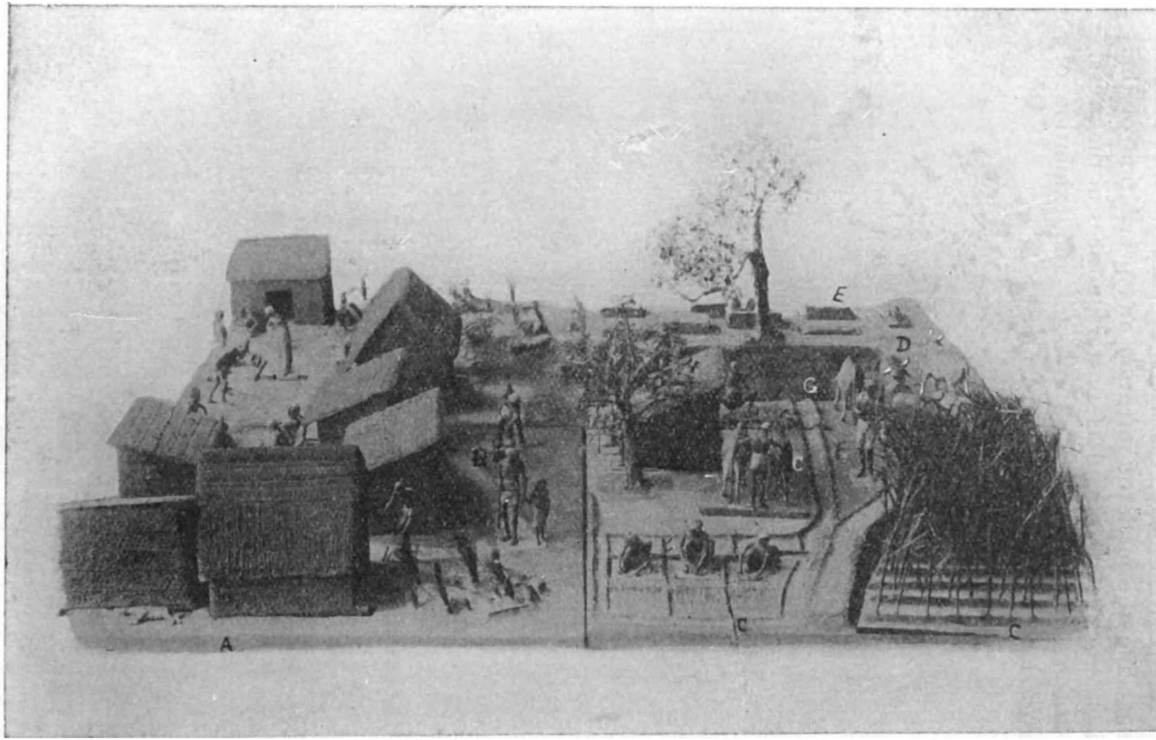



Fig. 60—An Insanitary Village.
A, a group of ill-ventilated huts; B, a shallow *katcha* well; C, fields; D, cattle grazing near a tank; E, graveyards; F, a drain falling into a tank; G, a *katcha* tank.

## CHAPTER XXII.

### VILLAGE SANITATION.

In India villages are in an insanitary condition owing to the ignorance of the people about the elementary principles of hygiene. It should, therefore, be a part of the duties of a sub-assistant surgeon in charge of a travelling dispensary to collect the people of a village at some prominent place, and to explain to them the advantages of general cleanliness and sanitation and the methods by means of which this may be observed. However, it should not be forgotten at the same time that the people must be willing to adopt those principles; otherwise no amount of sanitary rules and regulations enacted to guide them will be of any avail. For this purpose the best thing will be to introduce elementary education, and to include lessons on practical hygiene into vernacular text-books. In 1892 an Act known as the United Provinces Village Sanitation Act was passed, which empowers the Collector and the Sanitary Commissioner (deputy) to take necessary steps to maintain the purity of water-supply and to adopt special preventive measures on a serious epidemic outbreak of some infectious disease in Act XX (of 1856) towns and villages containing not less than 2,000 inhabitants.

The main principles of sanitation are given below, which can safely be applied to these towns and villages.

### HOUSES.

In villages no particular care is taken in selecting the sites for building houses. As a rule these houses are *katcha* ones made with mud taken from an adjoining dried pond or tank. They have no arrangement for

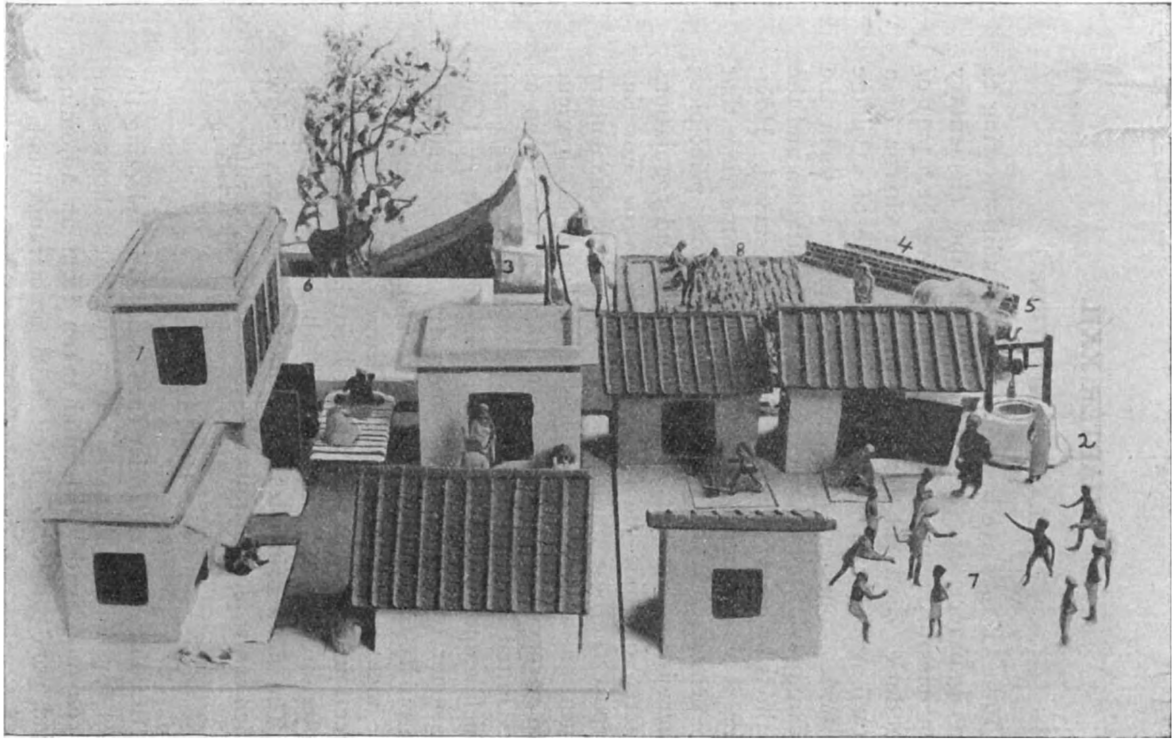



Fig. 61—A Sanitary Village.

1, well-ventilated huts ; 2, a *pucca* deep well ; 3, a *pucca* well for irrigation purpose ; 4, a *pucca* drain ; 5, cattle yard ; 6, a masonry-built tank with well-raised banks ; 7, an open space ; 8, fields.

ventilation excepting one main opening, which serves the purpose of an entrance and of exit as well. Owing to want of sunlight and fresh air in such houses, tuberculosis has been increasing in villages, even though most people lead an outdoor life in agricultural occupations.

Cattle and fowls are kept either in front of the dwelling houses, or in the courtyards attached to them. Cowdung is allowed to be accumulated in front of the house, before it is taken to the fields for manure purposes.

In order to improve the sanitary conditions of the dwelling houses in villages, the following points should be carefully noted:—

1. Main streets or roads in a village should not be less than 30 feet in width, and the back lanes not less than 15 feet wide, if the houses are *pucca* ones; but the roadway between the mud houses (huts) should be 20 feet wide, and the houses should not be more than 16 feet high. The width of the streets should be increased to at least 50 feet, if the houses abutting on the road are built of two storeys.

2. The houses should not be grouped together at random so as to obstruct ventilation, but they should be built in parallel rows with a courtyard in front as well as on the back, and there should always be a space of about 9 feet between two houses. There should be enough apertures for inlet of sunlight and fresh air and outlet of foul and vitiated air.

3. There should always be two different sets of apartments, one of which should be devoted exclusively to domestic use; and the other should be reserved for keeping cattle, fowls and other domestic animals. There should be an open courtyard between these apartments, so that the passage of air and light might not be obstructed. Those meant for the use of animals should be fully exposed to the rays of the sun, and the

floor should be paved with stone or bricks-on-edge set in cement, so that no stinking should occur.

4. If possible, it is much better to induce people to make arrangements to keep their animals on their fields, or in some suitable place on the outskirts of a village, or in some less populous parts of the village. Care should be taken that these stables are not near any well or other public or private reservoir of drinking water.

5. Earth required for house building or for any other purposes should be taken only from tanks or hollows beyond the inhabited site specially set apart for this purpose, but no excavations should be made anywhere else within the inhabited area.

## WATER-SUPPLY.

The chief sources of water-supply in villages are from wells, tanks, canals, rivers and streams.

**Wells.**—Wells are either sunk in the heart of the villages or on their outskirts.

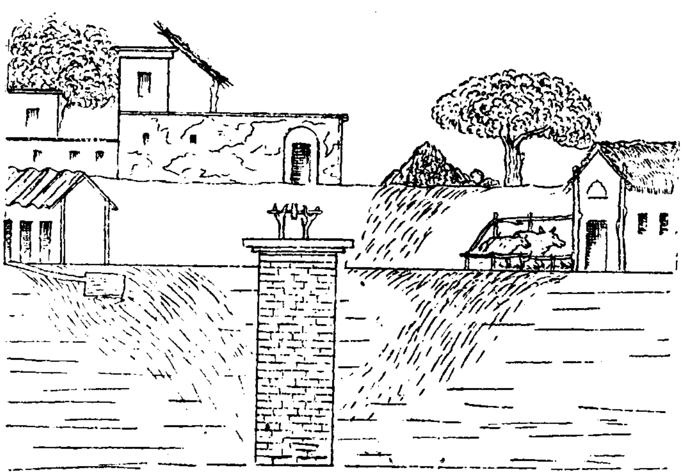


Fig. 62—Contamination of a well situated in the heart of a village.

A well drains the ground all round it in the shape of an inverted cone, the base of which is 4 times the depth of the well. If the depth of the well is 50 feet, it will

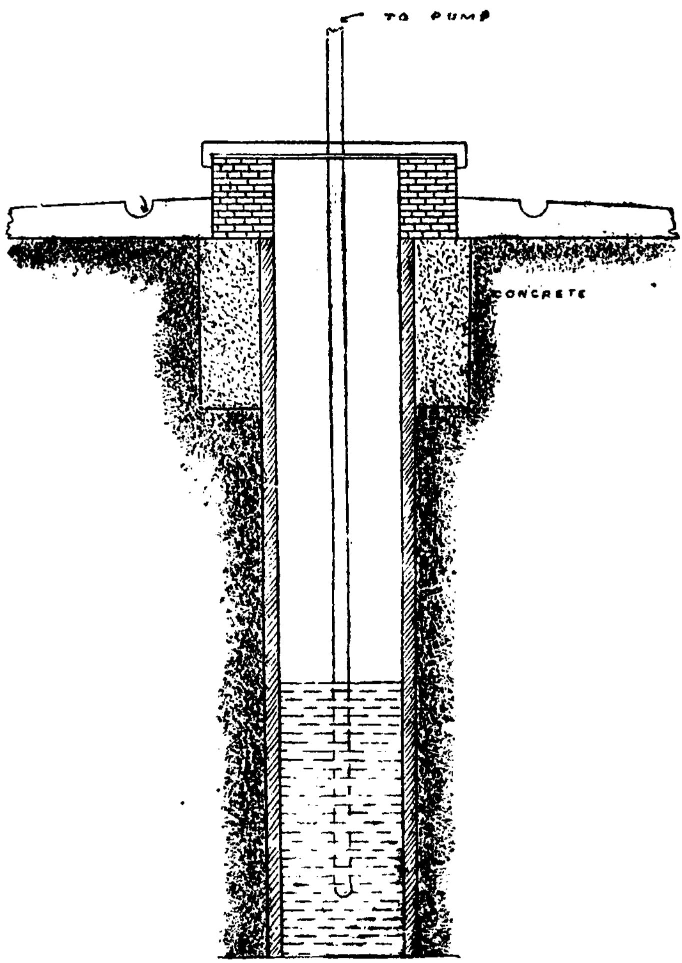



Fig. 63—Well properly protected from surrounding contamination.

thus drain an area of 200 feet in diameter on the surface of the soil, that is to say, any impurity within this area will gradually drain into the well and affect its water. A well situated in the heart of a village, naturally, therefore, is always in danger of being contaminated, owing to the proximity of latrines, cesspools, drains and cowsheds. To prevent such contaminations, superficial shallow wells should, as far as possible, be discarded, and deep wells should be used instead. These wells should, if possible, be on high ground and outside the village. The sides of the well should be steined by lining with brickwork covered thickly with cement or with stone slabs all the way from its mouth down to the level of the impermeable layer of the soil, which it pierces. The lining must be smooth, so as not to allow birds to build their nests in. The ground round the well should be paved with stone, and covered with concrete and should have a slope in the opposite direction from the well so that no waste water should soak and percolate into it. It should have a parapet round its edge and a plinth with gutters to carry off the waste water. The mouth of the well should be covered with trap-doors, so that no filth might drop into it. The well should also be provided with a windmill or pump, wherever possible. No trees should be allowed to grow near it, so that dead leaves and droppings of birds and squirrels might not fall into it. People should not be allowed to wash their soiled clothes and vessels on its platform, nor should any sick persons be given their sacred baths on it. There should be a separate iron bucket and chain to draw water, and none should be allowed to use his own dirty *lota* or *ghara* or leather skin (*mashak*) and a rope, which may carry disease-germs to water, if any case of cholera or any other water-borne disease has occurred in the house of such a man.

The practice of throwing sugar, flowers, cocoanuts and sacred threads into a well should be put a stop to. A well should be cleaned at least every 6 months, when all the refuse, silt and stagnant mud, and all the foreign impurities at the bottom, must be scrupulously scooped up and carried away. At the same time the lining of its walls should be repaired, if there are any defects, and offshoots or roots of any trees growing on the sides of its shaft should be removed. The troughs built for watering cattle by charitably disposed persons near a well, should always be kept in a clean condition, and

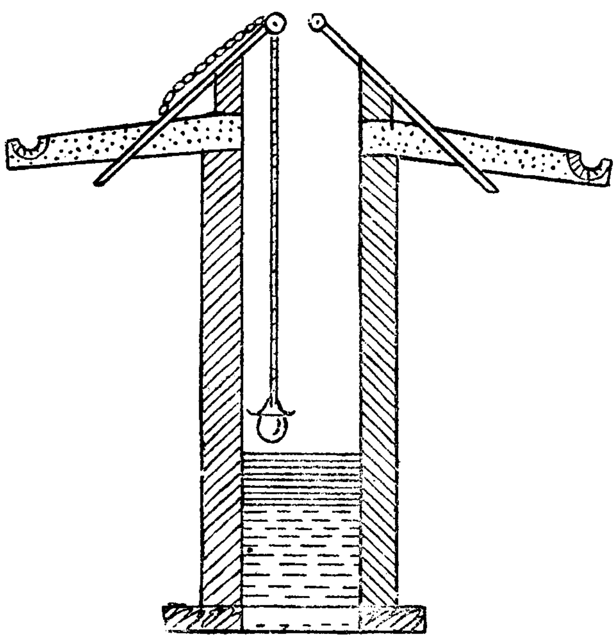


Fig. 64—The model of a Well as recommended in the "District Board Manual."

animals should never be allowed to be washed there. If any repairs are needed, they should be promptly carried out. Provision should also be made to repair *katcha* wells. Owing to vast differences in the habits and customs of people it is a good plan to separate wells for the use of high and low castes.

It will not be out of place to quote the following instructions from the District Board Manual for the protection of wells.

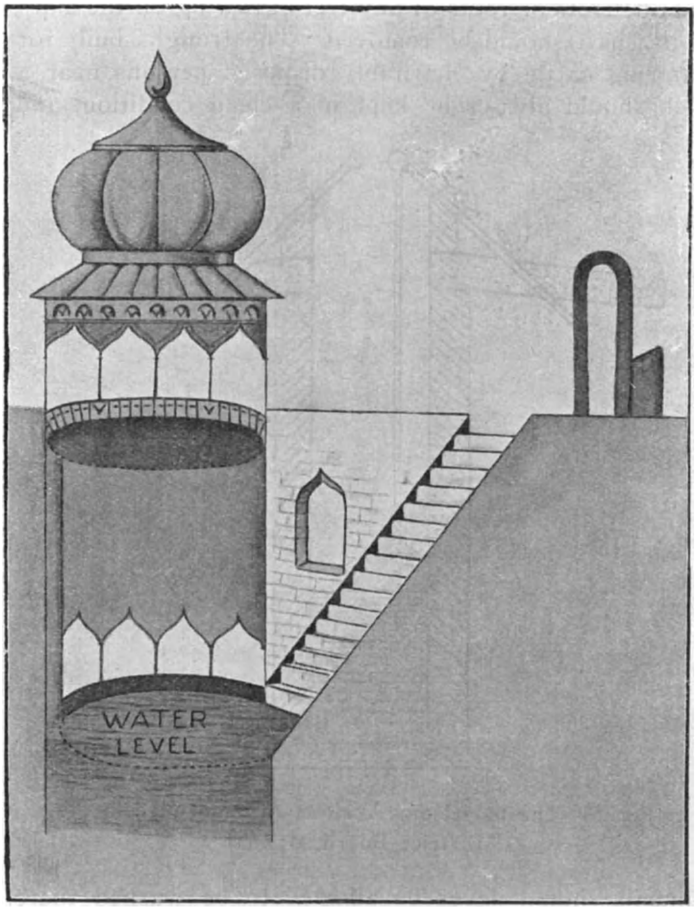



Fig. 65—A Step Well or "Bauri."

The *pacca* brickwork (of the cylinder wall) should be so sloped off at the top that people drawing water from the well cannot stand upon the top or place *gharas* there. This wall may be about 14 inches thick and 2½ feet high above the platform. Two or more pulley blocks, according to requirements, should be fixed on this wall as shown on the plan and may be of either wood or iron. The object of the raised wall is to prevent the splashings from dirty or disease-infected clothes or hands and feet from going into the well. The sloping top is to keep them from putting their feet or *gharas* which may have come in contact with vomit, etc., of a cholera patient, on the coping of the edge of the well and thus greatly increasing the danger of infecting the water of the well. Where there is an already existing *pacca* platform the rammed *kankar* will not be required. In the event of a new platform being required, it should be made of rammed *kankar*, as shown on the plan, at least 8 feet broad. The platform should be well drained and the length of the *pacca* drain carrying off the water should be one-and-a-half times the depth of the well.

**Step Wells.**—In some districts wells or " bauris " are provided with steps, so that the people have direct access to the water—an arrangement which is largely responsible for the dissemination of cholera, when it is prevalent in the neighbourhood, and for the spread of guinea-worm at all times. They are particularly dangerous, when they happen to be on a route much frequented by pilgrims. Such wells are greatly objectionable, and should be discouraged wherever possible, or the steps should be removed.

**Tanks.**—Tank water is liable to be polluted in several ways. In the early morning people go for nature's call in the vicinity of a tank, and then perform ablutions in the tank itself. They rinse out their mouths, clean their throats and teeth and spit into the water. They take their baths, and wash dirty clothes and cooking utensils. Cattle are seen wading, drinking and fouling the water. In Bengal jute is steeped in tanks. In short, tank water is a fruitful source of danger to health, and should always be condemned. Wells should, therefore, be sunk at a distance of 10 to 20 yards from the tanks. However, if tank water is the only available source of drinking water for the community in a village, there should be at least two tanks—one to be reserved for drinking purposes and the other to be used strictly and solely for purposes of bathing and washing and the watering animals. The tank, which is to be used for drinking purposes, should be surrounded by wire fencing and the margins should be paved with stone, or grass should be grown on its banks. The water should be obtained from pumps placed outside the enclosed line, so that there should be very little danger of water pollution by people getting into the tank to fill their *gharas*.

**Canals.**—In those villages, where the water-supply is from canals or irrigation channels, the following steps should be taken to guard against their contamination:—

1. People should take water from the canal far above the village.
2. Ships and boats should not be allowed to frequent the canal.
3. There should be no house or hut near the banks of the canal.
4. No fishing should be allowed in the canal from where water is taken for drinking purposes.
5. There should be no latrines near the canal, and its banks should not be used for purposes of nature.
6. Animals should not be allowed to graze in the vicinity, nor should they be watered there.
7. No one should wash his clothes or take a bath there.
8. A lower portion of the canal below the village

should be used for washing and bathing purposes, and for watering animals.

**Rivers and Streams.**—In the case of rivers and streams, the banks must be kept clean and free of jungle, and the beds of old watercourses and of *nullahs* which flow into them must be kept clean and guarded from improper uses. The water should be taken from above the village, and no offensive trades, no burial grounds nor burning *ghats* should be allowed on or near the banks of the stream above the village. Cattle should not be allowed to graze or to be watered there, but a lower part of the river must be set aside for watering cattle and for washing and bathing purposes. Carts and carriages should not be allowed to cross the river at a place from where the village community take their water-supply. A watchman should be appointed to guard against all these sources of pollution.

Moreover, with all these precautions, it is impossible to guard against the contamination of water in canals and rivers, for where the river or the canal supplies drinking water to several villages along its course, the villages lower down must necessarily use contaminated water coming from the portion of the river or canal set apart for inferior purposes in the villages higher up. In this way cholera is easily spread from village to village situated along the banks of a river or a canal, as is frequently observed. It is, therefore, best to provide properly constructed wells in such villages, so that the people may not resort to rivers or canals for their water-supply.

## CONSERVANCY.

The sites of all ruined houses should be levelled, and vacant sites should be enclosed by owners, so that people cannot use them for purposes of nature. All useless jungle should be removed, and overgrown bushes and weeds growing within and around the village, should be removed at least once every six months and buried under four feet of ground. The lower branches of all trees should be lopped off, and other trees (Eucalyptus or Neem) should be planted on bare, damp, vacant spaces, and between the village and any marshy ground. Marshy grounds and unnecessary ponds should be drained or filled up. The roads and streets should be kept in a trim condition, and pits, hollows and depressions should be filled up, so that there should be no obstruction to the outflow of storm water. The streets in the village should be raised in the centre, with a slope to each side, leading to a drain which should be kept free and clean, and no refuse or rubbish should be allowed to accumulate to obstruct the flow of water. Owing to want of adequate funds in villages, it is not possible to engage sweepers to clean and sweep the roads and streets, but the owners themselves should be held responsible to broom the road in front of their own houses, and thus to keep it clean and free of dust.

The people should be prevented from collecting on their premises house refuse, rubbish and cowdung for the purposes of manure, nor should they be allowed to throw it anywhere in the village, but should be asked to carry it once a day in closed baskets and to deposit it on some fixed places or depôts specially selected for this purpose on the outskirts of the village far away from any source of drinking water-supplies. Care should be taken to cover it well with dry earth, so as not to allow flies to collect or breed. It should then be apportioned off to several contributors when required by them as manure for their fields, or if this is not possible, it may be sold by auction by some responsible authority, such as a Naib-Tehsildar.

No one should be permitted to perform offices of nature in the village street, lane or open space. Some sites outside the village not near any well or drinking water-supply should be set apart for this purpose. These places should be divided into two separate parts, one for men and the other for women and children. They should be surrounded by a thick hedge, and cattle should be carefully kept out. In these places, trenches one foot broad and 1½ feet deep and as long as required should be dug up. Each person using the trench should be instructed to cover up his filth with dry loose earth. To secure privacy these trenches may be partitioned into separate trench latrines by erecting grass screens (*tatties*). When one piece of ground has been so used up all over, another site should be selected, and the old site should be ploughed for growing crops.

Villagers in better circumstances, especially women, may object to go to the places thus marked off for the purposes of nature. They may, therefore, be allowed to construct private privies in the backyard of their houses, which should be daily cleaned out by scavengers employed by them.

**Graveyards.**—These should not be situated near the dwelling houses, but should be at a distance from a village well away from the sources of water-supply. The grave should be at least 6 feet deep, 2½ feet broad and should not be less than 2 feet distant from the nearest grave. The body should be interred within eight hours after its arrival at the burial ground, and should not be buried in any grave in which another body has been already interred. In order that the graves should not be disturbed for a period of seven years, an area of half an acre for the graveyard is desirable for a population of 1,000 Mahomedan inhabitants, if land is available, but may be reduced to quarter of an acre, where such is very expensive. There should be an enclosure wall to the graveyard to prevent jackals from frequenting it. The ground round about the graves should be grassed, and some trees should be planted to remove dampness and moisture from the soil. Corpses should never be allowed to be exhumed unless under exceptional circumstances, and that too, not without the written permission of the District Magistrate and the Superintendent of Police.

**Burning Ghats.**—The bodies of Hindus ought not to be burned on the banks of a river above its stream or near a tank which supplies drinking water to the village. They should be burnt only at properly fixed places, and always below the area from which the drinking water is taken. Owing to the high cost of fuel the bodies of poor Hindus are partially burnt, and the charred bodies are thrown into the river or stream, which may be contaminated by disease germs. It is, therefore, necessary that the rich proprietors of village lands should financially help the poorer people of the village to burn the dead bodies completely, so that the burnt ashes alone might be thrown into the running stream. The bodies should be burnt within eight hours after their arrival at the burning *ghat*. There should also be proper arrangement for the disposal of unclaimed bodies. It is also necessary that no one should be allowed to remove wood or coal that had been employed in the pyre from the burning ground, and all such wood or coal should be reduced to ashes.

**Offensive Trades.**—Offensive trades, such as the skinning of animals, the curing of skins, the keeping of pigs, etc., should not be allowed to be carried out within the inhabited area, but separate localities outside or on the outskirts of the village should be assigned for such purposes. These places should not be in the windward direction of the village or within at least 100 feet of a source of drinking water. The hides, etc., should never be soaked in a tank or a running stream, whose water is used for drinking and domestic purposes.

## PROTECTION OF FOOD SUPPLIES.

In bigger towns it is much better to have in their centres special markets for the sale of vegetables and other eatables, so that they may be easy of inspection by proper authorities.

Stale vegetables, unripe or over-ripe fruits should never be allowed to be sold. This is especially important during outbreaks of cholera. The sweets sold in confectioners' shops in the bazars should be made of articles of proper and wholesome quality and should be properly cooked, otherwise they are liable to produce digestive disturbances. Persons preparing sweets should observe thorough cleanliness. They should wash their hands and feet before they touch any raw materials with which they are going to prepare several varieties of sweets. The floor of a shop must be clean and must be made *pacca* instead of it being made *katcha* and being *leeped* with cowdung, so that rats and mice may not frequent it. The shop should not be used as a dwelling house by the owners, who must have a separate house to live in. The shop should be well ventilated and lighted, and there should be an arrangement for the escape of smoke, if there is no separate kitchen to prepare sweets. Trays used for exposing sweets for sale should be thoroughly cleaned, and should be tinned every now and then, if they are made of copper or brass. There should be an arrangement to protect them from flies by covering them with a wire-gauze netting. It will be still better to keep sweets in wooden almirahs, the sides of which are fitted with wire netting instead of glass panes.

Care must also be taken that the *banias* do not sell unwholesome corn or unwholesome flour of wheat or any other variety, and that they construct their shops rat-proof. If they cannot afford to build *pacca* shops owing to the prohibitive cost, they can build the rat-free shops of any material, provided the roof is water-tight, by raising the floor on uprights surrounded by rat-guards similar in design to those commonly employed on ships. These uprights should be at least 3 feet high, and would support the beams on which the floor rests. This floor may be made of wood. The space underneath the floor should be left open, and should be kept free from weeds and the growth of rank vegetation.

## EPIDEMIC DISEASES.

It is very necessary for the Deputy Sanitary Commissioner to inspect towns and large villages of 5,000 inhabitants and upwards in all parts of his circle during his tours or journeys, so that he can report on their general sanitary defects. On an outbreak of an infectious disease he should visit the place and recommend to the Magistrate the necessary preventive measures to be adopted. The Magistrate should at once take steps to arrange for the employment of a proper conservancy agency to have lanes, open spaces and the village generally kept clean and free from rubbish and offensive matter, which should be properly disposed of at a distance from the village or should be destroyed. He should also take steps to have all the wells disinfected, and to carry out the disinfection of the houses, huts, sheds, clothing, bedding or other articles, which are likely to retain or convey infection. The necessary arrangement of treatment of the patients with proper supplies of medicine should also be taken in hand at once.

## REGISTRATION OF BIRTHS AND DEATHS.

The report of births and deaths in towns and villages administered under Act XX of 1856 is made by the *chaukidars* at the police station within their circle, where the head constable writer, who is known as the circle registration officer, makes entries in separate registers of births and deaths. Still-births are also recorded separately. The *chaukidars* usually make these reports once every week, when they visit the police station. This arrangement does not seem to be satisfactory, inasmuch as the *chaukidars*, being illiterate, have to depend on their memory for the dates of the occurrence of the births and deaths during the interval that they do not visit the police station, though they are permitted to have these entries entered up in their pocket register by the *patwari*, or any other village official. Hence it is necessary to entrust this work to *mukhias* (village headmen), *patwaris*, or school masters in those towns where there are schools, and to medical men in those towns where there are dispensaries. These statistics are at present verified by the circle inspector and the officer in charge of the police station, but it is better that they should be verified by the sub-assistant surgeons in charge of the travelling dispensaries. Besides, the causes of deaths as entered in a death register are not reliable owing to the fact that more than half the people in India die without being seen by a qualified medical man, and the so-called registrars are too ignorant to label the disease from symptoms. To ensure, therefore, correct recording of the causes of deaths as far as possible, the Deputy Sanitary Commissioners, who have to test birth and death registration, should draw up for the guidance of these men a set of certain questions leading to the symptoms of different diseases to be put to the relatives of a deceased person.

Whenever deaths are found to be more than usual in any village or town, care must be taken to find out a cause or causes operating to enhance the number of such deaths, and necessary precautions should at once be taken to check it, if it happens to be an infectious epidemic disease.

# CHAPTER XXIII.

## FAIRS, FAMINE CAMPS AND POOR HOUSES.

### FAIRS.

AT Hardwar, Allahabad, Benares, Ajmere, Pandharpur and other sacred places of pilgrimage, fairs have been held annually for a very long time, where hundreds of thousands of people congregate together for purposes of worship. In ancient times, these fairs were more or less commercial institutions, where people from different districts used to barter their goods locally manufactured. Even now some fairs are held, as at Meerut, Batesar and other places, where horses and cattle are sold, as well as other articles of merchandise.

Owing to improved facilities of travel the number of pilgrims going to these large centres of pilgrimage has increased considerably, and the risk of importation and exportation of disease to and from these centres has consequently become greatly intensified, and as such, they form an ever-increasing menace to public health. It is, therefore, necessary to make the following medical and sanitary arrangements for the pilgrims at such places.

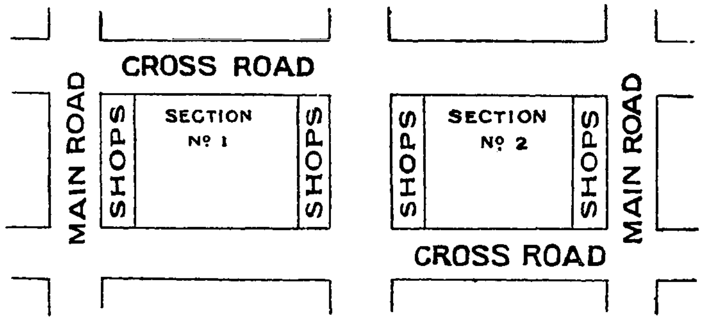
**Duties of the Magistrate.**—The Magistrate of the district in which the fair is held, is the officer in charge of the fair. With him must rest the responsibility for the general management, for the measures adopted for the protection of life and property and for the enforcement of the sanitary regulations. In case the Magistrate is unable to take immediate charge of the fair, he should depute one of his covenanted staff for the duty. He should communicate freely and confidentially with the sanitary officer on matters relating to the sanitation of the fair and to the health of the people attending it. The Sanitary Commissioner exercises administrative medical and sanitary control over all fairs and large gatherings, and additional medical officers placed at his disposal will be under his entire control during the time of the fair or the gathering.

About a month or two before the occurrence of any large fair, the Magistrate of the district should inform the Sanitary Commissioner of the date of the fair and the probable number of persons likely to be present, with an estimate of the strength of the conservancy staff and the police, according to his opinion, required for conservancy and the enforcement of sanitary regulations. The Sanitary Commissioner should reply if he agrees to the proposals, or should suggest modifications and at the same time inform the Magistrate of the date on which he or the Deputy Sanitary Commissioner would be likely to be present at the fair. The Magistrate should then make necessary arrangements to collect the staff of vaccinators, sweepers, and police.

**Ground Plan.**—Some time before the fair the officer-in-charge should prepare a ground plan of the site of the fair correctly drawn to scale. Upon this plan the site should be divided by wide roads of communication in such a way as may be most convenient for the purposes of the fair.

The land between the main roads should be divided by cross roads, and the space between any two cross roads should be considered as a section of the fair, and should, as far as possible, have its separate arrangement for the supply of food. The following ground plan of two contiguous sections is given in illustration of the preceding rule:—

The site of the fair should then be divided in correspondence with the plan, the main roads, if possible, being permanently marked out by stones placed in line on each side of the road. All jungle growth standing on the roads or on the places set aside in each section



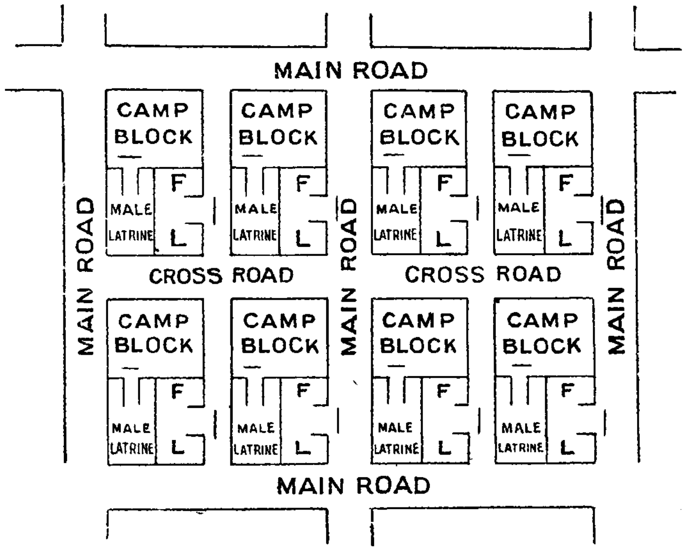

for the camping of the people should be cut down, and, if possible, may be used to construct the latrine fences. Whenever at any fair a very great assembly of people may be expected, strong barricades should be erected across the roads of communication at such places as the police authorities may determine.

The people, as they arrive, must be made to encamp in orderly arrangement on the vacant spaces between the roadways. No one should be allowed to encamp on a roadway. Shops of *banias* and sweetmeat sellers should be established in every division in sufficient numbers to furnish a supply of food for the division. These shops should be located immediately at the side of the main road, but not on the road.

**Conservancy Arrangements.**—In the immediate outskirts of the fair, space should be set aside for conservancy purposes. This space should extend from end to end of the fair at convenient distances, and should not be less than 30 yards square, every portion of it being enclosed by a mat fence six feet high. It is very important that the enclosures should stand on fallow land which could be brought under cultivation in the ensuing season. Immediately on the inside of the fence a trench should be provided, running all round the enclosed space, except at the entrance way. The trench should be 12 inches deep, and when a new trench is required it should be dug on the inside of that just filled up. Care should be taken that the margins of the trench should be firm, and if the nature of the soil does not permit of this, the margins must be strengthened and preserved by means of good-sized stones placed in order along each margin of the trench, or by rough pieces of wood laid down on each side of it, or by any other suitable means. The spaces between the fenced enclosures whenever jungle or crops exist, should be guarded by watchmen. Suitable portions of space should be set apart for the use of women only. The people should be required to frequent the trenches and no other place, for the performance of the offices of nature within the fair boundaries, and a sufficient staff of sweepers should be employed to ensure that the enclosed space is kept decent and cleanly and that the contents of the trenches are at frequent intervals covered with earth so as to be completely hidden out of sight; and for this purpose every sweeper employed should be provided with a shovel. There should be efficient supervision over the sweepers attached to the trenches to see that they perform their duty well ; for, if proper cleanliness is maintained and the trenches always kept easily approachable, the people will use them with comfort ; if improperly kept or in any way very offensive, the people will naturally avoid them, and the result will be that as many, as can, will frequent other places for the purpose.

Whenever the fair is of such an extent as to cover many miles of ground, every section of the fair should be supplied with a separate fenced latrine space, and the site of the fair should then be arranged after the following ground plan :—

Trenches should, in these latrine spaces, be dug across the space from side to side, and at one end of the space an enclosure for women should be provided.




Immediately after the termination of the fair, every trench should be filled up completely with earth, and any earth that may afterwards remain should be heaped over the place where the trench was, so as to mark the position of the trench and prevent its being opened at any immediately succeeding fair.

Small separate trenches may be provided, if practicable, for rich pilgrims and their families, who should be responsible for the cleanliness of the fenced space and for allowing the public sweepers to keep the trench in proper order.

Behind or near to each latrine space, a pit should be provided for the reception of stable refuse and camp sweepings.

A sufficient number of urinals should be erected in the fair area. They should be constructed after the pattern of absorption pits at conspicuous and easily approachable sites. The pits should be dug up and filled up to the level of the surface with brickbats and two bricks should be placed for squatting. They should be divided into separate compartments by means of *tatti* screens. They can be used next year, when brickbats should be removed and new ones put in.

Instead of brickbats, a tin canister, perforated on one side and filled with sawdust previously treated with cyllin or some other disinfecting solution, may be placed in the pit, and ballast put round it. A solution of mercuric chloride should not be used, as sawdust is apt to be eaten by cattle.

A number of sweepers should be employed to sweep the bazar and other public roads. *Bhishtis* should also be employed to water these roads.

Vaccinators should be stationed at short distances on the roads and streets to look to their cleanliness and to guide the people to use specially made latrines and urinals.

There should be proper arrangement to light the bazar, streets and lanes at night, so that there might be no cases of theft, and people should not take advantage of the dark to pollute the streets and lanes by using them for offices of nature.

If any animal should die in the fair, its body should at once be carried on a cart out of the fair and buried with its skin under the direct supervision of vaccinators appointed for the purpose. At some places the Tehsil officials object to the burying of dead animals with their skins. It is, therefore, necessary to obtain definite orders on this point from the Sanitary Commissioner, but it should be insisted that animals dying of an infectious disease must be buried with their skin.

The slaughter or sacrifice of animals should be permitted at certain places only, and every part of the animal should be carried out of the fair as soon as possible, and the places reserved for this purpose should be carefully swept twice in the day, dry earth at the same time being plentifully sprinkled where blood may have been spilled. The sweepings of these places must be carefully buried underground. If as part of a religious ceremony it should be necessary to permit a dead person or the body of a dead animal to be placed in any stream running through or past the fair, it should only be allowed below the site of the fair.

**Hospitals.**—At every fair of importance at least two hospitals should be provided ; one a general hospital and dispensary, and the other a hospital for contagious diseases. The hospitals should consist of a thatched roof raised six feet off the ground by means of poles well set into the ground, and so bound together and strengthened by cross-poles as to be able to stand up safely against a strong wind ; walls of *jhamps* or matting should be furnished on all four sides. The floor of the hospital should have a pathway, six feet wide, along the centre, and be slightly raised for berths on each side. The general hospital should be erected at any appropriate and convenient place near to the centre of the fair and should be 50 feet long and 20 feet broad.

The contagious diseases hospital should be built near to, but outside, the fair at any retired place, so that there should be no direct communication with the inmates of the hospital and the pilgrims present at the fair. This hospital should be 30 feet long and 20 feet broad ; but a sufficient quantity of material should always be kept ready in the vicinity so as to permit of the immediate erection of other similar hospitals in case it is found necessary to construct them. Such hospitals should be surrounded by a light fence or a bamboo railing about one yard high, and no stranger should be allowed inside the railing or any patient outside the same, without the permission of the medical officer-in-charge.

The staff attached to each hospital should consist of a sub-assistant surgeon, a cook, a sweeper and a *bhishti*, who should be under the direct control of the Civil Surgeon of the district where the fair is held, as he is considered the medical officer of the fair, and as such, he should visit these hospitals at least twice a day and render professional aid to those in the hospital, if necessary. He is also required to visit any part of the fair, where any case of sickness or death has occurred. The sick should, as far as possible, be removed to the nearest available hospital and their families may as well be removed, if deemed necessary.

At every important station as at Allahabad, Agra or Benares the Civil Surgeon may, at his discretion, depute an assistant-surgeon to act for him and under his orders as the medical officer.

The medical officer should furnish a supply of medicines and surgical instruments for the proper equipment of the hospitals at the fair, and is responsible for advising the Magistrate on any points of sanitation in connection with the fair on which he may be consulted, or on which he may think proper to offer advice.

A supply of blankets must be furnished to every hospital, but patients should provide their own bedding. Two large *gharas* with drinking water should be supplied to every hospital.

There should be a latrine for every hospital but detached from it. The latrine should be constructed of the same material as the hospital, and should be furnished with a sufficient number of earthen *gamlas* for conservancy purposes. Dry earth in a sufficient quantity should be kept near the *gamlas* in a wooden box or some other suitable vessel. The sweeper should mix the contents of the *gamlas* with dry earth, before they are removed for burying them underground. The contents should not be kept exposed for a long time, so that flies may not sit on them. Bed-pans should be given to those patients who are not fit to leave their beds and the same precautions of mixing earth should be used by the sweepers.

**Police.**—The duties of the police at fairs are (1) to maintain a careful watch that the sanitary arrangements are fully carried out ; (2) to forbid the performance of the offices of nature in or near the fair at any place not set aside for such purpose ; (3) to report to the medical officer of the fair the appearance of sickness in any part of the fair ; and (4) to cause all persons suffering from cholera, plague, small-pox or any other serious disease, to be removed at once to the hospital set apart for such purposes, and, if possible, to prevent the approach to the fair of any person affected by any of these diseases.

**Inspection of Pilgrims.**—Sub-assistant surgeons and compounders should be stationed at railway stations to inspect all pilgrims so as not to allow persons suffering from any infectious diseases, particularly cholera, plague and small-pox to visit the fair, and some special arrangement should be made to inspect those, who are coming from neighbouring villages by routes other than by rail by erecting some *chowkies* at principal roads leading to the fair area.

An encamping-ground with a good well should, if possible, be provided at the railway stations near the fair. From this encamping-ground to the site of the fair a pilgrim route should be laid down so as to avoid large towns, and camping-grounds should be provided at proper distances, of a day's march, apart on the line of the road. The arrangement should be made for supply of sufficient and good healthy food, and fenced trenches for conservancy purposes with two sweepers should be provided, and a party of police should be appointed to have the charge of each camping-ground. A hospital space should be set aside at each camping-ground where patients suffering from cholera or other infectious disease should be removed for treatment, but they should not be allowed to proceed with other pilgrims, and the pilgrim route should at once be diverted from the camp into some other road, a new camping-ground being provided to which the camping pilgrims should be directed.

**Lodging Houses.**—These are defined as houses or parts of houses in which pilgrims are lodged for hire, for any term less than a week at a time. After inspection and approval by the Municipal Board each must be registered in the name of the keeper. Executive officers should be authorised to inspect these houses and to see that pilgrims are not housed by any other persons not holding a municipal license for the purpose. It should also be seen that there is no overcrowding in these lodging houses, and that the number of pilgrims in each room does not exceed the sanctioned number. The rooms must be kept clean and well ventilated, and notice of any case of infectious disease must at once be sent to the health officer. The latrines attached to these houses should be kept thoroughly clean, for which purpose a number of sweepers in proportion to the accommodation of the pilgrims should be permanently maintained on the premises. Besides the executive officer, the health officer should be authorised to inspect such houses, to look to their sanitary arrangement, to investigate cases of sickness and to disinfect them in the event of a case of an infectious disease occurring therein.

**Water-Supply.**—A week or ten days before the commencement of the fair, all wells likely to be used by the pilgrims should be cleaned and disinfected with potash permanganate. A few suspicious wells may be redisinfected during the fair. Any wells thought to be dangerous should at once be closed. To further protect these wells, individuals should not be allowed to lower their *lotas* or *dols* into them, but a *kahar* should specially be appointed to draw water from each well. If the fair is held near a river or a running stream, it should be the duty of the police to see that sweepers do not pollute river water by throwing excreta and refuse into it. People should be persuaded not to drink river water as far as possible, but should use disinfected well water at those places where there is no municipal water-supply.

**Food-Supplies.**—A sanitary inspector or sub-assistant surgeon should be appointed to inspect food-supplies. He should work under the orders of the medical officer-in-charge of the fair. Old, stale, indigestible and improperly cooked food, and unripe and over-ripe fruits should be destroyed, but except in emergent cases, the order for destruction of such food should be obtained from the administrative officer-in-charge of the fair. Sweetmeats, *puries* and other eatables should be well protected with wire-gauze netting or some such other contrivance from flies to avoid infection with cholera germs.

**Epidemic Diseases.**—If cases of cholera, plague, small-pox or any other contagious disease occur at a fair, the people suffering from the disease should at once be removed to the infectious diseases hospital built for the purpose, and should be treated there until the disease has proved fatal or until convalescence has been established. They should be removed to the hospital in a *dooly*, which should always be kept ready with bearers at every police station in the fair. The *dooly* should be retained at the hospital, and a new *dooly* should be provided at the police station. All the *doolies* thus used should be burnt before the hospital is broken up. The clothes and the bedding of the patient should be burnt immediately after his death. The place where cases of cholera or other infectious disease occur should be promptly disinfected by the disinfecting gang under the supervision of a sub-assistant surgeon. If the locality is a room of a lodging house, thorough disinfection with perchloride of mercury (1 in 1,000), cyllin (1 in 200) or phenyle (1 in 20) must be carried out, the room contents, surroundings and especially the floor of the latrine being completely soaked with the disinfecting solution. If it is possible, the lodging house should be vacated and closed up, but in any case, the infected room or rooms should not be allowed to be occupied for at least a week. All the *gamlas* of the latrines should be destroyed and metallic vessels disinfected. The contacts should be isolated and their belongings disinfected. If the case has occurred in the open, the ground, which was occupied by the patient, should be disinfected, and should be covered with thorn bushes to prevent further occupation.

**Epidemic Cholera.**—If cholera should appear, in an epidemic form at any fair, a telegraphic intimation should be sent by the officer-in-charge of the fair to the magistrates of all the surrounding disrticts and to the Government, while the magistrate of the district should give intimation by a demi-official letter or telegram to all magistrates and political agents of localities where disease-stricken people are likely soon to arrive. The officer-in-charge of the fair should then encourage the pilgrims assembled at the fair to disperse to their homes with the least possible delay.

Pilgrims coming from a place where cholera is known to be raging in an epidemic form, should be prevented from visiting the fair.

If it is found necessary to close the fair owing to the prevalence of cholera or other infectious disease in an epidemic form, the fact should be notified to the public by the Civil authorities, and the railways should not run any special trains to the fair, should withdraw all other facilities which are usually provided for the convenience of the traffic on such occasions, should post up, at conspicuous places on all stations, a notice to the effect that the fair has been stopped, and should require the booking clerks to warn intending passengers of this fact.

## FAMINE CAMPS.

The following sanitary and medical arrangements as regards huts, conservancy, water-supply, etc., should be observed for famine camps to be erected for relief works in a famine-stricken district.

**Huts.**—To give shelter to the workers screens should be put up, which should be about 6 feet long and 4 feet wide, made of very open bamboo trellis work strongly tied, and thatched with about one inch thickness of any thatching grass available. Six to eight persons can be accommodated with two such screens.

Grass huts, 9 feet by 9 feet with the ordinary pent roof prolonged 3 feet beyond the door end of the hut, should be supplied to officials connected with the works, for whom tents cannot be provided. The walls, both inside and out, should be plastered with mud and then whitewashed as a protection against fire. The white-wash and mud plaster should be renewed at intervals.

**Hospitals.**—No special hospital arrangements are necessary if a famine camp is situated within two miles of an existing branch dispensary; for the sub-assistant surgeon and his staff can daily inspect the camp, treat trifling cases on the spot and can remove serious cases to the dispensary, where the accommodation, if insufficient, can be increased to any extent by the addition of grass huts. However, a separate sub-assistant surgeon should be appointed in case any epidemic disease should break out.

Where a famine camp is situated beyond the reach of an existing branch dispensary, two hospitals, 25 feet by 16 feet with walls 8 feet high, should be provided—one for males and the other for females. Two isolation huts, each 10 feet by 10 feet, should be kept ready. The sub-assistant surgeons in charge of their hospitals should be provided with a hut divided into two rooms, of which one will serve as a dispensary. There should be a separate hut for the hospital kitchen. Two small mat enclosures—one for males and one for females—should be put up at a little distance from the hospital to act as latrines for the patients; if the huts are surrounded by an enclosure wall, one side of the wall should be made of mud or clods with a gateway in the middle to enable the patients to escape in the event of fire. The abandoned hospital should immediately be burned to the ground; if patients suffering from any epidemic disease have been admitted into it, the site should be sprinkled with about six cubic feet of quicklime, sifted evenly over it, the whole being well sprinkled over with water until the lime is thoroughly wet.

**Conservancy.**—The conservancy of every hospital should be carried out by its own staff of sweepers under the directions of the medical officer-in-charge. The usual latrine of screens and ditch should be provided for the staff. Similar latrines should be provided for workers on works near a large town. On works not near a large town, a line of yellow flags about 100 yards apart should be set aside on each side of every road work and round every tank or quarry work, and every camp and hospital, and at a distance of not less than 150 yards from the work or camp. The ground within these flags must be kept clear of all nuisances, and a few sweeper patrols should be posted to insist on the workers going at least outside the flags for calls of nature usually in the mornings. The people should generally go to the east of the work; but if there is a village near on that side, they should be asked to go in another direction.

There should be a proper arrangement for the disposal of the dead, and this becomes much more necessary in the case of an epidemic outbreak. At every three or four miles of a relief work there should be a burning place for Hindus and a burying place for Mahommedans. The two places should, if possible, suit the local customs; they should be far apart, and neither should they be near the village nor within half a mile of the work. Each should have a small staff.

If friends are willing to dispose of corpses according to their various customs, they may be assisted with free firewood or ready dug graves; but in other cases the bodies must be buried. The graves should be not less than five feet deep and the dead bodies should be completely and decently covered in.

**Water-Supply.**—A satisfactory supply of drinking water should be secured before any relief works are opened. To keep the water-supply pure, it is necessary to guard all the adjacent wells from contamination for some days before a relief work is opened. Some respectable, cleanly and reliable man of a high caste should be appointed as foreman of the water arrangements. He should have four or five Brahman mates, a *kahar* mate, about 20 *kahar* carriers and the same number of Brahman drawers and distributors under him. He should take possession of all the wells close to the future work a week or so ahead of the workers, disinfect them at once (for which purpose he should be kept supplied with a few two-ounce packets of permanganate of potash), fence them round with a light bamboo trellis, and at once put each in charge of a Brahmin with one or more assistants, and arrange that these men shall draw water for anyone who requires it, and shall not allow anyone else to go on the well platform. The foreman should be supplied with at least 20 iron *dols* for drawing and about 200 kerosene tins for carrying water. If water has to be taken a long distance, it is best to carry it in casks fitted with brass cocks and loaded two in a cart.

The actual distribution of water is best effected by setting up *piaos* or drinking places at short distances apart. A large earthen jar called a *gol* should be set up a little aslant on a low mud platform. By the side of it a narrow sheet iron trough some four feet long should be set up on two stakes on a slight incline with the further end about two feet above the ground. This trough should always be made of iron, for it can be disinfected by its rust and heating it in the sun for a short time, if it happens to get infected. These drinking places should be distributed in the manner most convenient for the workers and close to their work; along a roadway it is most convenient to place one at every second furlong and close to the road, but not within 20 feet of it. A similar procedure should be adopted in the case of tank and other works.

The water *kahars* should fill the jars from the kerosene tins and no one else should touch them. The Brahman distributor will sit by the side of the jar and when anyone comes for water, he will fill his brass pot or *lota* and pour water into the man's *ghara* or pot by means of the trough but not direct. The practice of drinking water direct from the trough should be discouraged, as it may cause infection and always involves waste of water. The people should be supplied with *gharas* for the storage of water, and smaller pots for drinking. If they have not got them, they are apt to drink direct from the trough in the day, and to wash and even drink at dirty ponds or tanks at night or in the early morning. The large jars or *gols* should ordinarily be broken up on departure, and new ones should be purchased at each new place. If new jars are not available, the old ones may be used again, but must first be disinfected with a small amount of permanganate of potash. The deep red permanganated water should stand in them for six hours and then be poured off.

Where possible, an arrangement should be made to run water-carts at frequent intervals up and down the works.

If there are more wells than are required, the unused ones should be guarded as should also be all doubtfull or tainted wells. All wells in use should be disinfected with permanganate of potash once a week in the evening, preferably on Sundays. If there are no wells, tube wells may be sunk in the vicinity of tanks or in the beds of dried rivers or streams.

**Food-Supply.**—For the supply of food there should be a small market consisting of two rows of huts made of shelter screens, with a 20-foot roadway between them and a fence of light bamboo trellis round them with openings at the ends of the street. The quality of the food should be frequently examined and immediate action should be taken against any one found selling unsound food. The unwholesome pulse called *khasari* or *kesari* should not be admitted into the market.

## POOR HOUSES.

These are institutions where cooked food is distributed gratuitously to the inmates, who are poor and unable to go to relief works owing to physical debility or illness; but lepers should not be admitted into them. However, if lepers have no fixed homes, they should be kept in isolated huts at a reasonable distance from the poor houses. They should be situated in a grove on a tolerably high and dry land about one mile from the headquarters of the subdivision and there should be an ample supply of water for drinking and bathing purposes.

**Buildings.**—The enclosure wall should preferably be made of mud. If it is necessary to use grass or hurdle screens as walls, they should be plastered with mud as a precaution against fire. There should at least be two main exits from the poor houses not less than 8 feet wide; and no thatched or inflammable material should be employed in any structure within 50 feet on either section of the exits. A number of *gharas* filled with water should be kept ready for use in the case of fire.

To every poor house should be attached a hospital, which should usually be placed at a reasonable distance from the paupers' quarters, but always as near the poor house as is consistent with health. The hospital should be in charge of a sub-assistant surgeon, who should be provided with accommodation. Separate, dry and well-ventilated huts for the reception of infectious diseases should be constructed at a reasonable distance from the poor house to secure a complete isolation. Both the hospital and segregation huts should have their own separate latrines. A small latrine should also be erected separate for the staff.

**Food-Supply.**—The food should be distributed twice a day, unless the district medical officer with the sanction of the Collector directs that only one meal a day be given. The flour should be of the best quality, as the presence of husk, or any foreign matter may give rise to intestinal complaints such as diarrhœa and dysentery. It should be carefully weighed out for cooking, and the pulse should contain a quantity of pepper and spices according to local custom.

Freshly prepared and warm *chapatis* should be issued to the very old and toothless inmates, as they are easy to digest; and cold, stale ones to the more robust.

**Water-Supply.**—Drinking water should be drawn from a well outside the poor house. The well should be carefully guarded against contamination, and no one should be allowed to draw water from it except persons of high caste appointed for the purpose. There should be a separate well for bathing and washing clothes at some distance from the poor house and the drinking well. It should have two troughs—one for bathing and the other for washing clothes.

**Latrines.**—Two night latrines with earthen or iron receptacles should be provided inside the enclosure. Other latrines are best provided on the trench system with a movable screen. They must be at a sufficient distance but not too far away. Boys or able-bodied individuals should be told off to help very old, blind and lame inmates to latrines, etc.

Every inmate should be provided with a piece of *chatai* to sleep on, spread over the grass or straw in the hut, and he should expose it to the sun on both sides for about an hour outside the hut.

## DISEASES LIKELY TO OCCUR DURING FAMINE AND THEIR PREVENTIVE MEASURES.

1. **Diarrhœa and Dysentery.**—Owing to extreme hunger people eat anything that comes to their hands and so they generally suffer from intestinal troubles. Those that are removed to a poor house in a weak and exhausted condition, start eating *chapatis* or any other solid food, and consequently contract diarrhœa and dysentery. To such men it is, therefore, better to give boiled rice and *dal* for the first few days until their digestive power has improved. Special care should be taken in dieting children and old people on their first arrival into a poor house. *Dalia* soup is very good for constitutions weakened by starvation. It is made by mixing one seer of flour with five seers of water and one *chatak* of salt, the mixture being boiled down to about 4 seers.

2. **Deaths due to Starvation.**—In order that people should not die of starvation, the Superintendent of Police should organise a system of patrols for the lanes and the bye-ways of towns and villages, and for temporary rest-houses or *sarais* on trunk and district roads, for conducting starving wanderers to the nearest relief work, poor

house, police station or outpost. He should also make arrangements to provide such wanderers with food in transit. Private charities should also be directed to this end.

3. **Cholera.**—If cholera breaks out in a relief work the following measures should be adopted:—

1. Cholera cases should at once be removed to an isolation hospital. Contacts should be removed to segregation huts.

2. All infected materials, such as old clothes, rags, etc., belonging to the sufferers or those in contact with them, should, if possible, be burnt or at any rate should be thoroughly disinfected. *Chappars*, small huts, and all materials used for bedding, should be burnt.

3. Two-ounce packets of potash permanganate should be supplied to the officer-in-charge of relief work, who should use them for disinfecting wells and drinking water on the outbreak of cholera.

4. The workers should be divided into as small gangs as is compatible with supervision and discipline.

5. The gangs so formed should either be transferred to a new public work at a distance from the infected area, or returned to their respective villages for employment there.

The following procedure should be adopted if the gangs are transferred to another public work:—

1. The water-supply on the new ground should be carefully selected and rigidly protected, advance parties being sent for the purpose.

2. The new site should be kept scrupulously clean.

3. Every case of an epidemic disease should be isolated as it occurs.

If a poor house is infected by cholera, the undermentioned measures are necessary to adopt:—

1. The water-supply should at once be changed, the

former source of supply being effectually closed. The new wells should be permanganated before use.

2. All food (except grain actually stored in the poor house at the time of the occurrence of the outbreak) should be destroyed.

3. Six inches of earth should be removed from the floor of the barracks. If the roof be thatched, it should be burnt.

4. The trenches in use should be filled up, the grass screens burnt and a new latrine erected on a new site.

5. All drains should be washed down with a solution of mercuric chloride (1 in 1,000) and hydrochloric acid.

6. If there is overcrowding, the inmates of the least infected barracks should be separated into small gangs; and any gangs remaining free from disease after five days should be drafted off to a suitable locality after bathing and having their clothes thoroughly disinfected.

4. **Plague.**—As a precaution against plague, workers on relief works should be inoculated with Haffkine's serum and eatables should not be allowed to be exposed, so that rats might be attracted. There should be an arrangement to trap rats if there are any, and mates of gangs should be instructed to report if any rats are found dying.

5. **Small-pox.**—If any cases of small-pox occur, they should at once be removed to an isolation hospital; contacts should be segregated, and attempts should be made to vaccinate or re-vaccinate them as the case may be. The other workers should, if possible, be all vaccinated, except those who might have suffered from small-pox previously. The clothes and bedding belonging to small-pox patients should be destroyed and the hut or huts occupied by them should be dismantled and burnt if possible.

6. **Relapsing Fever (Famine Fever).**—The Sub-Assistant Surgeon should be well acquainted with the symptoms of relapsing fever. The occurrence of a

relapse in fever after a remission of a week should excite his suspicion. The fourteenth day after the commencement of a primary attack followed by a remission is the one upon which the relapse is most likely to occur.

As soon as a case of relapsing fever is detected, he should be isolated, and his clothes should be thoroughly disinfected. It is now an admitted fact that the germs of relapsing fever are chiefly carried by body lice in the clothes and beddings of the patients, and so people should not be allowed to wear one another's clothes, and they should wash and keep them clean, so that they might not be infested by lice.

7. **Scurvy.**—The gums of all the inmates of a poor house and those on relief work should be examined for scurvy, to prevent which, the issue of a ration of vegetables twice a week is very desirable. In the absence of vegetables *amchur*, fleshy calyx of *patwa* or fresh limes, should be given. If ulcers are found on the legs or other parts of the body, they should be promptly treated.

8. **Malaria.**—Quinine sulphate should be distributed once a week to persons employed on relief work and inmates of poor houses. The camps should be situated on a well-drained site, so that there should be no undue accumulation of water for the anopheles to breed ; and workers and inmates should not unnecessarily keep *gharas* filled with water or there should be no pools near wells where water may be clogged. Besides these, there are other diseases incidental to want of food, but they need not be discussed here.

## CHAPTER XXIV.

### VITAL STATISTICS.

VITAL statistics may be defined as the science of figures applied to the life histories of communities or nations. They refer to those events which have to do with the origin, continuation, and termination of the lives of the inhabitants. They ordinarily relate to the numbers of the population, of their births, deaths, marriages, diseases, the duration of their lives, and to some extent their social and mental condition. The recording of these statistics is very necessary, so that we may know the rate at which the population in different parts of the country is increasing or diminishing and the causes that tend to this increase or decrease. In India these are computed in the office of the Sanitary Commissioner of each province from the returns forwarded by the District Mortuary Registrar during the first week of every month, and are expressed in terms of the population, usually as rates giving the number for each 1,000 inhabitants. The District Mortuary Registrar is the Health Officer of a municipal town or city.

### THE CENSUS.

This is an enumeration of the population which has been taken regularly every tenth year in the United Kingdom with increasing care ever since 1801. In India the census was first taken in 1851, was then taken every fifth year until 1871, and since then has been taken every tenth year. The last census was taken at the end of March, 1911. In taking a census it is desirable in so far as possible to take it at a time when the greatest number of people will be at their homes; hence the time selected is usually midnight. The enumeration of all, who are travelling, as well as vagrants, is taken at the same time. It shows the number of *pucca* and *kutcha* houses, the number inhabited, the individual particulars about sex, age, religion, conjugal condition, educational state, language, tribe, caste, nationality, occupation, and infirmity. In spite of every precaution taken there is always a possibility of many errors creeping in, the chief of which are regarding the age, caste and occupation. These errors are either due to the carelessness of the enumerators, or due to the ignorance of or the intentional fraud on the part of the people.

**Population.**—Populations are constantly changing. Emigration and immigration are the two principal factors which contribute to these changes. Migration not only may affect the population of a country as a whole, but also may alter the distribution of people within a country. Owing to the increase of industrialism and irregularities in rains many young adults of both sexes migrate from rural areas to the cities, and from one locality to another in search of work. Again, populations are also being increased by births and suffering losses by deaths. The rate of change, however, resulting from births and deaths, is usually comparatively constant or alters gradually, while the changes due to migrations may be exceedingly irregular.

The exact information about the population is obtained from the census taken every tenth year, but the information about the intervening years can be ascertained by the following four methods:—

1. The method adopted by the Registrar-General of England and Wales is based on the assumption that the increase or decrease of the population has been fairly uniform since the last census at exactly the same rate as

between that and the previous rate. This is, of course, in geometrical progression, and may be compared to the accumulation of money at compound interest.

Assuming a ten-yearly census, let

$P$ = the population in 1901,

$P^1$ = the population in 1911,

$R$ = the annual increase per unit of the population,

Then the population would be—

In 1902 $= P\ (1+R)$

In 1903 $= P\ (1+R)^2$

In 1904 $= P\ (1+R)^3$

In 1911 $= P\ (1+R)^{10}$

$$\therefore \frac{P1}{P} = (1+R)^{10}$$

$$\therefore \sqrt[10]{\frac{P1}{P}} = 1+R \text{ and } R = \sqrt[01]{\frac{P1}{P}}-1$$

In practice, the calculation is made with a table of logarithms, and given the value of R the estimated population per any inter-censal or post-censal year is readily obtained.

2. The second method consists in estimating the population by multiplying the number of inhabited houses by the average number of persons per house, as deduced from the last census.

3. The third method for calculating the population is from the birth-rate on the assumption that it remains constant every year. The following formula is used for the purpose:—

$$\frac{\text{Number of births in the year} \times 1{,}000}{\text{Birth-rate per 1,000 in the last census-year}} = \text{Population.}$$

4. The fourth method can be adopted only if complete records of births, deaths, emigration and immigration are kept after a primary enumeration, but this is not practicable in most cases.

## REGISTRATION AND COMPILATION OF BIRTHS AND DEATHS.

To secure accuracy it is essential that there should be a double compulsory report of these events on the one hand by the public at a recording station in a municipal town or city, and on the other hand by the sweeper to the officer in immediate control of them who, in addition to recording the reports, should also exercise a check on the information given. According to the United Provinces Municipalities Act, 1916, it is compulsory for the head of every family resident in or on a visit to the municipality, and the keeper or person in charge of every lodging house, *dharamsala*, *sarai*, hospital or other similar institutions therein, to report within three days the occurrence of any birth or death in his family or among persons staying in the same premises. It should be remembered that births include still-births, but they are entered in a separate register.

In registering births the following particulars are noted:—

1. Date and time of birth.
2. Name (if any) of child.
3. Whether still-born.
4. Name of father or mother.
5. Sex.
6. Caste.
7. Profession of parent.
8. { Name of muhalla. / Number of house according to door-plate.
9. Name of reporter.
10. Signature of recording officer with date.

The following particulars are noted in registering deaths :—

1. Date and time of death.
2. Name of deceased and name of father, husband or guardian.
3. Sex.

4. Caste and profession.
5. Age.
6. Cause of death attested by a medical practitioner in case when a medical practitioner is in attendance.
7. Name of muhalla. Number of house according to door-plate.
8. Place of cremation or burial.
9. Name of medical practitioner who attended deceased during last illness.
10. Name of reporter.
11. Signature of recording officer.

When the cause of death is not ascertained by registrars from the symptoms described by the reporter, it is generally entered as "Not known."

**Birth-rate.**—This is stated as the number of births occurring during a year per 1,000 of the total population estimated at the middle of that year (mean population). It is obtained by multiplying the number of births in the year by 1,000 and dividing the result by the mean population. This is known as the crude birth-rate. A more satisfactory method of calculating the birth-rate is by estimating the number of births occurring during the year per 1,000 child-bearing females between the ages of fifteen and forty-five.

The birth-rate is generally affected by the habits and customs of the people, by their desire to have children or their desire not to have them. Also a high infant death-rate is usually accompanied by a high birth-rate, and, conversely a low infant death-rate by a low birth-rate.

The birth-rate is higher in towns owing to a higher marriage rate, the earlier age at which women marry, and the high rate of infant mortality. The commercial prosperity increases the birth-rate owing to an increased number of marriages. The birth-rate is high in large industrial centres. It has also been noted that the birth-rate is higher among the poor people than among the well-to-do people.

The greater number of births takes place during the first half of the year. The male births exceed the female in the proportion of 104 to 100, but before the end of the second year the numbers are almost equal owing to the greater mortality among male infants.

**Death-rate.**—In India there is no rule of not allowing a dead body to be buried or cremated, unless a death certificate from a registered medical practitioner is forthcoming, as is the case in England and other countries. It is also not possible to introduce this rule for some years to come, as the number of registered medical practitioners is much too small for the population.

The death-rate is ordinarily calculated by the following equation:—

$$\text{Annual death-rate} = \frac{\text{number of deaths in the year} \times 1{,}000.}{\text{Population in the middle of the year.}}$$

In the same way weekly, monthly and quarterly death-rates may be calculated from the following equations:—

$$\text{A weekly death-rate} = \frac{\text{number of deaths in the week} \times 52.17747 \times 1{,}000.}{\text{Population.}}$$

$$\text{A monthly death-rate} = \frac{\text{number of deaths in 4 weeks} \times 13 \times 1{,}000.}{\text{Population.}}$$

$$\text{A quarterly death-rate} = \frac{\text{number of deaths in the quarter} \times 4 \times 1{,}000.}{\text{Population.}}$$

The death-rate calculated in the above-mentioned manner is called the *crude* or *gross* death-rate. The death-rate obtained by deducing the number of deaths occurring among strangers admitted into large hospitals or asylums and by adding those of natives dying out of the district is known as the *recorded* death-rate. It is known as *corrected*, when it is calculated in accordance with the age and sex distribution of the population, as also non-resident or migratory persons.

*The standard death-rate* is the average death-rate at all ages for the previous decennium, and is obtained by multiplying total deaths thus calculated by 1,000 and dividing by the number of the population. The factor of a particular town can be obtained by dividing the standard death-rate of a country by the standard death of that town.

The comparative mortality figure represents the corrected death-rate in each town compared with the recorded death-rate at all ages in a country, *e.g.*, England and Wales taken as 1,000.

The death-rates are mostly influenced by the various direct and indirect causes of disease, *e.g.*, age, sex, race, locality, season, climate, occupations, etc.

**Zymotic Death-rate.**—This is the number of deaths from the seven chief zymotic diseases multiplied by 1,000 and divided by the population. The seven chief zymotic diseases are small-pox, measles, scarlet fever, "fever" (*i.e.*, typhus, simple and continued fever, enteric), diphtheria, whooping cough and diarrhœa. The zymotic death-rate is regarded by many as a guidance to judge the sanitary condition of a locality, but this can be better judged from the death-rate of every communicable disease separately considered. It will also be helped very much by considering the specific death-rates showing the incidence of death by age groups, sex, occupation, etc.

**Infantile Mortality.**—The infantile mortality is stated to be a proportion of deaths of infants under one year of age to the total number of births registered during the year. The rate of infantile mortality is obtained by multiplying the number of deaths of infants under one year by 1,000 and dividing by the number of births registered during the year.

The infantile death-rate has been so very appalling in India that of late years it has greatly attracted the attention of the Government authorities, who have been taking all pains to diminish the rate.

**Causes.**—The chief causes of infantile mortality so far as can be ascertained are premature birth, congenital defects, hereditary tendencies, such as alcoholism, syphilis and tuberculosis, inexperience and neglect of mothers, want of proper medical aid during labour, tetanus, improper food, overlying, respiratory diseases, such as whooping cough, bronchitis, broncho-pneumonia and pneumonia, measles, diarrhœa, dysentery and convulsions.

**Preventive Measures.**—Some of the measures that should be adopted to prevent the infantile mortality are as follows :—

1. Organisations about maternity welfare and the care of infants should be started in municipal towns and cities, as well as in a group of villages for the rural area.

2. Maternity hospitals should be opened, where poor women should be confined free of charge, and where they can get free medical aid.

3. Trained nurses and midwives should be appointed by municipalities for each *mohalla* in municipal towns and by District Boards in rural areas to attend on poor women during confinement free of charge, and should also arrange to supply them necessary comforts, such as milk, bed, blanket, etc., free of charge.

4. Facilities should be given in big hospitals for the training of that class of Indian women called "Dhais" who, owing to their ignorance and carelessness, are a great source of danger to both mothers and their infants. They should thoroughly be trained in asepsis, so that they should abserve these principles in conducting labour cases as well as in cutting the cord, for infants are known to have died of tetanus, when the cord is cut without regard to asepsis.

5. A Midwives Act should be passed by Government forbidding untrained women to practise as "Dhais,"

forbidding qualified medical men and women to entertain any such women during their practice and allowing only trained and licensed midwives to practise, as is done in England.

6. A register of such trained and licensed nurses and midwives should be maintained in each district.

7. Introduction in girls' school-courses of lessons on dieting and rearing of children.

8. Milk depôts should be established, where poor women can get pure milk at cheap rates, or it should be still better to provide them with pure milk in small bottles enough for one feed only, so that there may be no danger of home contamination.

9. All patent foods offered for sale as beneficial to the health of infants should be certified by a Government analyser as non-injurious and the ingredients of their composition should be mentioned on their labels. If they contain starch, they are likely to cause fatal diarrhœa.

10. When infants are affected by measles, whooping cough, bronchitis, or any other respiratory disease, they are usually left to themselves owing to the mother's superstitious belief as to the cause of such diseases. Hence most of them succumb to these diseases. They ought to be put at once under the medical treatment of qualified men, though it should be recognised that these beliefs will vanish only with the spread of education.

11. During pregnancy, if there be any taint of syphilis, the woman should at once be properly treated.

12. Pregnant women should not be allowed to indulge in excessive alcohol, as alcoholism is known to have produced premature birth and cause deformities in some instances, both of which tend to shorten the life of the infant.

13. The mother must nurse her own child, but in cases where the mother is unable to do so owing to her

suffering from syphilis, phthisis or any other wasting disease, the infant should be fed according to the following instructions:—

During the six weeks after birth, the infant should be fed every two hours during the day, leaving an interval of four hours at night. If the infant is asleep at the hour for its food, it must be awakened. From the beginning of the second month, the interval between the feeds is gradually increased, until at the end of the second month the infant should be fed every two and a half hours, and after the end of the third month, every three hours, but it should not be fed at night, unless it happens to be awake.

Cow's milk should be given to infants, but as it differs in its composition from human milk, it is necessary to alter it so as to make it resemble human milk. Thus for a child up to six weeks, one part of cow's milk with two parts of water should be taken, and a teaspoonful of brown sugar should be added to a pint of the mixture. The quantity at one feed to be given should be three or four tablespoonfuls. From six weeks to three months, equal quantities of milk and water should be taken with the same quantity of sugar, but two teaspoonfuls of cream should be added to each feed, which should be about eight ounces. From three months to seven months, one part of water should be added to two parts of milk. The cream to be given at each meal should be the same, but the quantity to be given at each feed should be increased from eight tablespoonfuls to about ten. After seven months it is not necessary to mix water with milk, but cream must be added and a teaspoonful of baked flour or arrowroot may be added to each feed. As the child advances in age, bread, rice and other light foods may be given. The child should be gradually weaned after the ninth or tenth month of its age. If cream is not available, cod-liver oil may be added instead. It is always safe to add boiled water to cow's milk, which should also be boiled. Barley water or lime water may be used with advantage instead of plain water, especially when the child is suffering from diarrhœa, or sodium citrate, two grains to an ounce of milk, may be given in case of gastro-intestinal troubles.

The feeding-bottle should be boat-shaped with an opening at either end, so that it may easily be cleaned out. It should be fitted at both ends with rubber teats without the intervention of tubes. The bottle should be boiled and rinsed out immediately after use, and should be kept in a solution of soda and water, when not in use. It should be thoroughly rinsed out with cold water before the milk is put into it. The rubber teats should be turned inside out, and should be well washed out with water. Any milk left in the feeding-bottle after the child has been fed should be thrown way.

In the "Medical Record" of May 29, 1915, Epstein gives a very simple method of humanising cow's milk, as shown below:—

A quart bottle of milk should be allowed to stand undisturbed for six hours at a temperature of from 40° to 50°F. and then the upper 15 ounces of this bottle should be mixed with an equal volume of boiled water, to which 4.75 per cent. of sugar has been previously added.

The quantity of feeds to be given should be determined by the weight, age and general condition of the infants.

## **APPENDIX A.**—MODEL BYELAWS.

### I.—PROJECTION BYELAWS.

1. Every application for permission to erect or re-erect any projection over a street or drain shall be accompanied by the following plans in duplicate, prepared in the manner prescribed in byelaws:—

   (*a*) A key-plan of the locality showing the precise situation of the building concerned ;

   (*b*) A plan indicating the situation of the building concerned in relation to the streets or lanes adjoining the building and to the adjoining buildings or land, and indicating the breadth of the adjoining streets or lanes, and in the case of a street or lane of which the breadth is not uniform, the width in the narrowest part ; and

   (*c*) Where an open municipal drain has to be closed, a plan and section, showing clearly how it is proposed to cover the drain in question, and where a culvert is to be built, showing the exact tunnel size of the culvert.

2. The plans shall be drawn to a scale of not less than five feet to the inch. The scale used shall be marked on the plans and the position of the north point shall also be clearly indicated. All plans must be signed by the applicant and show all details necessary to enable the board or the executive officer to judge as to the suitability of the proposed projection. The names of the owners of adjoining buildings or lands, together with the *chuk* and house number shall be given. All projected work shall be indicated by a distinctive colour and a key to any colour used displayed on the plan.

3. The dimensions and position of proposed projections must conform with the conditions hereinafter prescribed.

4. No projection from a ground-floor shall be allowed, except for the purpose of permitting access across a drain to a building.

5. Under every projection over a drain other than a culvert a space of not less than one foot must be left open towards the street.

6. No balcony, verandah, *chhajja* or other projection shall be allowed from an upper storey of a building over a street which has a width of less than 20 feet at any point in front of the building. In measuring the street the width shall be taken from the edge of the drain nearest to the roadway on the side of the building concerned up to the edge of the drain nearest the roadway on the opposite side.

7. No projection, such as is described in the preceding byelaw, shall exceed 3 feet in width except in the following streets (except over a street exceeding feet in width at every point in front of the building concerned).

8. Projections over public streets or drains may be permitted only on the following conditions:—

(*i*) That the owner or occupier shall daily remove all refuse from the land over which his projection extends and keep the land clean ;

(*ii*) That the owner shall keep any open drain over which the projection extends in good working order and free from depressions in which liquid can stagnate ;

(*iii*) That the owner or occupier shall at any time, on demand, vacate the surface of his projection, for a period of not more than six hours to permit of municipal servants inspecting or repairing or cleaning any covered drain therein ;

(*iv*) That the owner shall duly pay in advance the fees prescribed by the next following byelaw.

9. Subject to byelaw 10, the annual fees for projections shall be as shown in the accompanying schedule.

10. When two or more projections from the same storey cover the same ground the highest fees chargeable for any one of such projections shall be levied and no other.

11. Nothing in these byelaws shall be construed to derogate from the power conferred on the board by Section 211 of the Act to remove encroachments and projections over streets and drains, notwithstanding that such encroachments and projections may have been sanctioned.

## II.—BUILDING BYELAWS.

1. The board hereby requires, with reference to Subsection (2) of Section 178, that notice be given in the case of all buildings wheresoever situated within municipal limits.

2. Every notice of intention to erect, re-erect or make a material alteration in a building or to make or enlarge a well shall be accompanied by plans in duplicate, as prescribed in the following byelaw. Each such notice shall also be accompanied by a key-plan, showing the precise situation of the building.

3. The plans shall be drawn to a scale of not less than 5 feet to the inch. The scale used shall be marked on the plans ; and the position of the north point relative to the site plan of the house shall also be clearly indicated. All plans must be signed by the applicant. They must show all details necessary to enable the board to judge as to the suitability of the proposed building. In particular, the following matters must be clearly shown on the plans:—

(*a*) The situation of the proposed building, relative to the streets or lanes adjoining it and to the adjoining houses or other properties, the names of the owners of the adjoining houses or other properties together with the *chuk* and house number should always be given. The breadth of the adjoining streets or lanes must be shown. In case the breadth is not uniform the narrowest width should also be shown.

(*b*) Gutters and down spouts should be clearly marked on the plans.

(*c*) The position of, and full details regarding all wells, drains, latrines, *sandases* and other sanitary conveniences, should be clearly given.

(*d*) When sanction is required in respect of a well, the internal diameter and the distance from the nearest privy should be shown, and it should be clearly stated whether the suggested work is compatible with the conditions laid down in the byelaws.

(*e*) Each application in respect of a building should be accompanied by plans showing *inter alia* the following:—

(*i*) The ground floor and the position of the building relative to adjoining streets, properties and unoccupied spaces.

(*ii*) The first or upper floor and each additional floor.

(*iii*) The addition of the building on the main frontage line.

(*iv*) At least one cross-section of the building.

All plans must be duly dimensioned. The height of the plinth must be stated in all cases. The dimensions of all walls and doors as also the height of the rooms, windows, or other openings must be given. All new work should be indicated on the plan by a distinctive colour ; and a key to the colours used should be given on the plans. It should be stated whether the house is to be *pucca* or *kutcha* and of what material the outer covering of the roof will be made.

4. No mosque, temple, church or other sacred building shall be erected or re-erected unless the frontage is at least 15 feet from the centre of the road on which it abuts.

5. All houses intended for human habitation must be *pucca* or *kutcha-pucca*, except in the following areas :—

6. Except in the areas mentioned in byelaw 5 above, the outer covering of all roofs must be made of tiles, iron sheets or other non-inflammable materials.

7. Every person who erects or re-erects a building which is within 100 feet of the sewer and the water-main shall link the privies in such building with the sewer.

8. Every person who erects or re-erects a building the whole or any part of which is intended or used for human habitation shall, if so required, construct one or more privies in connection with or as part of such building.

9. All persons who erect or re-erect buildings must conform to the standard types of privies prescribed by the board for (*a*) privies connected with the sewer, (*b*) servants' latrines for bungalows in civil lines and *ahatas* in the city, (*c*) privies on ground-floors, and (*d*) privies on first and higher floors.

Sanction will not be given unless these plans and all the conditions imposed in respect thereof are adhered to ; when any deviation from these plans or conditions is proposed, the health officer will be consulted by the Public Works Committee before a decision is given.

10. The Public Works Committee will fix in each case the precise position of the privy or privies inside the house or compound.

11. All privies connected with the sewer must be properly tapped and the plumbing and pipe work must conform to the specifications prescribed by the drainage byelaws.

12. All privies connected with the sewer must be separated from any room used or intended to be used for human

habitation by a masonry wall. Approach to a privy shall be through a tightly fitting door.

13. Every privy shall have a window opening directly upon the external air and of at least 4 square feet superficial area. This window shall be situated immediately under the platform of the privy. Sufficient ventilation shall also be provided to carry gases from the privy into the open air. In this byelaw "window" shall mean an opening protected by wire netting or by iron bars not closer than one inch to each other.

14. The platform of every privy shall be of non-absorbent material, such as glazed earthenware or smooth Portland cement not less than half an inch thick, so that no urine can penetrate. The whole privy shall, as regards both internal and external walls, be constructed of *pucca* masonry in lime.

15. The floor of a privy must be made of one or other of the following materials, to be selected by the owner: glazed tiles, stone cement or thoroughly well-burnt bricks plastered with cement not less than one-fourth inch thick. The floor must be in every part of a height of not less than nine inches above the level of the surface of the ground adjoining the privy and must be sloped in all sides of the drain.

16. The house drains through which waste or sullage water is likely to pass must be made of half-round or whole earthenware glazed pipes not less than six inches in diameter properly laid upon a bed of concrete not less than four inches thick, where a house is connected with the sewer. In other cases the drain must be a *pucca* masonry cemented drain and all joints must be rendered tight with cement. These latter drains must be connected with the roadside drain, where a roadside drain exists within 100 feet of the premises.

17. The house shall be provided with iron gutters and down spouts to take all the rain-water which falls on its roof, *chhajjas* or other projections. The gutters and down spouts shall be securely fixed and the latter shall discharge into the surface drains by an elbow piece, the orifice being not more than one foot above the level of the bed of the drain and discharging in the direction of the flow of the drain.

18. Every room intended for or used for human habitation must have at least two ventilating openings of a superficial area of not less than 12 square feet each.

19. When a house is used for dwelling purposes not more than two-thirds of the total area of the site shall be built

over. In the case of properties where there are shops below and houses above, this byelaw shall not apply to the storey occupied by the shops, but shall apply to all other storeys.

20. The lowest point of the plinth shall be at least 1½ feet above the highest point of the road opposite the house.

21. No rooms intended for or used for human habitation shall have a height of less than 10 feet.

22. (1) The term storey shall be held to mean a room or set of rooms in a building the floors of which are at or near the same level.

(2) The height of a building shall be held to mean—

(*a*) in the case of pent-roofs the greatest height to top of walls (excluding gable walls) above the level of the centre of the street on which the building abuts.

(*b*) in the case of flat-roofs, the height to the top of the parapet above the level of the centre of the street.

(3) No three-storeyed house, or any part thereof, abutting on any street shall exceed in height one and a half times the width of the street :

Provided that, if a building, or one or more of its storeys, be set back from the edge of the street, the height of such building or portion that is set back may be increased beyond the height otherwise required by this byelaw by double the distance that it is set back.

(4) The number of storeys shall not in any case exceed four and the aggregate height shall not exceed 60 feet, except with the special permission of the Public Works Committee.

(5) If a building abuts on two or more streets of different width, the building shall be deemed, for the purpose of this byelaw, to abut on the street that has the greatest width.

23. No wells shall be sanctioned, except and unless they are *pucca* throughout. If built inside a house, the internal diameter must be at least 3 feet. No well shall be sanctioned within 15 feet of a privy unconnected with the sewer.

## III.—BYELAWS FOR THE REGULATION AND INSPECTION OF SLAUGHTER-HOUSES.

### INSPECTION OF ANIMALS FOR SLAUGHTER.

1. No animal shall be slaughtered in any slaughter-house unless it has been inspected and passed by the inspecting officer appointed in this behalf.

2. The board shall give public notice of the time and place whereat inspections of cattle intended for slaughter in the municipal slaughter-house are held.

3. At the time and place so appointed, the inspecting officer shall examine every animal produced before him, and satisfy himself that the animal—

(*i*) is fit for use as human food,

(*ii*) is not diseased or advanced in pregnancy,

(*iii*) is not very infirm or excessively old :

Provided that an animal which has met with an accident, rendering it unfit for further work, shall not be rejected merely on this account.

4. If the inspecting officer is satisfied as above, and not otherwise, he shall fill up, or cause to be filled up under his signature, columns 1 to 6 of a pass with its counterfoil in form A appended to these byelaws and giving it to the person producing the animal for inspection. The animal shall then, in the presence of the inspecting officer, be marked on the head, hair or skin with a municipal seal or branded with a municipal brand, as the board may prescribe.

5. Any animal produced for inspection which is affected by any contagious disease, or which may reasonably be suspected of being so affected shall, if the inspecting officer so directs, be forthwith seized and removed to the cattle infirmary for treatment at the expense of the owner ; or the animal may be disposed of in accordance with Section 244 of the Act.

6. Any animal produced for inspection, which is in a dying condition, but not so affected as to be dealt with under the preceding byelaw, shall, if the inspecting officer so directs, be forthwith seized and disposed of in such manner as the inspecting officer may direct:

Provided that this byelaw shall not apply to an animal which has met with an accident.

OFFICER-IN-CHARGE OF SLAUGHTER-HOUSE.

7. A municipal officer shall be on duty at the slaughter-house throughout the hours prescribed for slaughter and such officer shall be deemed to be the officer-in-charge of the slaughter-house.

8. The officer-in-charge shall keep up a daily register showing the number and description of animals slaughtered at the slaughter-house ; and shall send a monthly abstract of this register to the municipal office.

## SLAUGHTER-HOUSE FEES.

9. Every butcher using the slaughter-house shall pay fees at the following rates, which shall be posted up at the door of the slaughter-house :—

**For each animal slaughtered.**

| | Annas. | Per head. |
|---|---|---|
| Bullocks | | |
| Buffaloes | | |
| Goat, sheep, kids and lambs | | |
| Horned cattle | | |
| Other animals | | |

10. Unless the collection of fees is farmed every person from whom any such fees are leviable shall pay them to the officer-in-charge.

11. On receipt of the fee the officer-in-charge shall fill up a ticket and counterfoil in the form B attached to these byelaws, and hand the former with the coupon attached to the person who paid the fee. The progressive total of the daily receipts shall be entered in the place provided at the foot of each counterfoil as each ticket is issued.

12. The holder of a ticket shall produce the ticket when called upon to do so by the executive officer (secretary or any other officer of the board duly authorized in this behalf). Such officer shall, after such examination as he may think necessary, fill up the counterfoil and shall return the ticket to the holder after initialing it.

## AT THE SLAUGHTER-HOUSE.

13. No animal shall be admitted, and no person shall bring any animal, into the slaughter-house, unless it is covered by a pass in form A, as prescribed in byelaw 4 above, and unless the fee prescribed in byelaw 9 has been paid. The pass must be presented at the slaughter-house within 3 days of the time of issue.

14. The officer-in-charge shall receive the pass and if it is in order and the fee prescribed in byelaw 9 above has been paid, he shall allow the animal or animals covered thereby admission into the slaughter-house, filling up columns 7 to 9 of the pass. The passes shall be dealt with in such manner as the board may direct.

15. Except with the general or special permission of the board no one but the butchers, their assistants, and the

municipal officers connected with the slaughter-house, shall enter or be allowed to enter the premises during the process of slaughtering, skinning or cutting up the carcasses.

16. No person affected with leprosy, or with any skin disease, shall enter, or be allowed to enter, the slaughter-house premises.

17. No dogs shall be admitted into, or be allowed to enter, the slaughter-house. All dogs found there shall be destroyed.

18. No animal shall be admitted and no person shall bring any animal, into the precincts of the slaughter-house, unless it is intended for immediate slaughter. All cattle awaiting slaughter shall be kept in pens attached to the slaughter-house, and there properly secured with ropes until required for slaughtering.

19. Butchers shall make their own arrangements for the feed of their cattle while in the pens, and shall have their own servants to look after them.

## WITHIN THE SLAUGHTER-HOUSE.

20. No person shall slaughter any animal except at such hours as may from time to time be fixed by the board. These hours shall be notified in some conspicuous place in the slaughter-house.

21. Each butcher shall have a place assigned to him for slaughtering by the officer-in-charge, and he shall slaughter his cattle immediately over the central drain so as to prevent the blood of the animal from flowing upon the floor.

22. Immediately after the slaughter of an animal the butcher shall cause the portion of the slaughter-house assigned to him to be carefully washed and cleaned.

23. Every carcase shall, after slaughtering, skinning and cleaning, be presented for the inspection of the officer-in-charge of the slaughter-house, and no butcher shall remove from the slaughter-house, except in accordance with the next clause of this byelaw, any carcase which appears to the officer-in-charge to show signs of any contagious disease, or other disease rendering the meat unfit for human consumption.

If any such carcase be found, it shall be disposed of in accordance with the provision of Section 244 of the Act. In the event of a dispute arising under this byelaw the matter shall be referred to the health officer of the board whose decision shall be final.

24. If, on the inspection prescribed by the preceding byelaw, the carcase is found to be fit for human consumption, each piece of meat cut therefrom shall have impressed thereon or affixed thereto, under the supervision of the officer-in-charge, such stamp or seal as the board may from time to time prescribe.

25. The skin of an animal whose carcase has been condemned under byelaw 23 above shall, if the officer-in-charge or the health officer so direct, be disposed of in the same manner as the carcase.

26. Skins, entrails, and offal shall be removed from the slaughter-house by the butchers, and any skin, entrails or offal not removed before the time at which the slaughter-house is closed for the day shall become the property of the board, and may be disposed of in such manner as seems to it fit :

Provided that, if the board so prefers, it may delegate to the officer-in-charge the power to have such skins, entrails or offal removed at the owner's or butcher's expense ; and the officer-in-charge may refuse such butcher or owner or his servant, any subsequent admission to the slaughter-house until such expense is made good to the board.

27. No person shall remove any skins, entrails and offal from the slaughter-house until they have been properly washed and cleaned.

28. The solid contents of the entrails shall not be washed into the cesspools, but shall be cleaned up and removed by the butchers or their assistants at the same time as the entrails and offal are removed under byelaw 26 above.

29. Meat, entrails and offal shall be removed from the slaughter-house in covered carts or covered buckets or vessels, of a pattern to be approved by the board, and the officer-in-charge of the slaughter-house shall daily inspect the said carts, baskets or vessels, and see that they are kept clean and in good order.

30. No person shall employ the process of insufflation (the blowing of carcases) in the slaughter-house.

31. No butcher or other person shall sell, or allow to be sold, meat on, or at the slaughter-house premises.

32. Butchers or private individuals using the slaughter-house shall be responsible for any damage wilfully or negligently caused to the slaughter-house either by their own act or the acts of their servants and any butcher and private

person using the slaughter-house who refuses to pay such damage shall be excluded from the slaughter-house until he pays the cost of damage done.

33. No butcher or other person shall remove, deface or alter any seal or brand impressed in accordance with byelaw 4 above, or any stamp or seal impressed upon or affixed to any piece of meat in accordance with byelaw 24 above.

PENALTY.

In exercise of the power conferred by Section 299 (1) of the Act, the board hereby directs that a breach of any of the provisions of byelaws 9, 10, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 33 shall be punishable with fine which may extend to Rs. 50, and, when the breach is a continuing breach, with a further fine which may extend to Rs. 5 for every day after the date of the first conviction during which the offender is proved to have persisted in the offence.

IV.—BYELAWS REGULATING THE SALE OF MEAT.

1. In these byelaws "meat" means the flesh of horned cattle, goats, swine, or sheep intended for human or animal consumption.

2. No person shall sell or expose for sale any meat within the limits of the municipality unless he has been granted a license in this behalf.

3. The executive officer or Secretary shall be the licensing officer for the purposes of these byelaws.

4. A license granted under these byelaws shall be subject to the following conditions:—

(1) No one shall sell or expose for sale the flesh of any animal which has died from a natural cause, or any meat which has been blown up or artificially stuffed.

(2) No one shall place any meat intended for sale in or on a dirty basket or board or expose such meat without covering it with a clean cloth.

(3) The shop for the sale of meat shall have chicks hung up on all the open sides, so that the meat kept for sale may not be seen by the passers-by, and shall be free from flies.

(4) The floor of the shop must be paved with bricks plastered all over, and it must be thoroughly washed every day before the shop is closed.

(5) The shop itself must be whitewashed once a month.

(6) The licensee shall not sell meat at any place other than that mentioned in the license.

A breach of any of these conditions shall involve forfeiture of the license.

5. On receipt of an application for a license, the licensing officer shall either grant the license or, for reasons to be recorded, may refuse to grant it.

6. The licensing officer may cancel or suspend a license for breach of any of the conditions specified in byelaw 4.

7. An appeal shall lie to the board (or *Chairman* or *Health Committee*) from an order of the licensing officer refusing or cancelling or suspending a license: provided that the appeal is made within 10 days of the date of the receipt of the order.

8. No one shall carry meat through any street or public place except in a clean receptacle and covered with a clean cloth.

## PENALTY.

In exercise of the power conferred by Section 299 (1) of the Act, the board directs that any breach of the provisions of byelaw 2 or 8 shall be punishable with fine which may extend to fifty rupees, and when the breach is a continuing breach, with a further fine which may extend to five rupees for every day after the date of the first conviction during which the offender is proved to have persisted in the offence.

**Note.**—If a board desires to charge a fee for such license it must make a byelaw for the purpose.

## V.—DAIRY BYELAWS.

### PART I.

*The manner in which cattle-sheds and cow-houses are to be constructed and connected with the municipal drains.*

1. Every cattle-shed and cow-house must be well paved with asphalt, stone, brick-on-edge with cement pointing, or flagstones set in cement, or with some other suitable impervious material approved by the Chairman or the executive officer.

2. (1) The floor of every cattle-shed and cow-house must incline to a channel or gutter, sloping towards and draining directly into a gully pit communicating with a sewer situated immediately outside the shed or house.

Provided that, in the unsewered area :—

(a) such channel or gutter must drain directly into a cesspool similarly situated, the contents whereof shall be removable, and

(b) such cesspool must be constructed of bricks set in cement and cement plastered, or of some other suitable impervious material approved by the Chairman or executive officer and must be so constructed as not to admit rain-water.

(2) The slope of the floor must be made so as to incline away from the heads of animals, and, in the case of floors of sheds or houses hereafter constructed and accommodating two rows of animals, must be made so as to incline outwards.

3. Every cattle-shed and cow-house in which cattle are kept for sale or for the sale of their produce must have, for purposes of light and ventilation, an opening of not less than one foot in width, on all sides below the junction of the eaves and the wall of the building.

4. Every cattle-shed and cow-house must have one storey only, and there shall be no construction, arrangement or fixture permitting of any lifts or sleeping places, either over the roof or within the interior over the stalls:

Provided that—

(a) the Chairman or executive officer may sanction the erection of the upper storey, if the floor thereof be constructed of impervious material to his satisfaction; and

(b) an appeal shall lie to the health committee in any case in which the Chairman or executive officer refuses such sanction.

5. The interior fittings of every cattle-shed and cow-house must be so constructed and placed as to provide for each animal kept in the shed or house a clear superficial floor space of at least 40 square feet and a clear lateral space of at least 5 feet.

6. The walls of every cattle-shed or cow-house must be at least seven feet in height from the level of the floor up to the junction of the eaves with the walls.

7. (1) No cattle-shed or cow-house in which cattle are kept for sale or for the sale of their produce shall be so constructed as to provide for the storage of milk or milk vessels therein.

(2) For every cattle-shed or cow-house where milch cows

or milch buffaloes are kept there shall be provided a separate shed or place for the temporary storage of milk and milk vessels.

(3) Such shed or place shall not communicate directly with any cattle-shed or cow-house, and shall not, without the special permission of the Chairman or executive officer, be placed within a distance of fifteen feet from any privy connected with a sewer or 25 feet from any service privy or urinal.

## PART II.

*Inspection of milch cattle and cleansing, drainage, and water-supply of dairies and cattle-sheds in the occupation of persons following the trade of dairymen or milk-sellers.*

8. In this part—

(*a*) **Cattle-shed** means any place in which milch cattle are kept, and

(*b*) **Dairyman** means any person following the trade of cow keeper, milk supplier or milk seller.

9. Every occupier of a cattle-shed, every person having the care or control of milch cattle, and every dairyman shall afford all reasonable assistance and facility to the executive officer, health officer, the sanitary inspector, and any other servant of the board appointed to inspect milch cattle, whenever he is so required by any such servant desiring to inspect such cattle.

10. Every dairyman—

(*a*) shall cause every part of the interior of every cattle-shed in his occupation to be thoroughly cleansed from time to time and as often as may be necessary to secure cleanliness, and

(*b*) shall cause the floor of every such shed to be thoroughly swept, and all dung and other offensive matter to be removed, at least twice every day, and

(*c*) shall, after the floor is so swept, cause it to be swilled with fresh water.

11. Every dairyman shall cause the drainage of every cattle-shed in his occupation to be so arranged that all liquid matter which falls or is cast upon the floor shall be drained off by suitable means to be approved by the Chairman or executive officer.

12. Every cattle-shed in which milch cattle are kept for the sale of their produce, and which is within a radius of 600 feet from a municipal standpost, must be provided with an adequate supply of filtered water to the satisfaction of the Chairman or executive officer—

(*a*) for the cattle to drink,

(*b*) for washing utensils used for milk, and

(*c*) for flushing purposes.

No unfiltered water shall be supplied to any such cattle-shed.

## PART III.

*Cleanliness of milk stores, milk shops and milk vessels.*

13. In this part—

**Dairyman** means any person following the trade of cow keeper, milk supplier or milk seller.

14. Every dairyman who is in occupation of a milk store or milk shop shall cause every part of the interior of such store or shop to be thoroughly cleansed from time to time, and as frequently as may be necessary to maintain the store or shop in a thorough state of cleanliness.

15. Every dairyman shall—

(*a*) cause every vessel used by him for containing milk to be thoroughly cleansed with steam or boiling water immediately after such use ; and

(*b*) take all proper precautions for maintaining every such vessel in a constant state of cleanliness.

## PART IV.

*Procedure on the occurrence of contagious disease.*

16. In this part—

(*a*) **dairy** includes any farm, farm-house, cattle-shed, cow-house, milk stall, milk shop or other place from which milk is supplied, or in which milk is kept for the purpose of sale, and

(*b*) **dairyman** includes any owner or occupier of a dairy, as defined in clause (*a*) of this byelaw, and any person following the trade of dairyman, milk supplier or milk seller.

17. Every dairyman shall, whenever any milch animal in his dairy is affected with any contagious disease, forthwith give notice to the health officer.

18. Every dairyman shall, in order to prevent infection or contamination, forthwith remove or cause to be removed from his dairy and from the proximity of other animals any animal therein which is found to be suffering from any contagious or infectious disease.

19. On the outbreak of any contagious or infectious disease every dairyman shall if so required by notice from the health officer—

(*a*) cause his dairy to be temporarily emptied of all animals, and

(*b*) cause the whole interior surface of the dairy to be disinfected or limewashed, or both.

20. No dairyman shall at any time permit any person suffering from any dangerous disease to enter or remain in his dairy or the precincts thereof.

21. No dairyman shall sell or permit to be sold the milk of any animal suffering from any contagious or infectious disease (including tubercular disease of the udder), or shall add such milk, or permit it to be added, to any milk of other animals which is intended for sale or for human consumption.

22. No dairyman shall deposit or keep any milk which is intended for sale—

(*a*) in any room or place where it would be liable to become infected or contaminated by impure air, or by any offensive, noxious or deleterious gas or substance, or, by any noxious or injurious emanation, exhalation or effluvium, or

(*b*) in any room used as a kitchen or inhabited room, or

(*c*) in any room or part of a building which is used for sleeping, or

(*d*) in any room, place or part of a building in which there is any person suffering from any dangerous disease, or

(*e*) in any room, place or part of a building which has been used by any person suffering from any dangerous disease, unless it has been thoroughly disinfected to the satisfaction of the health officer, or

(*f*) in any room or part of a building in which there is any urinal or privy or any direct inlet to any drain, or

(*g*) otherwise than in covered receptacles.

23. No dairyman shall cause or permit any cow belonging to him or under his care or control to be milked for the purpose of obtaining milk for sale or for human consumption—

(*a*) unless at the time of milking the udder and teats of such cow are thoroughly clean, and

(*b*) unless the hands of the person milking such cow are thoroughly clean and free from all infection or contamination.

24. No person shall—

(*a*) carry any milk for sale or for human consumption in any vessel unless such vessel be made of some impervious material and be provided with a suitable covering, or

(*b*) allow any milk while being so carried to be exposed to dirt, dust or any other offensive matter.

## PART V.

25. If any person commits a breach of any of the foregoing byelaws, the Chairman or executive officer may, in his discretion, send him written notice to discontinue such breach.

## PART VI.

## PENALTY.

In exercise of the power conferred by Section 299 (1) of the Act, the board hereby directs that every breach of any of the foregoing byelaws shall be punishable with fine which may extend to twenty rupees, and, in the case of continuing breach, with a fine which may extend to five rupees for every day during which the breach continues after the date of the first conviction.

## VI.—BYELAWS FOR CONTROLLING THE MANUFACTURE AND SALE OF ÆRATED WATER.

**Note.**—*These byelaws may be applied* mutatis mutandis *to ice factories.*

1. No person shall establish the business of an ærated water factory within 100 feet of any cow-house, stable, public latrine, cesspit or public dust-bin.

2. Every owner or occupier of an ærated water factory shall comply with the following conditions :—

(*a*) He shall not maintain a privy on the premises unless it is separated from the factory by an open passage at least 6 feet wide and is situated more than 20 feet from the factory windows and has no direct communication with the factory.

(*b*) He shall not cause or suffer any room adjacent to the factory to be used as a living or sleeping-room unless it is separated from the factory by a substantial wall, and unless it contains a window opening directly into a passage or space open to the sky not less than 8 feet wide.

(*c*) He shall cause any drains, pipes or sewers for carrying off sullage and sewage matter which run under the factory to be constructed to the satisfaction of the health officer.

(*d*) Where drains communicating with municipal drains cannot be constructed he shall cause a separate receptacle to be kept for the reception of all foul water, and the contents thereof to be removed daily to such place as the health officer may direct.

(*e*) He shall provide that the premises shall have a window or windows with an area for the passage of light of at least one-tenth of the floor area of each room, and that each window shall be capable of being opened and shall be covered by wire gauze of such a mesh as will keep out flies, and (if considered necessary by the health officer) he shall provide for the premises self-closing doors partly of wood and partly of gauze netting of a similar mesh to that covering the windows.

(*f*) He shall cause the floors, drains and the walls, to a height of 6 feet, to have a smooth, non-absorbent surface.

(*g*) He shall cause the water used in the manufacture of ærated water to be drawn from the municipal filtered supply or, if such a supply is not available, from a well of a type approved by the health officer.

(*h*) When a filtered water-supply is available he shall provide a stand-pipe and tap within the factory.

(*i*) He shall provide within the factory three tanks or receptacles—

(1) One a special covered cistern to contain water to be used in aeration, which he shall connect directly to the supply tap or pump, and shall so locate as to be free from sources of contamination, but to admit of being readily cleansed ;

(2) One for washing and disinfecting the bottles and brushes; and

(3) One for finally washing out bottles before re-filling.

(*j*) He shall cause the premises to be open to the inspection of the chairman, executive officer, health officer or any other member or officer duly authorized in this behalf.

(*k*) He shall not himself dwell or sleep or suffer any other person to dwell or sleep in the factory.

(*l*) He shall not suffer any animal to be kept in the factory.

(*m*) He shall not suffer any *hookah* or other appliance for smoking or any bedding or soiled clothes, or other articles not required for the purposes of the factory, to be kept in the factory.

(*n*) He shall cause the utmost cleanliness to be observed in the various processes of manufacture, and the premises and appliances to be kept in a thoroughly clean and sanitary condition.

(*o*) He shall cause all the inside walls, about the height of six feet, and all the ceilings or roofs of the factory, whether plastered or not and all passages to be limewashed at least once in every three months.

(*p*) He shall not use or suffer to be used in the manufacture of aerated water sugar, acid and essence of flavouring agents which are not of good quality.

(*q*) He shall not allow water used in the factory to be carried in *massaks* or otherwise than in metal vessels.

(*r*) He shall cause all bottles to be filled direct from the tap in the storage water cistern and shall not suffer any dippers to be used for filling the bottles.

(*s*) He shall cause the brushes used for scrubbing the interior of dirty bottles and the bottles themselves to be cleaned in a solution of permanganate of potash of the strength of five grains to a gallon of water and shall cause the bottles after the preliminary soaking and cleaning in one tank to be finally washed out in or from a second tank, which shall contain a tap water solution of permanganate of the strength of half a grain to the gallon. When the permanganate in the second tank has turned brown, he shall cause it to be renewed.

(*t*) He shall cause the three tanks to be well cleaned and rinsed out once a week with permanganated water of the strength of half a grain to a gallon.

(*u*) He shall not suffer any rubber rings to be used in the bottles unless they are in good order and shall cause any ring which has deteriorated to be destroyed.

(*v*) He shall cause labels bearing the address of the factory and the name of the owner or manager to be affixed to each bottle.

(*w*) He shall not employ on the premises a person suffering from any contagious or infectious disease.

PENALTY.

In exercise of the power conferred by Section 299 (1) of the Act, the board directs that any breach of any of the provisions of the above byelaws shall be punishable with fine, which may extend to Rs. 100, and when the breach is a continuing breach, with a further fine which may extend to Rs. 5 for every day after the date of the first conviction during which the offender is proved to have persisted in the offence.

## VII.—BYELAWS FOR THE REGULATION AND CONTROL OF BAKERIES.

1. **Bakery** means a building in which European confectionery is prepared for sale. Confectionery includes all sorts of bread, biscuits, sweetmeats or the like.

2. No person shall establish a bakery or cause a bakery to be established within 100 feet of any cow-house, stable, public latrine, open sewage, cesspit or public dust-bin.

3. Every owner or occupier of a bakery shall comply with the following conditions:—

(*a*) He shall not maintain a privy on the premises, unless it is separated from the bakery by an open passage at least six feet wide and is situated more than 20 feet from the bakery window and has no direct communication with the bakery.

(*b*) He shall cause any drains or drain pipes or sewers for carrying off sullage or sewage matter which run under or near the bakery to be constructed to the satisfaction of the health officer.

(*c*) He shall not cause or suffer any room adjacent to the bakery to be used as a living or sleeping room, unless it be separated from the bakery by a substantial wall, and unless it contains a window opening directly on a passage or space open to the sky not less than eight feet wide.

(*d*) He shall provide the bakery with a window or windows with an aperture for the passage of light of one-tenth of the floor area and capable of being opened, and shall cover the windows with wire gauze of such a mesh as will keep out flies and (if considered necessary by the health officer) shall cause the bakery to have self-closing doors, with panels partly wood and partly filled in with galvanized gauze netting.

(*e*) He shall cause a good impermeable floor to be provided over the whole area of the bakery.

(*f*) He shall cause the kneading tables or troughs, if not of masonry, to be covered with galvanized iron or zinc sheeting or tin or other impermeable material.

(*g*) He shall cause the bakery to be open to the inspection of the chairman, executive officer, health officer or any other member or officer duly authorized in that behalf.

(*h*) He shall not himself dwell or sleep or suffer any other person to dwell or sleep in the bakery.

(*i*) He shall not suffer any animal to be kept in the bakery.

(*j*) He shall not suffer any *hookah* or other appliance for smoking, or any bedding or soiled clothes, or other articles not required for purposes of the bakery, to be kept in the bakery.

(*k*) He shall cause kneading tables, troughs, and all utensils used in the bakery to be thoroughly scrubbed and washed with water daily.

(*l*) He shall not use or suffer to be used in the preparation of confectionery any unwholesome materials.

(*m*) He shall cause all dough and other materials used in preparing the products of the bakery and all products of the bakery to be kept in clean receptacles and to be cleanly covered to the satisfaction of the health officer.

(*n*) He shall cause all the inside walls and the ceiling of the bakery, whether plastered or not, and all passages to be limewashed at least once in every three months.

(*o*) He shall not cause or suffer any person other than employés or a member or official of the board to enter the bakery.

(*p*) He shall not employ in the bakery any person suffering from any contagious or infectious disease or allow any such person to sell confectionery in his behalf.

(*q*) He shall not carry or cause to be carried confectionery for sale or delivery to a customer except in tins or other suitable metal boxes provided with properly fitted covers.

PENALTY.

In exercise of the power conferred by Section 299 (1) of the Act, the board directs that any breach of byelaws 2 and 3 shall be punishable with fine which may extend to Rs. 100, and when the breach is a continuing breach, with a further fine which may extend to Rs. 5 for every day after the date of the first conviction during which the offender is proved to have persisted in the offence.

# APPENDIX B.

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## DISINFECTION OF A MUNICIPAL WATER-SUPPLY.

(G. O. No. 100-XI 438 R., dated the 6th May, 1899.)

On the occurrence of an epidemic of typhoid fever or cholera traceable in any way to the water supplied from the municipal water-works, clear water reservoirs and distribution pipes have to be disinfected in the following manner :—

The depth in one compartment of the clear water reservoir should be lowered until only 200,000 gallons of water are left in the reservoir. Ten pounds of permanganate of potash (previously dissolved in buckets or in an iron tank) should then be gradually added at about 6 or 7 o'clock in the evening. At 11 P.M., by which time the demand for drinking purposes will have ceased, the pumps should be started and the pink water slowly pumped through the distribution system. Where there is a raised reservoir this should be emptied by opening some of the scour valves before pumping is commenced, so that the disinfectant may thoroughly wash out the reservoir as well as the pipes.

Arrangements should be made while pumping is in progress, to have all the scour valves opened in rotation, to ensure a proper circulation of the disinfecting fluid.

When the reservoir has been pumped empty the supply from the filters should be turned on, and, as soon as sufficient water has collected, the pumps should be re-started and clear water pumped slowly through the system for half an hour.

By starting pumping at 11 P.M., it should be possible to have the whole operation completed by 3 or 4 o'clock in the morning, before water is required for domestic purposes.

The above procedure is to be observed in the case of an outbreak of typhoid, the only difference in the event of the epidemic being one of cholera is that 10 gallons of commercial hydrochloric acid should be added to the solution of permanganate of potash in the clear water reservoir. The hydrochloric acid should of course be previously diluted in buckets of water before being put in the reservoir.

# APPENDIX C.

## NOTE ON WATER-SUPPLIES TO FAMINE CAMPS.

In dealing with water supplies for charges the main points to be kept in mind are:—

**Firstly**—Disinfection of water at its source.

**Secondly**—Subjection to as little handling as possible, from the source to the consumer, to avoid liability of infection by cholera carriers.

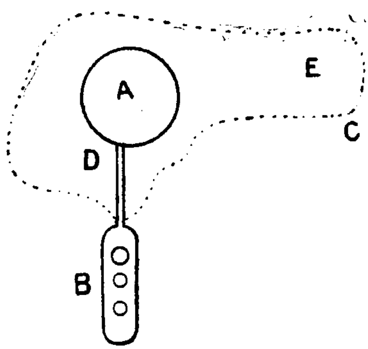
1. Strict instructions must therefore be issued, that only *dols* should be used for drawing water from wells. Kerosene oil tins must never be used, as they may be readily exchanged for those employed in distribution.

2. The use of the two-gallon iron *dols* is to be preferred to those of a larger size, as one man can draw the smaller size from a well. The best method of arranging for the water-supply at wells is to provide a large iron pulley and two *dols*, one of which is affixed to each end of the rope, or one *dol* and a slightly heavier counterpoise weight at the other end of the rope. By this method the rope and *dols* never leave the interior of the well or its platform.

3. A second method is in use which is not by any means as good as the former, but which may be sanctioned where a large amount of water is required to be drawn from a well, situated at a distance from villages. A 4-gallon *dol* is drawn from the well by two or three *Kahars* hauling on a rope. If this method is adopted, the whole of the area the rope traverses outside the well must be surrounded by bamboo fence in which thorn bushes are woven. The rope also should overnight be soaked in permanganated water.

4. Where cattle have to be watered at wells in addition to the supply to workers, a mud stall should be raised a short distance from the well and *naunds* placed in it. These *naunds* should be connected up to the platform and to each other in sequence by iron or tin *parnallas* which should carry the water spilled on the platform to the *naunds* and the fencing and thorn

hedge round the well carried up to the edges of the drinking trough.




A.—Well. B.—Naunds.
C.—Fencing. D.—Parnallas.
E.—Space enclosed for haulage of rope.

5. No *piaos* should be situated on the well platform but may be allowed at a short distance from the well.

6. All small ordinary wells used for the charge water-supply should be treated with potash permanganate 1 ounce on Sundays and 2 drachms daily. In wells with a wide cylinder and containing over 6 feet of water 2 ounces of pot. permanganate on Sundays and half an ounce daily should be used.

7. The *Kahars* or *Brahmans* at *piaos* should not be permitted to hold the *lotas* used for removal of water from the *matkas* in their hands but should affix to the *lota* a split bamboo stick of about 1½ feet in length.

8. When wells are absent or are brackish and water is obtained from rivers, pools or streams, it should be poured into cisterns provided with a stopcock or into large earthen *gharas*. If loaded with silt it should be treated with 6 grains of alum to the gallon. This carries down suspended particles and most bacteria. After this the water should be pinked with potash permanganate or Nesfield's powders or solutions may be used.

9. When streams are liable to be polluted, *kutcha* wells sunk in the banks will in all probability yield the desired amount of water. The wells and their vicinity must be scrupulously protected from contamination. They should be Hankinized as in the directions given in paragraph 6 above.

# APPENDIX D.

## MEASURES TO BE ADOPTED ON THE OCCURRENCE OF CHOLERA IN FAMINE CAMPS.

1. On the appearance of cholera on a charge all the water supplied to the staff, workers and dependents should be treated as follows:—

Sterilization stations should be selected on the roads to the wells. At each station a special *Kahar* sterilizer should be appointed. Each station should be provided with two *matkas*, a zinc pail, one bottle each of A, of B and of Nesfield's solution and two small measuring cups of tin made of the exact size to sterilize the water in one cistern and one pint enamel cup.

Every cart proceeding to a well visits the sterilization station. The sterilizer empties one measure of solution A and one measure of solution B into a pint enamel cup and pours it into a bucket of water, mixes up the solution and empties the bucket into the cistern on the cart, which then proceeds, to the well and is filled with water. On the return journey the cart again visits the sterilization station, where the above operation is again repeated, one measure of solution C being used in place of A and B solutions. A separate cup is used for A and B and C as traces of "C" neutralize A and B. This cup should be painted a distinctive colour. The cart then proceeds to the *piaos* and on its return empty again visits the sterilization station. This process is carried out in addition to the usual permanganization of wells and *matkas*.

The solutions A, B and C are of such a strength that 5 drops of each are required to the gallon of water. If therefore 50-gallon cisterns or casks are in use, the tin measures should be constructed to contain 250 minims, *i.e.*, half an ounce (nearly).

2. In most cases no further action will be required, but if cholera persists for over 6 days, remove the charges at once from the infected area and repeat sterilization of water.

3. If cholera cases still occur in the first five days after removal, break them up into as small a unit as is compatible with supervision and discipline.

4. Carefully select and rigidly protect the water-supply on the new ground taken up; search parties being sent in advance for the purpose. All water-supplies to be permanganated forty-eight hours before use.

5. Destroy as much infected material, such as huts, old clothes, rags, etc., as possible.

6. Freely use phenyle or cyllin (1 in 200) for disinfection purposes.

7. Flies spread the disease. Disinfect all discharges.

8. Disinfect all latrines.

9. Destory all suspicious food supplies.

10. Keep the site clean.

11. Isqlate cases as they occur.

12. For the individual use of camp officers using small amount of water Nesfield's tablets are recommended; or all water used for drinking ana washing up of dishes, etc., may be boiled. Boiled water for drinking should, as a rule, be used within 24 hours, and should be carefully protected from dust and contamination. Officers should see that their servants dip their soup-straining cloths and *jharans* into boiling water before use.

13. Hot, cooked food should preferably be eaten and all milk should be boiled. Ten drops of dilute sulphuric acid taken twice daily is recommended when cholera is about.

# APPENDIX E.

## DIRECTIONS FOR TUBERCULOUS PATIENTS GOING TO BHOWALI SANATORIUM.

1. The Sanatorium is situated at Bhowali on the Ranikhet road at a height of 6,000 feet ; it is 21 miles distant from Kathgodam Railway Station by cart road, and 14 miles by bridle path, *via* Bhim Tal.

2. Only those suffering from tuberculosis of the lungs are available for admission. The disease must be in an early stage and the patient in a fair general state of health. Experience has proved that cases with fever over 100° F do not do well in the hills, nor those with a pulse over 110 per minute.

3. Applications for admission must be accompanied by the Medical Certificate form filled up by the patient's medical attendant and must be made to the Superintendent of the Sanatorium.

4. Patients may be of any race or sex. Inhabitants of the United Provinces will be given preference for admission to vacancies as they occur ; apart from this admissions are made strictly in the order of application of the cases, which the Superintendent considers are likely to benefit by Sanatorium treatment in the hills.

5. Europeans and Anglo-Indian patients are charged from rupees 50 to rupees 200 per month according to their circumstances. Ordinarily the fees are one-third of their salary. Suitable food is provided. No friends are accommodated. Each patient must be accompanied by one servant.

6. Indian patients are classed as A, B and C.

"A" patients pay a minimum fee of Rs. 50 per month, and are provided with a two-roomed cottage. Each patient may be accompanied by two servants.

"B" patients pay Rs. 20 per mensem and are provided with a single room ; one attendant for cooking must accompany each patient.

"C" patients have not to pay any fees, but are expected to contribute, as far as possible, towards the cost of their food cooked and provided by the Sanatorium.

7. Patients are advised that it is useless to expect any real lasting advantage from Sanatorium treatment under less than three months' stay ; they should, therefore, make arrangements to live there for at least that period.

8. The Medical Certificate to be filled up by the patient's attendant is as under:—

Name of Patient..............................................

Address..................................................

Age...........Sex.........Married..........Race...........

Occupation...............Religion or Caste..................

Duration of illness.............................................

Physical signs in lungs—Right lung..........................

.................................................................

.................................................................

..........................Left lung..............................

.................................................................

.................................................................

Are *Tubercle bacilli* present in the sputum ?..................

Average evening Temperature ?..........Average Pulse rate ?

.........What is the condition of Larynx ?.................

Is there any other complication present ? If so, state nature and extent.

.................................................................

.................................................................

Has there ever been Hæmoptysis ?............................

Is the patient gaining or losing Weight ?...........Present weight ?.........Can the patient take Walking exercise ?...... .................If desirous of becoming a "C" patient, can anything be contributed towards his support either by himself or relatives ?......................

Has the patient been treated with Tuberculin...........if so, state the variety and dosage and over what period...........

.....................................................

*Signature of Medical Attendant.*

*Date*...............................

*Place*...............................

9. The form of application for admission into Sanatorium is given below:—

SIR,

I herewith send a medical certificate and wish to enter the Sanatorium as an A|B|C European patient. I will pay Rs..... per mensem $\frac{\text{as the Sanatorium Charges (A. B. and European Patients only).}}{\text{towards my food expenses (C. patients only).}}$

I agree to conform to all the rules of the Sanatorium and $\frac{\text{have read}}{\text{have had read to me}}$ the information for applicants.

*Signature or Mark*...............................

*Address*...............................

*Date*...............................

*To*

THE SUPERINTENDENT.

N.B.—*Cross out the words that do not apply.*

# APPENDIX F.

## DIRECTIONS FOR PATIENTS PROCEEDING TO KASAULI FOR ANTI-RABIC TREATMENT.

1. Kasauli is situated in the Lower Himalayas at about 6,300 feet above sea level. The climate is moderately warm in summer and cold in winter. Snow occasionally falls during the winter months. Patients should, therefore, take with them warm clothing and bedding.

2. The most convenient railway station for Kasauli is Kalka on the East Indian Railway, 9 miles from the Pasteur Institute. The road from Kalka is entirely uphill.

3. No patients are accommodated at the Institute itself; but quarters are available on the payment of a nominal rent from 4 annas to 8 annas, while lines have been provided for indigent patients, where they may live during treatment.

4. The treatment is free of all charges and the course lasts 14 days.

5. Patients when bitten by an animal, unless it has disappeared or been killed (in which case, if rabies be suspected, they should proceed to Kasauli immediately), are advised to consider the following points before deciding to have a course of anti-rabic treatment:—

(1) A rabid animal may be furious or it may be paralysed.

(2) An animal may be rabid without being afraid of water.

(3) An animal is never infective more than 10 days before it becomes rabid.

(4) Treatment is only necessary in the case of bites which have broken the skin, or when the saliva has come in contact with a fresh abrasion.

(5) The risk of infection has become very small two months after the person has been bitten.

(6) Never kill the animal until certain that it is rabid, but see that it is impossible for it to bite any one else. If it lives for ten days after biting any one, treatment is not necessary.

(7) If the dog is suspected to be rabid, do not wait until the brain has been examined, as a negative result of the examination is inconclusive.

(8) If after reading the above, one is still in doubt, a long telegram to "Pasteur" Kasauli, will not cause much delay and may save much expense. After it has been decided to undergo a course of treatment, no time should be lost in proceeding to Kasauli as the earlier the treatment is commenced, the better.

6. Almost all the railways allow concessions to indigent patients and their attendants proceeding to the Pasteur Institute at Kasauli for anti-rabic treatment under the conditions noted below :—

(*a*) An indigent person not in the public service (together with one attendant when such indigent person is a woman or is a child under 16 years of age, or is a man who, by reason of age or other sufficient cause, is incapable of travelling alone), will be granted 3rd class tickets free of charge;

(*b*) Tickets for the return journey will be issued on production of a certificate signed by the authorities of the Pasteur Institute;

(*c*) Only one attendant as above will ordinarily be allowed with each patient or each party of patients of the same family; and

(*d*) The requisition for tickets must have the impression of the official seal of the office from which issued; it must be signed by one of the authorities, namely, commissioned medical officers, civil surgeons, military and civil assistant surgeons, and civil apothecaries in independent charge of hospitals, and, when there is no medical officer present at the station, by collectors or commissioners, divisional officers, tahsildars, taluqdars, deputy tahsildars in independent charge, officers of the police department of and above the rank of deputy superintendents, sub-registrars and sub-assistants of survey. in the absence of a gazetted officer the highest civil authority in the place is empowered to issue the requisition.

7. The Government of India have granted both to Government servants and to such indigent persons as are unconnected with the public service and are not assisted by private employers, etc., special concessions to enable them, when bitten by a rabid animal, to proceed without delay to the Pasteur Institute at Kasauli for treatment.

# APPENDIX G.

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