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HYGIENE:

A MANUAL

OF

PERSONAL AND PUBLIC HEALTH,

BY

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PREFACE.

THIS work has been chiefly written from my notes of lectures delivered at Exeter Hall, to the students studying for the Examination in Hygiene of the Science Department in the Advanced Stage; and it is primarily intended for the use of my own class in that subject. As, however, it covers the entire syllabus for the Elementary and Advanced Stages of Hygiene, issued by the Science Department of the Committee of Council on Education, it is hoped that it will prove useful to science teachers, as well as to all elementary and advanced students of Hygiene.

The Laws of Health are of importance to the general public, as well as to medical men and other students of this subject. Instances frequently come under my own observation in which severe and even fatal disease has arisen from ignorance and consequent neglect of the laws, which it is the aim of this book to expound and illustrate in as simple and popular a manner as the nature of the subject will allow.

My best thanks are due to my friend, Dr. F. R. Walters, who has assisted me greatly, and made most valuable suggestions in the progress of the book.

I am also indebted to Mr. Pilley, F.C.S., for the use of several illustrations from his book on the same subject; and to Messrs. Farwig, Hayward, Maignen, J. Stiff and Sons, Twyford, and Watts, for the use of illustrations.

ARTHUR NEWSHOLME.

39, HIGH STREET, CLAPHAM, S.W.,
April 24th, 1884.

The following works may be consulted by those wishing to obtain fuller information on various points:—

Parkes' Practical Hygiene	J. and A. Churchill.
Wilson's Handbook of Hygiene	J. and A. Churchill.
Galton's Healthy Dwellings	Clarendon Press.
Healthy Houses: by Various Writers	Cassell and Company.
The Book of Health: by Various Writers	Cassell and Company.
Chambers' Manual of Diet in Health and Disease	Smith, Elder, and Co.
Pavy's Food and Dietetics	J. and A. Churchill.
A Manual of Public Health: edited by E. Hart	Smith, Elder, and Co.
Corfield's Digest of Facts Relating to the Treatment of Sewage.	Macmillan
Turner's Hints to Househunters and Householders	B T. Batsford.
Husband's Digest of the Sanitary Laws of England and Scotland	E. and S. Livingstone.
Various Articles in Encyclopedia Britannica.	

CONTENTS.

PAGE

CHAPTER I.—INTRODUCTORY - - - - - - - - - - - - - 7
The History of some Preventible Diseases.—The Amount of Preventible Disease.—Personal and Public Hygiene.

CHAPTER II.—FOOD - - - - - - - - - - - - - - - - 11
The Objects of Food.—Classification of Foods.—Nitrogenous Foods.—Fats.—Amyloids.—Salts.—Water.

CHAPTER III.—THE VARIETIES OF FOOD - - - - - - - - - - - 19
Gelatin.—Red and White Meats: Beef, Mutton, Veal, Pork, Birds, Fish.—Eggs.—Milk and its Products.—Animal Fats.—Butter.—Cereals.—Wheat, Oatmeal, Barley, Maize, Rye, Rice.—Legumens.—Potatoes, and other Vegetables.—Fruits.—Starches: Sago, Tapioca, Arrowroot.—Sugars.

CHAPTER IV.—DISEASES ARISING IN CONNECTION WITH FOOD - - - - 34
Meat from Animals Dying a Natural Death.—Measly Meat.—Trichinosis.—Tuberculous Meat.—Putrid Meat.—Tinned Meats.—Disease from Fish.—Dangers of Unboiled Milk.—Pellagra.—Ergotism.—Starvation.—Scurvy.—Rickets.—Gout.

CHAPTER V.—DIET - - - - - - - - - - - - - - - - - 41
Influence of Diet on Animals.—Circumstances Modifying Diet.—Times for Meals.—Vegetable and Animal Foods.—General Rules as to Diet.—Determination of Diet.—The Naturalist's Theory.—Theory of Income and Outcome.—Examination of Dietaries.—Calculation of Diet.

CHAPTER VI.—THE PREPARATION AND PRESERVATION OF FOOD - - - 48
Objects of Cooking.—Methods of Cooking: Roasting, Boiling, etc.—Cooking of Mixed Dishes.—Cooking of Vegetables.—Bread.—Potatoes.—Kitchen Utensils.—Cooking Ranges.—The Preservation of Food.

CHAPTER VII.—CONDIMENTS AND BEVERAGES - - - - - - - - - 60
Use of Condiments.—Condiments Proper.—Spices.—Flavouring Agents.—Acids.—Aërated Waters.—Mineral Waters.—Tea: Constituents, Mode of Preparation, and Effects.—Coffee: Constituents, Mode of Preparation, and Effects.—Cocoa: its Varieties and Preparation.—Minor Stimulants.

CHAPTER VIII.—FERMENTED DRINKS - - - - - - - - - - - 77
Properties of Alcohol.—Effects Produced by Moderate Quantities of Alcohol.—Effects of Immoderate Quantities.—Circumstances Modifying the Action of Alcohol.—Is Alcohol Advisable as an Article of Diet?—The Varieties of Fermented Drinks.

CHAPTER IX.—WATER - - - - - - - - - - - - - - - - 90
The Uses of Water.—The Quantity of Water Required.—Sources of Water Supply.—Rain-water, Upland Surface, Spring, Well, and River Waters.—Their Relative Merits.

CHAPTER X.—THE STORAGE AND DELIVERY OF WATER - - - - - - 101
Relation of Water-supply to Rainfall and Character of Soil.—Construction of Reservoirs and Conduits.—Cisterns.—Intermittent and Constant Systems of Supply.

CHAPTER XI.—IMPURITIES OF WATER - - - - - - - - - - - 108
Properties of Pure Water.—Gaseous Impurities.—Mineral Impurities.—Hardness of Water.—Organic Impurities of Water.—Danger of Impurity not in Proportion to its Amount.

CHAPTER XII.—ORIGIN AND EFFECTS OF THE IMPURITIES OF WATER - 122
Origin of the Impurities of Water.—Effects of Mineral Impurities.—Effects of Organic Impurities.—Typhoid Fever and Cholera in Relation to Water.—Effects of an Insufficient Supply of Water.

CHAPTER XIII.—THE PURIFICATION OF WATER - - - - - - - - - 130
Distillation.—Boiling—Chemical Measures.—Filtration on a Large Scale.—Domestic Filtration.—The Varieties of Filters.

CHAPTER XIV.—COMPOSITION AND PROPERTIES OF AIR - - - - - - 140
The Constituents of Air.—Nitrogen, Oxygen, Ozone, Ammonia, Carbonic Acid.—The Changes in Air Produced by Respiration.

CHAPTER XV.—SUSPENDED IMPURITIES OF AIR - - - - - - - - - 147
Nature of Suspended Impurities, Organic and Inorganic.—The Impurities Inhaled in Various Occupations.—Hay Asthma.—Contagious and Septic Diseases.

Aylesbury Dairy Co's Analyses

Cheeses

	water	fat	casein	lactose	sucrose	ash
Stilton	32.07	34.55	26.21	3.32	—	3.85
Cheddar	34.42	32.37	27.37	2.20	—	3.64
Emmenthal	33.61	29.47	32.42	—	—	4.78
Danish Skim Cheese	45.99	13.41	30.07	5.10	—	3.63
Swedish Whey Cheese	23.66	16.91	8.90	47.75	—	4.78

Milk

Anglo-Swiss Condensed	25.02	9.39	11.03	11.21	41.32	2.03
Goats	87.33	3.94	3.52	4.39	—	~~2.36~~
Ewes	81.31	6.83	6.31	4.73	—	0.82
Mares	91.	1.18	2.08	5.31	—	0.82
Asses	89.64	1.64	2.22	5.99	—	0.43
Human	87.02	3.94	2.36	6.23	—	0.57
Cow's	87.42	3.65	3.41	4.87	—	0.45
Cream	61.67	33.43	2.62	1.56	—	0.71
Skimmed Milk from Setting	90.10	0.70	3.51	4.96	—	0.72
Do. fr. Separator	90.55	0.20	3.53	4.98	—	0.73
Buttermilk	90.28	0.40	3.70	4.95	—	0.74
Whey	93.21	0.35	0.85	5.03	—	0.67
						0.56

Just as ash in one place in this col.

Sir W. Jenner used to begin his lectures on medicine with the dictum that "the first duty of the physician is to prevent disease."

HYGIENE.

CHAPTER I.

INTRODUCTORY.

The History of some Preventible Diseases.—The Amount of Preventible Disease.—Personal and Public Hygiene.

In classical mythology, Æsculapius was worshipped as the god of Medicine, while his daughter Hygieia had homage done to her as the sweet and smiling goddess of Health. The temples of these two deities were always placed in close contiguity; and statues representing Hygieia were often placed in the temple of Æsculapius. In these statues she is represented as a beautiful maid, holding in her hand a bowl, from which a serpent is drinking—the serpent typifying the art of medicine, then merely an art, now establishing its right more and more to the dignity of a science.

That considerable attention was paid in very early times to matters relating to health, is also shewn by the elaborate directions contained in the Mosaic law as to extreme care in the choice of wholesome foods and drinks, in isolation of the sick, and attention to personal and public cleanliness. It is not surprising to find as a consequence of this, that the Jews, throughout the whole of their history, have been remarkably free from epidemic diseases, and that the average duration of their lives has been considerably greater than that of other races.

In this country great ignorance of the laws of Health has until recent years prevailed, and consequently preventible diseases have been rampant, and have claimed innumerable victims. Each century has been marked by great epidemics, which have swept through the country, scattering disease and death in their course. In the fourteenth century, for instance, there was the Black Death, a disease so fatal that it left scarcely one-fourth part of the people alive; while Europe altogether is supposed to have lost about 40

millions of its inhabitants, and China alone 13 millions. A century and a half later came the Sweating Sickness (though there were a score of minor epidemics in between.) This was carried by Henry the Seventh's army throughout the country, and so great was the mortality, that "if half the population in any town escaped, it was thought great favour." Considerable light is thrown on the rapid spread of this disease after its importation, when we remember, that there were no means of ventilation in the houses; that the floors were covered with rushes which were constantly put on fresh without removing the old, thus concealing a mass of filth and exhaling a noisome vapour; while clothing was immoderately warm and seldom changed; baths were very seldom indulged in, and soap hardly used.

In the sixteenth and seventeenth centuries there were five or six epidemics of The Plague, and it was only eradicated from London, when all the houses from Temple Bar to the Tower were burned down in the Great Fire of September 2nd, 1666, which destroyed the unsanitary houses, and necessitated the building of new and larger ones.

Scurvy, jail-fever, and small-pox, are other diseases which were formerly frightfully prevalent. Jail-fever, the same disease as the modern typhus-fever, has now become practically extinct in its former habitat, owing largely to the noble work of John Howard, "whose life was finally brought to an end by the fever, against the ravages of which his life had been expended." This disease was fostered by over crowding, ill ventilation, and filth.

Scurvy formerly produced a very great mortality, especially among sea-faring men. In Admiral Anson's fleet in 1742, out of 961 men, 626 died in nine months, or nearly two out of every three, and this was no solitary case. Captain Cook, on the other hand, conducted an expedition round the world, consisting of 118 men, and although absent over three years, only lost one life. He was practically the first to demonstrate the potency of fresh vegetables in preventing scurvy.

In Prev. Med are we not fighting against the great Law the survival of fittest? Weakly cradled & bec progenitors of like kind. Is the life thus protracted worth living?

May take ground of physical & say life is a sacred thing. "His not to reason why"

Also monetary value of lives saved & sickness prevented & longer lives of children.

Teetotaler. Educationist Religionist all assert that their particular views will lead to cleanliness health Morality. Sanitarian holds that pure air food & exercise will make man in such state as not to crave stimulants, as to open his mind to influences of education & religion.

Civil registn: 1st estabd in 37. Ditto rate pract & stat. f. '38–70. Extr range was f. 24·7 & 25.1 in '47 & '49 (when epidcs of Influenza & Chol.) to 20.5 in '56. In 10 yrs '61–70 was 22.5. In '72 P.H. Act bec. law. Mean d.r. of yrs '71–75 fell to 22.0, & in '76–80 to 20.8. In '81 was 18.9 & in '82 was 19.6.

Army d.r. 9.8 per 1000, agst 22.2, 17.6, 14.0, & 11.8 respectly in 4 prevs yrs. Was 7.5 at home & 12.1 p 1000 abroad.
Navy d.r. f-dis: 4.05 + fr vil: 1.85.

The facts respecting small-pox hardly require to be given in great detail. But few now living, however, have any adequate conception of the enormous amount of suffering and death it occasioned before the introduction of vaccination. In the Danish dominions, for instance, from 1762-92, 9,728 died from small-pox. About the year 1802 vaccination was first introduced, and soon was generally though not universally adopted, with the result that only 58 died of small-pox between 1802 and 1810; that is, 7 per annum as against 320. At the last date, vaccination was made compulsory by command of the king, and the inoculation of small-pox prohibited, with the result that, from 1810-19 not a single case of small-pox occurred.

It is cause for congratulation that so much has already been done in the prevention of disease; as may be inferred from the fact that, while the yearly mortality in London 200 years ago was 80 per 1,000, it is now only 23, and that, while 30 years ago the mortality among English troops on home service was 20 per 1,000, it is now less than half that number.

The reason why more progress has not been made in the prevention of disease is not far to seek. In order to prevent a disease it is necessary to remove its causes. The causes of disease can only be ascertained by a careful investigation of its phenomena; and it is only within the last century that these have been studied to any large extent scientifically. The consequence of such knowledge of morbid processes is not only seen in improved measures of treatment, but in the formulation of rules for preventing their onset. Thus, not only is the number of diseases which are *curable* becoming gradually augmented, but the number *preventible* is even more rapidly on the increase.

Inasmuch as the preservation of health involves the prevention of disease, Hygiene, the science of health, is sometimes called *Preventive Medicine.* That much still remains to be done is evident on every hand, and is very clearly stated in the calculations of Dr. de Chaumont. He shows that, while the present

mortality in this country is annually 22 per 1,000, or about 1 in 45, and in certain places and at certain times of the year 40 per 1,000, by the application of the laws of health it might at once be reduced to 15 per 1,000, and in time to a still smaller number. This implies that at least one-third of the deaths, and a proportionate amount of the sickness, in this country are due to preventible causes. Reckoning the population of Great Britain as 34 millions, it follows that the deaths are three-quarters of a million per year, of which a quarter of a million might have been prevented.

Allowing 20 cases of sickness to every case of death, it follows that nearly half the population is ill at least once a year; but it is probable that many more than 20 are ill for every one who dies. If we allow 30 to 1 as the proportion, then two-thirds of the population, or 22½ millions people, are ill every year. Now, if a third of the cases of illness, like those of death, are preventible, one may possibly obtain from these data some idea of the suffering, loss of time and money, and many other troubles and inconveniences which result from illnesses that need never have occurred.

It has been estimated, by a very low calculation, that at least £20,000,000 are lost every year in consequence of these diseases, which the science of Hygiene teaches us how to avoid.

Typhoid fever alone kills 20,000 people every year in this country; as only about 15 per cent. of those attacked die, there must be at least 134,000 cases every year, and it is probable that the number is considerably greater.

Diphtheria, again, kills 4,000 per annum, and diarrhœa 20,000. Typhoid fever and diphtheria need never occur, and will doubtless be stamped out when our sanitary arrangements become perfect; while diarrhœa is generally due to preventible conditions.

Impure air, impure water, dampness of the atmosphere or soil, ill-adapted clothing, food deficient or excessive in quantity or bad in quality, uncleanliness, and many other conditions, are important causes of disease, and will have to be studied in detail.

The highest ratio of sick? & met? accomp? a v. fav? d. r. (Neison)
3 yrs sick? to 1 a. 8th among male memb?s of Friendly Soc? (")
W. Edmunds recd? 1 yrs of sick? to 1 a. 8th

Aver? annl? sick? among members of Friendly Soc? is 1½ wks (Sutton) This includes cases of members of all ages, many cases of chronic sick? & old age
Including the normal work? time of life 15–65 yrs, & that aver? annl? sick? 1.3 14 wk, in fem? v. slightly greater These not picked lives, but — just? compar? frugal.
In the Army aver? no of days' sick? per ann. is abt 17.
In Navy for last 5 yrs on home stat?s has aver? nearly 16 ds.

Food any substce, wh. when introd into the living org can minister to the mainte of its struct & actio (B. 400)

The knowledge of the causes of disease is half the battle; when once a disease is traced to its source, as a rule, the agency which produces it can be avoided. Unfortunately, in some cases, men cannot afford to give up an unhealthy occupation, and are obliged to work in ill-ventilated warehouses, and in other ways to contravene the laws of health. We shall find, however, that in most cases by personal care evil results may be prevented, or, at all events, materially diminished.

The subject of Hygiene naturally divides itself into two parts—the health of the individual, and that of the community, or—*Personal* and *Public Hygiene.*

The former treats of the influence of habits, cleanliness, exercise, clothing, and food on health; while the latter is concerned with the interests of the community at large, as affected by a pure supply of air and water, the removal of all excreta, the condition of the soil, etc. It is obvious, however, that these two divisions are not mutually exclusive. What is important to the health of the community, is equally so to each individual member of it. The purity of air and water, for instance, is of immense importance both personally and collectively.

It will be convenient to study first the three main factors in relation to health—food, water, and air—subsequently considering other matters of importance to health, as detailed in the table of contents.

CHAPTER II.

FOOD.

The Objects of Food.—Classification of Foods.—Nitrogenous Foods.—Fats.—Amyloids.—Salts.—Water.

Physiological Considerations.—All substances are foods which, after undergoing preparatory changes in the digestive organs (rendering them capable of absorption into the circulation,) serve to renew the organs of the body, and maintain their functions. Foods may either be *tissue producers* or *force producers*, the first

class renewing the composition of the organs of the body, and the second class supplying the combustible material, the oxidation of which is the source of the forces manifested in the body. The two main manifestations of force in the body are heat and mechanical motion, and these two forms of force are to a large extent interchangeable.

All foods come under one of these heads: they are either tissue or force producers. They may be both, and in many cases are so. Thus, all nitrogenous foods (as meat, legumens, etc.) help to form the nitrogenous tissues of the body, or, if they be in excess, become split up into fats and urea, and so form a source of heat to the body. Similarly fats may, after assimilation, enter into the composition of the various tissues containing fat (of which the brain is the most important), or they may supply an immediate source of heat. There is good reason for thinking that saccharine and starchy foods may also lead to the formation of fat, as well as constitute an immediate source of heat. In this way, nearly all foods may be either tissue or force producers, as the system requires. Commonly they are first worked up into the tissues of the body, and then serve as sources of heat and force.

There are certain foods which do not directly serve as tissue or heat producers, but which are useful in aiding the assimilation of food. Such are the various condiments which may be classed as adjuncts to food. Salt is so necessary to the assimilation of food and to the composition of the various tissues, that it may be ranked as an important food. Water, again, though already oxidised, and so not an immediate source of force, is absolutely necessary to the assimilation of food, to the interchange between the various tissues and the blood, and to the elimination of effete products.

Classification of Foods.—Inasmuch as milk supplies all the food necessary for health and growth during the first year of life, we may expect it will afford us some guidance as to the necessary constituents of a diet for the adult, although, the conditions of life being altered in the latter, we can hardly expect

Prout classif.d Foods as 1. aq.s 2. saccha.e 3. oleagin.s
4. albuminous.

This defect.e as salts omit.d Also 2 & 3 are physiol.y rel.d

Liebig grouped as 1). plastic elem.ts of nutrition
2). elem.ts of respir.n – or more purely
calorifac.t principles.

Prout's classifn he found.d on the deduct.n that milk cont.d all the necess aliment.s in the best form.

"Accessory foods" called by Germans Genussmittel a means of enjoy.t, as contrast.d with true foods, Nahrungsmittel, a means of nourishm.t

(see also p IV)

Freq. table given by MM. Vernois & Becquerel-

	Sp. gr.	H_2O	Solids	Sugar	Casein & extractives	Butter	Salts
Woman	1032.67	889.08	110.92	43.64	39.24	26.66	1.38
Cow	1033.38	864.06	135.94	38.03	55.15	36.14	6.64
Ass	1034.57	890.12	107.88	50.46	35.65	18.53	5.24
Goat	1033.53	844.90	153.10	36.91	55.14	56.87	6.18

Milk of ass nearest like human milk & much more dige. than cow's milk. goat's milk chem. is very like cow's, but pract. is more dige. & a little richer but no diff. in appear. or taste.
Asses milk more valu for delic. infants: goat's for strong ones.
Gt advant. of goat's milk is the ability to consume fresh & genuines.
Hard if any anim. will thrive upon so many diff. kinds of food as goat.
Scotch goats much inf. to Irish as milkers tho handsomer: but an Engl. goat of good stock surpasses both. Ann. of milk p. 1 to even 4 of Indian

All nitrog. aliments remarkably uniform in compos. cont. betw. 15.4 % & 16.5 % N. (Parkes) compare foods a next page. Late researches on energy of food do not impeach the propos. that presence of N. in an organ. struct. fits participation in the act. going on is the necess. cond. of any chem. change a manifest. of force.

Vietta gives for Cow's milk Water 87.5 to 87 %
Fat (butter) 3.5 - 3.8
Proteids 3.7 - 3.8
Lactose 4.6 - 4.8
Ash .7 - .8

the same proportions of the different materials to hold good. It cannot ~~hardly~~ be expected that the same proportions should hold good, as in the infant rapid growth and building up of new tissues and organs is going on, involving a larger proportional amount of nitrogenous food than in the adult.

The following is the composition of 100 parts of

	HUMAN MILK.	COW'S MILK.
Casein	3·92	4·83 Sn / 9·0
Albumin	—	·58
Fat	2·66	~~4·30~~ 3.5
Sugar	4·36	4·03
Salts	·14	~~·55~~ .76 to .72
Total Solids	11·08	~~14·29~~ 12.5
Water	88·92	~~85·71~~ 87.5

It is evident, from this analysis of milk, that our food must contain (at least) representatives of all the above divisions, and this is found to be actually the case. We have, therefore :—

1. **Nitrogenous Foods.**
2. **Hydrocarbons or Fats.**
3. **Carbohydrates or Amyloids.**
4. **Salts.**
5. **Water.**

Condiments and stimulants (tea, coffee, alcohol) are not foods in the strict sense of the word, and will be discussed in a later chapter.

Nitrogenous Foods include albumin, casein, gluten, legumen, fibrin, and gelatin. They all agree in consisting of a complex molecule containing many atoms of carbon, hydrogen, oxygen, and nitrogen, with the addition of smaller quantities of sulphur, and in some cases phosphorus. The nitrogenous substances used as food may be divided into *two* groups, one containing gelatin or

glutin, and the other numerous bodies which receive the common name of proteids or albuminoids.

The per-centage composition of gelatin is :—

CARBON.	HYDROGEN.	NITROGEN.	OXYGEN.
50·0	6·6	18·3	25·1

The per-centage composition of all proteids lies within the following limits :—

CARBON.	HYDROGEN.	NITROGEN.	OXYGEN.	SULPHUR.
52·7 to 54·5	6·9 to 7·3	15·4 to 16·5	20·9 to 23·5	0·8 to 1·6

Proteids also contain a small amount of phosphorus, chiefly as phosphate of lime, but also in minute quantity in their essential structure. The chief proteids used as foods are :—1. *Serum-albumin*, forming a large part of the blood and all the tissues of animals. 2. *Egg-albumin*, which differs from the last in being precipitable by ether. 3. *Plant-albumin*. 4. *Myosin*, the chief constituent of muscle. 5. *Casein*, which contains less sulphur than albumin, and no phosphorus. This deficiency of phosphorus is compensated for by the fact that a considerable amount of phosphates is carried down with casein from the whey of milk, when cheese is being made. The most striking characteristic of casein is its property of being coagulated by gastric juice before digestion occurs. 6. *Legumin*, or plant-casein, contained in the seeds of leguminous plants. 7. *Fibrin*, the filamentous part of a blood clot. 8. *Plant-fibrin*, an insoluble substance, occurring especially in the seeds of cereal grasses. A tenacious mass of *gluten* is obtained from wheat-flour by washing away the starch granules and soluble albumin by water. By boiling the gluten with dilute alcohol, the vegetable gelatin or glutin is removed, and after the fats are

Hypothetical formula of albuminoid (Graham)

$$C_{72} H_{112} N_{18} S O_{22}$$

If we take formula of starch as $C_{72} H_{120} O_{60}$ may see some indefinite connection. Probable that starch is only an allotropic form of albumin?

Drijardin-Beaumetz (Geo. p. 8) gives following formula:

$$C_{32} H_{17} N_5 O_4 = 2 (\underset{\text{cellulose}}{C_6 H_{10} O_5}) + 3 NH_3 - 6 H_2O.$$

Gautier has advanced the theory that albumins are built up on the CN. compounds as a sort of chemical framework, & that in the body these toxic compounds are eliminated in form of leucomaines.

Pettenkofer & Voit's experiments shew that nitrogenous substances compose tissues of body determine the absorption of O. When to a diet of meat caused a certain absorption of O, fat or sugar is added, absorption of O is diminished (Ranke) Absorption of O does not determine the changes in tissue but vice versâ, so with participation of nitrogenous bodies, nor tissue nor mass manifestation of Energy possible.

Acc. to Forlei skeletal Mn. form nearly ½ the body.

Voit has pointed out that albumin in body in two forms — (1) organic albumin and (2) circulating albumin — former relatively stable, latter undergoes rapid changes. Acc. to Voit 70 % of latter used up in 24 hrs, only 1 % of former.

Rel^n by decomp^n to carbohyd^s (lactose) – main source of muscular energy is the non-nitrog^s subst^s – no experiment to prove whether fat or sugar. If cd be extr^d that carbohyd^s form fat (vide pigs bees & geese) then need hold no distinct^n betw^n the two classes. Fat in milk now proved to be from prot^s in mammal gld – If this the case man cd live on a fat-free diet, & carbohyd^s cd practically replace fat.

Pavy states – "looked at in relⁿ to the performⁿ of work & taking as Joule's estimⁿ of the mechl equivt of heat as the basis of calculⁿ the capacities of these articles will stand thus –

1 grain beef-fat yields by oxidⁿ	27.778 foot pounds	
" starch (arrowroot) " "	11.983	"
" lean meat " "	14.803	"

Fatⁿ. Degenⁿ in P. poisⁿ. Voit & Bauer starved dog until all fat completely disappd & then poisd w. P. Fatⁿ degⁿ & all org. fd prsn. Fat cd not have come f. food & cd not have come f. abondt subcut^s fat, as this had gone. Must have been formed in situ f. the albumⁿ. constit. of org. themselves This due to nucl tissue change or dimd oxidⁿ albumⁿ. constit splits up normally into some nitrogs constit & fat, wh. then undergo further oxidⁿ. If too rapid metabolism then either fat accumⁿ or nitrog^s products imperfectly oxidd (as in fever or gouty glycosuria). If dimd O received than simⁿ result. In P. poisⁿ. with these observⁿ s fr measd of rise of, & CO_2 elimⁿ dimd.

Fatⁿ accumⁿ f. deficit oxidⁿ somet. in women f. severe floodⁿ.

Fatⁿ degenⁿ f. deficit oxidⁿ. seen in wⁿ of a paral^d limb (want of arterl supply) Same in heart f. ossifⁿ coronary arteries.

D. Mantell's story of pig wh. buried by fall of a chalk-cliff at Dover Castle in a stye for 160 days when lecture. alive at end of time weighed 160 lbs to begin with – red. in linear transⁿ. Moisture in chalk helpd to keep pig alive

extracted by ether, fibrin is left. Gluten must not be confounded with glutin (gelatin.) Gluten is a mixture of fibrin and glutin or gelatin. 9. *Peptones* are formed from any of the proteids by the action of the gastric and pancreatic juices. They differ from the other proteids, in not being coagulated by heat, and in being diffusible through animal membranes; hence they easily obtain entrance into the circulation.

By nitrogenous foods (and especially proteids), the fundamental tissues of the body are constructed and repaired. Some heat is also produced by their oxidation, and this oxidation may occur (1) as part of the constant molecular changes and renewal going on in the tissues, or (2) from direct oxidation of nitrogenous food. It is found that when nitrogenous food is given alone to dogs, all the oxidation processes are greatly increased, and there can be no doubt that in all cases nitrogenous food determines, to a large extent, the oxidation of non-nitrogenous food, and so is favourable to all vital action.

Hydrocarbons, or fats, consist of the three elements, carbon, hydrogen, and oxygen, the amount of oxygen present not being sufficient to oxidise completely either the hydrogen or the carbon. Thus the molecule of stearin, which may be taken as a typical fat, has the formula $C_3H_5(C_{18}H_{35}O_2)_3$.

In respect to their comparatively unoxidised condition fats compare favourably with starch and sugar, $C_6H_{10}O_5$ and $C_6H_{12}O_6$ respectively. It is evident that in starch the $H_{10}O_5 = 5H_2O$, and that in sugar $H_{12}O_6 = 6H_2O$, so that in both cases only carbon remains uncombined with oxygen. In accordance with these facts, it is found that dried fats produce by their oxidation $2\frac{1}{2}$ times as much heat as a corresponding amount of sugar or starch, and are, therefore, capable of producing a correspondingly greater amount of energy.

The fat obtained from food is not simply deposited in the body as such, to form a store of combustible matter, and to fill up the interstices between the different tissues. If this were so, we

Starch cont. 45 o/o Carbon and 6 o/o hydrogen.
Sugar " 43 " " " 6 " "
Fat " 79 " " " 11 " "

Fats in healthy man in act 1/13 of his wt

should have the kind of fat deposited varying with the food, which is not usually the case. The fat of the body is probably not formed directly from food, but as the result of the oxidation of nitrogenous tissues and foods when this oxidation is incomplete. In the formation of milk this can be distinctly proved: the fat-cells are formed from the protoplasm of the cells of the mammary gland; and as a matter of experience it is found that the quantity of fat in milk is largely and directly increased by albuminoid food, but is actually diminished by fatty food. This is partly owing to the fact that albuminoids increase oxidation-changes in the body.

In the "ripening" of a cheese there is a similar conversion of proteids into fat.

It is probable that amylaceous food may be a source of fat, as well as nitrogenous and fatty food. This is shown by the well-known case of the Strasburg goose, which is kept penned up in a warm room, and fed entirely on barley-meal, in order to produce an enormous fatty liver for the delicacy termed *pâté de foie gras.* It is shown still better by some experiments of Milne Edwards. He took some bees, weighed them, and then imprisoned them in a glass case, and fed them entirely on sugar. The bees formed their combs, composed of wax (which is a sort of fat), but they did not lose any weight, although the sugar did, and in proportion to the amount of wax produced.

Fats and amyloids, unlike proteids, do not excite oxidation-changes in the system, and so, if in excess of the requirements of the system, can be stored up with comparative ease. Quiet and warmth diminishing oxidation, conduce to the accumulation of fat in animals being fed for the market; and the same applies to human beings.

Carbohydrates or amyloids include the various starchy and saccharine foods. They are inferior to fats in nutritive power, but, being very digestible, are in much greater favour. In the process of digestion, starch is converted into grape sugar, and starch and sugar are practically equal in nutritive power. We

Subbotin fd that when dog kept with food till all fat disapp fr. body, & then fed on palm oil (cont palmitin & olein but no stearin), it yet laid on stearin fat; but stearin in somewhat less than half the normal quantity. When palmitin & stearin given to starv. dog, but no olein, it laid on fat cont even more than the normal qty of olein but less stearin (Brunton quotes)

J. Munk (Virchow's Archiv. Band XCV p 409) found that dog fed on rapeseed oil formed a pancreatic adipose, fed at the temp of room; while fed on mutton suet, the pancr. adip. consisted of hard whitefat, which consisted of 3 pts melting to 1 part liq fat.

This is now contradicted. The apparent increase of fat is probably owing to evap. lessening the p.c. of H2O. The conversion of albumen into fat seems confined to living protoplasm. But Lawes & Gilbert fd fattening pigs that 4 or 5 times as much fat was produced as was cont in their food. Negroes grow fat during time the sugar-canes are ripe & they are const. sucking the juice. Lawes & Gilbert fed 2 pigs on Indian corn & barley meal & fd as much as 40 pc of fat produced must have come fr. metab. proteid. Food rich in carbohyd. is excel. for fattening purposes. & diet rich in carbohyd. is excel. for fattening purposes. In plants & nutritive seed the fat or oil as the seed ripens is accompanied & parallel by increase of starch. In Canary the endosperm is washed away with the fat & starch. In Zebu a Brahmin bull of India, in yak of Tartary, in buffalo, & in camel large lumps of fat on back. Camel's hump varies w. nutrition - a reservoir of food. Same w. subcut. fat in man.

Blood cont. only ½ pc fat, muscles over 3 pc, brain 8 pc, nerves 22 pc. But last suffer last in starvation, just as bec. fed by fat absorbed from subcutaneous tissues.

In dog wh. had fasted 4 days, a diet of lean raised the proportion of fat in blood from 2.6 in 1000 to 3.1; meat raised it to 3.8; meal starch to 4.1

Lawes & Gilbert's interesting experiments on the same subject

Messrs Lawes & Gilbert – averd composn of grain of cereals.

	Old Wheat	Barley	Oats	Rye	Maize	Rice
Water	11.1	12.0	14.2	14.3	11.5	10.8
Starch	62.3	52.7	56.1	54.9	54.8	78.8
Fat	1.2	2.6	4.6	2.0	4.7	0.1
Cellulose	8.3	11.5	1.0	6.4	14.9	0.2
Gum & Sugar	3.8	4.2	5.7	11.3	2.9	1.6
Albuminoids	10.9	13.2	16.0	8.8	8.9	7.2
Ash	1.6	2.8	2.2	1.8	1.6	0.9
Loss &c	0.8	1.0	0.2	0.5	0.7	0.4
Total	100	100	100	100	100	100.

Composn of Wheat Grain Ash

	Lawes & Gilbert	Way & Ogston
H_3PO_4	49.68	45.01
Fe Phosphate	2.36	0.82
Potash	29.35	31.44
Soda	1.12	2.75
Magnesia	10.70	12.36
Lime	3.40	3.52
H_2SO_4	—	0.34
CO_2	—	0.02
Cl	0.13	0.13
Silica &c	2.47	3.67

Saccharin (Benzoyl sulphonic imide) $C_6H_4 \begin{matrix} CO \\ SO_2 \end{matrix} > NH$

a whiteamorphous powder – sweet: power 250-300 times that of sugar.
Passes thro' human system unchanged: innocuous even when given up to 7½ grains daily. Is insol in H_2O. Is not fermentible & powerful antiseptic: "the most remarkable of all the coal-tar industries" (Roscoe)
½ to 1½ gr. Quite sufficient to sweeten a cup of tea or coffee.

have already named the ~~probable~~ production of fat from amyloids in the system. According to some, this does not occur, but the amyloid acts as an easily combustible matter, saving the reserve fat in the tissues.

Even when amyloids are entirely absent from the food, they may be produced in the organism by the breaking up of nitrogenous matter. This certainly happens in diabetes, in which the nitrogenous food rapidly becomes converted into sugar and urea.

The deprivation of amyloid food is much better borne than that of fats, because in the latter the hydrogen is not completely oxidised, and because fats aid the assimilation of other food.

Salts, and especially common salt (chloride of sodium), are essential to health. Liebig has said, that for all purposes of nutrition, a diet free from salt is no better than eating stones. Excess of food is found to be much less injurious when salt is freely taken.

Chloride of sodium is necessary for the production of the acid (hydrochloric) of gastric juice, and of the salts of bile; half the weight of the ash of blood consists of it. An adult requires 150 to 200 grains of salt per day; a large part of this is taken in meat, bread, etc.; and it is advisable that what is added should always be thoroughly incorporated with the food, and not left, in the case of children, to choice. Potassium salts form an important part of milk, muscle juice, and the blood corpuscles. They are obtained from bread and fresh vegetables and fruits. Calcium phosphate (bone earth) is essential for the growth of bones, and is very important for the young. The best source for it is milk; its absence or deficiency is a common cause of rickets.

Liebig's beef extract contains phosphates largely, and so is useful as an addition to soups, and for making gravy for meats like veal, in which phosphates are deficient. Oxide of iron is always present in minute quantities in the ash of blood and muscles, and in minute quantities in milk. Fish and veal are usually deficient in it. It is estimated that there are only 150 grains of iron in a

man weighing 154 pounds; yet this amount is absolutely essential for health, and if deficient, the individual looks pallid, and is weak and unhealthy. After cremation, the iron in the ashes has been stated to be collected and made into a mourning ring.

Water forms an important article of diet. This is evident from the fact that 80 per cent. of the blood consists of it, and 75 per cent. of the solid tissues; and from the fact that the daily loss of water from the system averages 50 ounces ($2\frac{1}{2}$ pints) by the kidneys, 18 ounces by the skin, and 9 ounces by the lungs. Water is not simply received into the system as a liquid. It forms a large proportion of the solid food taken. Thus, $87\frac{1}{2}$ per cent. of milk, 78 per cent. of fish, 72 per cent. of lean meat, 38 per cent. of bread, 13 per cent. of peas, and 92 per cent. of cabbage, consist of water.

Without water the food cannot become dissolved in the alimentary canal, and so gain entrance into the blood. The water thus dissolving the food comes from the blood in the shape of the digestive secretions, and copious drinks during meals only hinder the process. In the blood, water serves to carry nutrient materials to all the tissues; and, at the same time being circulated all over the system, equalises the temperature, favours chemical changes, and lubricates all the tissues. By water again, the effete matters which have been separated by the kidneys are washed out of its tubes.

The **Oxygen** of the air, in a broad sense, forms one of the foods of the system. This will be considered later.

Besides the above classification, foods have also been classified as follows:—

1. *Inorganic food* – oxygen, salts.
2. *Organic foods*
   - Animal
     - Nitrogenous.
     - Non-nitrogenous.
   - Vegetable
     - Nitrogenous.
     - Non-nitrogenous.

Acc. to Brunton 59% of body weight of water.

Rotifer animalcules dried up fly abt as dust appear devoid of life, until again put in water.

Water gt. incr. tissue changes & waste results if excess. Compare to raking out ashes fr. a fire at same time making it burn more brightly.

Prob. $\frac{2}{3}$ as much H_2O elim. by skin as by kid (Brunton).

Acc. to Corfield abt $\frac{2}{3}$ wt of body of water -
Says 50 ozs excr'd daily by kd. 18 ozs by skin & 9 oz. by lungs.

14 lbs of soda cont. 9 lbs of water.

Gelatin not present as such in the tissues.

Is an albumen-sparing food (Yeo) Owg to the large proportion of N. in it, gelat. taken prod. ptn. elimn less than albs. prod. ptn. thirst if gelatins are taken. Schiff has stated that gelatinous foods promote secretion & are therefore peptogenic foods

Or, as—

1. *Solid foods*
   - Animal
     - Nitrogenous.
     - Non-nitrogenous.
   - Vegetable
     - Nitrogenous.
     - Non-nitrogenous.
2. *Liquid foods*
   - Water.
   - Milk and its products.
   - Tea and similar beverages.
   - Alcoholic beverages.
3. *Gaseous foods*—Air.

CHAPTER III.

THE VARIETIES OF FOOD.

Gelatin.—Red and White Meats: Beef, Mutton, Veal, Pork, Birds, Fish.—Eggs.—Milk and its Products.—Animal Fats.—Butter.—Cereals.—Wheat, Oatmeal, Barley, Maize, Rye, Rice.—Legumens.—Potatoes, and other Vegetables.—Fruits.—Starches: Sago, Tapioca, Arrowroot.—Sugars.

NITROGENOUS ANIMAL FOODS.—These are divided into two groups, the one containing gelatin, and the other all the proteid or albuminoid substances, which are taken in the flesh of various animals, and in milk and eggs.

Gelatin is obtainable from bones, and from connective tissue wherever found. Being easily digested and absorbed, it has been very popular as an invalid's food; but the fact that animals cannot sustain life on it without the addition of other nitrogenous food, proves that its value is very limited. Later experiments tend to show, that although gelatin alone is of little value, yet animals fed on it with an insufficient amount of albuminoid food continue to flourish, when with the latter alone they would rapidly lose strength. It is probable, therefore, that in the liquid condition in the blood gelatin is broken up into urea, carbonic acid, and water, thus forming a source of heat to the body, but that it is not built up into the body-tissues. It is useful for invalids, partly because it forms a bulk, and prevents

the evil tendency to give their food in too concentrated a form; partly because it forms a source of easily oxidised material, and so prevents tissue-waste; and partly because it commonly contains phosphate of lime, derived from the bones forming the source of gelatin.

Gelatin as prepared for the table contains a considerable proportion of water; as little as one per cent. of gelatin in water will cause it to gelatinise on cooling. Isinglass obtained from the floating bladder of the sturgeon is an example of the purest kind of gelatin; glue is an inferior sort, made from bones.

For dietetic purposes it is undesirable to have gelatin in a concentrated state, as it is in that condition less easily permeated by the digestive juices. This explains the comparative indigestibility of the stiff jellies sold by pastry-cooks.

The **Flesh** of various animals is one of the main sources of our nitrogenous and fatty food. Meats may be divided into two kinds, viz., **red meat** and **white meat.** These gradually merge into one another. As common examples of red meats, we have beef, mutton, pork, game, wild fowl, and salmon.

The common fowl and turkey, most fishes, rabbits, crustaceans, and molluscs, are examples of white meat. As a rule white meats are more digestible than red, having more delicate fibres, and containing a smaller proportion of nitrogenous matter.

Flesh consists almost entirely of muscular tissue, of which there are two kinds, striped and unstriped.

The striped is the variety most commonly used as food. Unstriped muscle has a softer texture, but is not so easily masticated as striped, and for this reason may be indigestible. *Tripe* is the best kind of unstriped muscle, and if well cooked forms a cheap and easily digested dish.

The influence of feeding on the quality of meat is becoming better appreciated. In ill-fed or old animals, connective tissue is more abundant, and so the meat is tougher. Well-fed and fattened meat contains for equal weights about 40 per cent. more dry animal

glue & starch in ord? sweets - "Neals-jaws"

The old Roman epicures suffocd their fowls in wine & cooked them forthwith - thus before onset of rigor mortis In the W. Indies a tough beefsteak is rendd tender by rubbing it in the juice of a fresh papaw fruit, wh. contn papain a ferment having simr actn to trypsin.

Mr Hayter Govt Statist of Victa says that average annl consumptn of meat in Australia per head is 276 lbs i.e. over ¾ lb per diem. In U States over 120 lbs. In Europe ranges fr. 105 lb fl. to 48 lb. Russia (Lancet Aug 90)

matter than non-fattened meat. Young animals, again, contain more water and fat and a larger proportion of connective tissue than the full-grown, and are consequently not so nourishing.

Meat ought to be eaten either before the onset of *rigor mortis*, or near its end, before putrefaction has commenced. During *rigor mortis* it is denser, and more difficult to digest; and before, it is tougher than after it.

The proportion of fat in meat varies greatly in different individuals of the same species, in different animals, and in different parts of the same animal. The proportion of water diminishes as the fat increases. According to Dr. Ed. Smith, the proportion of fat in fat oxen is $\frac{1}{3}$, in fat sheep $\frac{1}{2}$, in calves $\frac{1}{6}$, lambs $\frac{1}{3}$, and fat pigs $\frac{1}{2}$.

Good meat, whether beef or mutton, ought to have a marbled appearance, a medium colour, neither pale pink nor deep purple; its texture should be firm, and not leave the impress of the finger, its odour slight and pleasant, the juice reddish and acid, the bundles of fibres not coarse, and free from foreign particles imbedded in them; and lastly, it should not be taken from an animal killed near parturition, nor in consequence of any accident or disease.

Beef is, as a rule, more lean than mutton or pork; it has a closer texture, and more nutritive material in a given bulk. It is also fullest of the red-blood juices, and possesses a richer flavour than the two others.

If the nutritive matter from it is required in a liquid condition, little or no heat ought to be applied in the preparation. Liebig's beef extract contains neither albumin nor gelatin; it is not a food, but a valuable stimulant in cases of prostration, and increases the appetite for other foods. Its chief constituents are the various extractives of meat, the most important of which is kreatin ($C_4H_9N_3O_2, H_2O$), and inosit, or muscle sugar ($C_6H_{12}O_6, 2H_2O$), the latter giving to the beef-tea a slight food value equally possessed by a small quantity of cane sugar. One pound of fresh

mutton or beef yields five grains of kreatin; the same weight of fowl yields half as much again.

Mutton is more suitable for people of sedentary occupation than beef. The leg is the best joint, and the shoulder the next best. **Lamb** is more watery than mutton, and less nutritious. Its delicate flavour makes it a favourite, but it is an extravagant form of food.

Veal as ordinarily prepared in this country, is difficult of digestion, its shreddy, juiceless fibres eluding the teeth, and consequently not undergoing proper mastication.

Pork is not so digestible as beef or mutton, partly because of the large proportion of fat, and partly because its fibres are hard and imperfectly masticated. But its digestibility varies greatly with its age, breeding, and proportion of fat.

The **Flesh of Birds** contains very little fat, and that found separate from the meat is rarely nice. Most birds are edible, but fish-eating birds are apt to be nasty. As a rule, the flavour of the male bird is richer than of the female. The chief virtues in poultry are their tenderness, and the large proportion of phosphates they contain. They are deficient in fat and in iron. To compensate for the former, one commonly takes with them melted butter and fat bacon or pork sausages; to compensate for the latter, the addition of Liebig's extract to the gravy is valuable. During the winter months it is difficult to get tender fowls. Young, and consequently tender, birds are known by their large feet and leg-joints. When a bird appears at table with violet-tinged thighs and a thin neck, if possible avoid being helped to the leg. Wild fowls are harder and less digestible than tame. In ducks and geese fat is more abundant, and of a stronger flavour: they are, consequently, not so digestible as fowls.

Fish forms a very important and too much neglected article of diet. It is easily cooked, and usually very digestible; it possesses a larger bulk in proportion to its nutritive quality, and hence is very valuable for those who habitually take an excess of meat

Said Kean select beef when he had to act a murderer, pork for tyrants, & mutton for lovers.

Skim^d milk – wat^d milk freed sold as skim^d : but in skim^d sp. g. is
abt 1036, cream 0 to 1 p c, fat .5 to 1.5. No milk over 2% fat can
be procured for skim^g as some cows naturally give this.
Sour Milk – s.n.f. as rec^d, fat little aff^d ash not aff^d Lactose
rec^d lactic acid.

Flesh of crabs & lobsters is too hard & close packed to be
easily dig^d (Cufeld)
Oysters – Mussels.

"First strip^gs" of cow av^d poor in fat, last rich in it : s.n.f. fairly const^t

Milk a natural Emuls^n globules of fat in a serum of sug^r by
an envelope of condensed serum. Therefore milk should be thoroughly
mixed bef. taking a sample for analysis
Acc^g to Wigner good cream cont^s 50–65% fat butter

Ratio of cream to fat abt 1 to 3, but varies. Milkmen often add
H_2O to milk to make cream rise. Appar^t qty depends on rapid^y w. sh.
(made to rise
Sp. g. should be 1031–34 If above skim^g if below watering.

Tot. solids should be 12.5 s.n.f 9 & fats 3.5.
Somerset Hse allows 8.7 & 2.3 – wh. allows pract^y at least 10% margin for

W^m W. Blyth points out vital defect of Sale of Food & Drugs Act – if he denies accus^s
analysis & sample sent to Somerset House authors – charges & puts refs
the S. H. auth^s have adopted are untenable views, that all milks decomp^e acc. to certain
ratio, & that by chemical addition to the fig^s of the analysis of a decomp^d milk, orig^l analysis
can be built up & a genuine^e sample. W^m Allen of Sheffield adds alcohol to the milk
& W^m W. Blyth recommends L.A. to oppose all references of disput^d milk analyses to
S. H. as latter defend^t will accept opp^g send^r side by side w. his printed sample
an alcoholised sample. (Sm Rec. 7)

H_2O of 1.020 sp. g. to 1.030 sp. g.

food, which is commonly the case with those leading sedentary lives, and in declining years. As most fishes contain a larger proportion of phosphates than other meats, they form a useful brain food. Generally, white-fleshed fish is more digestible than red-fleshed (such as salmon), the latter usually containing more fat than the former. When the fat is distributed throughout the flesh, as in the salmon, fish is more satisfying than when it is mainly stored up in the liver, as in the cod-fish. According to Payen, the proportion of fat in soles is only 0·248, in whiting 0·383, conger eel 5·021, mackerel 5·758, eels 23·861. The addition of some fatty food, as melted butter, is very advisable to such meats as poultry, rabbits, soles, whiting, plaice, haddock, cod, turbot, and other fishes; whereas sprats, eels, herrings, pilchards, salmon, etc., are more or less rich in fat.

A Hen's Egg usually weighs a little under two ounces. It consists of 70 per cent. of water and 30 per cent. of solid matter. The white of the egg is chiefly albumin, the yolk consists of a very digestible oil, rich in phosphoric acid, each particle of the oil being enveloped in a form of albumin called vitellin. The salts are chiefly contained in the shell. There is no sugar in the egg, the necessity for such oxidisable material being obviated by the heat produced by incubation. Eggs, when kept for some time, lose weight, owing to evaporation through the porous shell; similarly, air entering from without sets up decomposition. In a solution of brine containing an ounce of common salt to half a pint of water, fresh eggs sink, stale ones float; rotten eggs may even float in fresh water. Eggs may be preserved by keeping them in brine, or, better still, by smearing them over with lard or butter, so as to render them non-porous.

Milk has a specific gravity of 1028~~·32~~ as estimated by the lactometer, and on allowing it to stand in a long narrow vessel ought to form ten or twelve per cent. of its volume of cream. The per-centage composition of human and cow's milk has already been given. There is great constancy in the amount of solids present in

pure cow's milk, the average being about 12½ per cent.; by stall-feeding this may be increased. Half a pint of milk supplies as much nitrogenous nutriment as two good-sized eggs, and as three and a half ounces of beef. Milk may be deteriorated by (1) skimming, or (2) the addition of water—the first diminishing the proportion of fats, and the second the total amount of solids. It is probable that not ten per cent. of metropolitan milk is absolutely genuine. It is found that rich milks containing a large proportion of fat are lighter than poor milks, and their specific gravity may actually be raised by skimming; it is evident, therefore, that the lactometer alone is not a safe guide in the detection of impoverished milk. Nor is the estimation of the proportion of cream, for cream separates more readily and completely in poor than rich milks. The only complete method of ascertaining the condition of milk is a chemical analysis of the amount and character of its solids.

Condensed Milk is milk deprived of a large part of its water. It represents two to four times its volume of fresh milk. It has one-third its weight of extraneous sugar added to it, and on account of this it tends in children to produce fatness, and a distaste for simple food; also, it is probable that in children fed on it alone, ossification is retarded, and resistance to illness is diminished. The only dietetic advantage it possesses over ordinary cow's milk is its easier digestibility, and this may make it preferable in a few cases.

Cheese is prepared by coagulating milk by "rennet," the mucous membrane of the fourth stomach of the calf, salted and dried before using. By this means the casein is precipitated, carrying down with it the cream, and a large proportion of the salts of milk. The whey, containing the sugar, soluble albumin, and remaining salts, is separated by straining, while the mixed curd and fat are pressed in moulds. Cheese thus consists of casein, fat in varying proportions, water and salts, especially phosphate of lime. It is coloured with annatto, a vegetable colouring matter. When new, cheese is tough; when old, its oils tend to become rancid; the best age is from nine to twenty months. It is probable that cheese

Donné's & Feser's lactoscopes depd on degr. of opacity given to a thin layer of milk fairly accurate – lactic rarely vary much more than .1 p.c. result of actual analysis – But they as well as Marchland's lactobutyrometer have regd only to one of constits of milk.

Fleischmann & others in Germany have been long trying to discover a relationship betwn Sp.gr. & p.c of fat & other solids. They find that given Sp.g. & fat, or given sp.gr. & total solids, other constit may be fd

Fleischmann's formulæ are :–

t = tot. solids p.c.
f = fat p.c.
S = Sp gr ($H_2O = 1$)
Sp.g. is calcd at 15°C = 60°F

(1) $t = f \times 1.173 + 2.71\left(100 - \frac{100}{S}\right)$

(2) $f = t \times .852 - 2.31\left(100 - \frac{100}{S}\right)$

Boracic Acid & Borax largely used by farmers & for preservg milk & prevg the lactic fermn. Doubtful whether it possesses toxic effects.

In prodn condensed milk, boiling is done in vacuo at 150°F
Casein not consold in condensed milk & no germs.

Condensed milk falsifications employed in connn w. a new industry, "milk blending", i.e. letting down rich milk so that it will agree w. the figures passed by Soc of Pub Analysts. Condensed milk important in churning specially for the use of dairymen. Better than skim water milk than this.

Cheese largely made now of other than butter fats. Presence of these detected in same way as for butterine. By age the soluble fatty acids in cheese become Am salts. Valerianate of Am causes the smell of old cheese. Hence insol. fatty acids in fat of cheese higher than in butter.

$KHCO_3$

By add^g $\frac{1}{6} - \frac{1}{4}$ oz to 1 lb of Gloucester cheese, cut^g into thin slices & slowly heat^g, the cheese is completely dissolved. The amt of K add^d repres^{ts} the K gone in the whey. (H. Williams).

Stilton cheese is finest made in Engl^d. – f. cows fed in rich past^s Becs mellower w. age. Port wine pour^d into holes prep^d in it to improve flavour.

Cheddar cheese made in Somersetsh. where rich past^s yields grass wh. gives it a peculr flavour. Dur^g making whey pour^d several times over curd to scald it.

Gruyère cheese f. a mixt^e of goat & cow's milk. Roquefort f. ewe's milk

As a rule the firmer a cheese, the bet^r it keeps.

Amer^n cheeses may belong to any of the classes; gen^y good

Olein & palmitin in both anim. & veg^e kingdoms. Stearin is peculr to animals.

Lard if it splutters when melt^d, water was add^d in prep^n

Lard pres^{ts} adult^d w. mixt^e fat, wh. not ½ value of pure lard.

in small amount helps the digestion of other foods, though itself a highly concentrated and comparatively indigestible food. When toasted it is proverbially indigestible.

There are many different kinds of cheese. The following classification gives the most important varieties :—

(1) Cream cheese is the new curd only slightly pressed, and is more digestible than ordinary cheese.

(2) Next to these are cheeses made with whole milk rich in cream, such as Stilton, Gorgonzola, Cheshire, and Cheddar.

(3) Cheeses made of poor or partially skimmed milk, such as Shropshire, Single Gloucester, and American.

(4) Cheeses made of skimmed milk, such as Suffolk, Parmesan, and Dutch.

Non-Nitrogenous Animal Foods.—These are all fats, and the most important are the various meat fats and butter. They possess a higher food value than amyloids, and are more rapidly transformed in the body. The composition of the various fats differs somewhat; they usually contain varying proportions of olein, palmitin, and stearin, which are compounds of glycerine with the radicle of a fatty acid (stearin = C_3H_5 $(C_{18}H_{35}O_2)_3$). Thus mutton suet consists of stearin, olein, and palmitin, with a preponderance of stearin. Beef suet contains less stearin and more olein than mutton suet. The more olein a fat contains the less solid it is. Olive oil is composed almost entirely of olein. Palmitin, which melts sooner than stearin, is the chief solid constituent of butter, while olein is its chief liquid constituent. In lard, olein is more abundant than stearin and palmitin. Lard is not uncommonly adulterated with suet; this makes it of a darker colour; to hide this, starch is often added, which may be detected by its producing a blue coloration with tincture of iodine. Occasionally, also, milk of lime is added, which hides the colour, and permits the lard to absorb as much as 25 per cent. of water.

Cod-liver oil is perhaps the most digestible animal fat known. The best cod-liver oil is frozen at a low temperature, by which

means the stearin is frozen out, and nearly pure olein is left. Traces of iodine have been found in it, and more commonly a small amount of bile, which probably increases its digestibility.

The temperature at which a fat becomes hard is a fair guide to its digestibility. Thus we know that beef, and still more, mutton fat, would become solid, under conditions in which bacon dripping is still soft. Where digestion is weak, there may be an instinctive loathing of fat meat; this ought not to be encouraged in children, and some other fat should always be substituted. Thus the addition of butter to the potatoes makes up the deficiency.

Butter forms $3\frac{1}{2}$ to $4\frac{1}{2}$ per cent. of cow's milk. It is separated from milk by churning, the oil particles being deprived by this means of their albuminous coats. The more completely the butter-milk is separated the longer the butter keeps. It can be kept longer if salt is added, or in hot weather by keeping it under frequently-changed water. Rancidity indicates the decomposition of traces of the fat of butter into its fatty acid and glycerine.

The odour and flavour of butter are not due to olein and palmitin, the two chief constituents, but to a smaller quantity of butyrin, a fat of a much lower series. Ordinary butter contains a considerable proportion of water, and the presence of about 8 per cent. renders it more palatable; the temptation is to add considerably more than this; if it is over 15 per cent., the butter is considered adulterated. Another fraud is the addition of an excessive amount of salt. Occasionally starch is added, as mashed potato; sometimes gelatin is added; the latter differs from fat in not being soluble in ether, and the former in giving a blue coloration with iodine. Extraneous fats are not uncommonly added to butter; these, owing to their greater solidity, are not so digestible as butter. They are detected with difficulty, but usually being harder than butter fat they are not perfectly mixed, and their melting point is higher than that of pure butter.

Cream contains about 30 per cent. of butter-fat, Cheshire cheese 25 per cent., and skim-milk cheese 7 per cent.

Johnson failed to gain in the channel path, rather from
effect of cold than muscl: exhaust: Capt: Webb with
a good coat of subcut: fat succeed?

The more finely div: fat is, & the more digestible
Diffs between swallt a pat of butter & same on head spread.
Mem ch: also. take fat if finely chopd & mixed w. potatoes.

Aver: compos: butter H_2O - 10-12 %. Curd 1-2, Salt 0-5
Mem tog: must not be over 25 %, shd not be over 20 %.

	melt: point	sp. grav:	saponif: & form: fat: acid.
Butter	32°. C	.913	88% insol. fat acid
Butterine	35°C: unless cotton oil add:	.904-907, unless cott: oil add:	95% do. no butyrin &.

In Butterine or Oleo-margarine the stearin of beef-fat is removed, & olein & margarine rem:, as they are fld at ord: temps. The stearin wh- forms 25-30 % of the whole fat is separ: by crystal: after melt:

Melt butt: in test-tube in a hot-water vessel, & note prop: of H_2O to oil & amt of curd.

Two fungi notinjest in flour. – bunt & smut. Bunt (Tilletia caries) a v. comm. disease of wheat. Grows within the seed, its spores from a fine soft & somewhat greasy powder, wh. rubbed emits a disagreable odour. The spores are abt .0006" wide, round & reticul.

Smut (Ustilago segetum) comm in barley & oats. Spores not more than .0002" diam & have no odour. They are circ. mucid. & not retic.

Mildew (Puccinia graminis) – ripe sporangia are dark brown club shaped bodies div. into compartments filled w. spores. In an early stage it constit. red dust.

Penicillium glaucum forms the mould on stale bread: appears when cells are in excess of moisture. Bead. tufts in greenish patches & may produce serious poisoning.

In wheat flour starch is 66.3, in bread 47.4

Bread			Flour	
– H_2O –	35–40 p.c		– H_2O –	12 p.c.
ash	1.4 "		gluten	11 or 12 "
(NaCl) salt	.6 "		starch	60 "
			ash	.7 "
			~~NaCl~~	~~.5~~ "

The ash of aq. extract is K_2HPO_4, abt. 1 p.c. of whole.

Too little NaCl in bread is a great fault, the bread being less palatable & not keeping so well. If rem. ash after NaCl deduct. is higher than .4 then bread dirty (alum never in suffic. qty to affect ash) NaCl almost absent fr. flour.

aq. extract obt. by shak. up 10 grms of flour in ½ litre flask of H_2O, filter. & evap. on Pt. = gum + sugar + albs.

If gluten not tenac., after obt. by wash. in bag of muslin under tap, flour damaged or adulter. w. oat or bean.

Zn & Cu – digest ash w. a little HCl, add NH_3 excess, filter cold, Cu filte is blue, verif. by $C_2H_4O_2$ & K_4FeCy_6. If Zn in Am. filte ($NH_4)_2S$ gives white ppte. Verify by being yellow when hot, white on cool & gives green when ignited w. Co. Nitre.

Alum – logwd sol. obt. by take 2 or 3 chips fresh logwood, digest w. a little CH_3OH, add 3 vol. H_2O & abt 5 cc sol. Am. Carb. If a flour make into a cream w. logwd sol., warm 10 mins on H_2O bath – alum purple flour pinkish. If a bread take a clean slice, not touch. by a knife. Immerse in logwd sol. & leave in dark. Normal bread after NH_3 gone turns yellow.

Butter-milk, which contains all the constituents of milk, except the fat, is a highly nutritious and easily digested drink, and one which is undeservedly neglected. It is especially valuable for invalids who cannot digest fats, and for children who are wasting.

CEREAL FOODS.—Gluten is peculiar to plants, and is chiefly found in plants belonging to the great family of grasses. Gluten is to bread, what casein is to milk, and myosin to flesh. If one takes a piece of dough made from wheat flour, and holds it under a stream of water from the tap, a large part of it is washed away, while a sticky adherent mass is left behind. This is gluten, and it is its tenacity which enables bread to be made. If the fluid with which the dough was washed is collected, it will be found to contain a large quantity of starch, a small amount of sugar, of albumin, and certain salts. All cereals possess these constituents in various proportions. The cereal which is most universally useful is wheat; from its fruit is obtained flour, the character of which varies according as the husk is removed before grinding or not. A hot summer diminishes the water in wheat and increases its gluten.

Good **wheat flour** ought to be white, not gritty or lumpy, not acid or musty, forming a coherent stringy dough, and possessing at least 8 per cent. of gluten. Examined microscopically, it should show the absence of any fungi, or vibriones, or acarus farinæ, or of foreign starches, such as barley, maize, rice, potato (known by the different shape of their starch granules). Alum is occasionally added to flour; more rarely sulphate of copper or gypsum. The chief object of the addition of both alum and sulphate of copper is to enable the baker to make a white and porous bread from damaged wheat flour. It is not uncommon for rice, potato, or pea flour to be added. 100 pounds of good flour ought to yield 130 pounds of bread.

Bread made from seconds flour is more nutritious than pure white bread. This is especially important for the poor, who live largely on bread.

Brown bread is less digestible than white, but is more nutritious

if digested, as the bran is rich in fat as well as phosphates. It acts as a mechanical irritant, ill borne by delicate stomachs, but very useful where a tendency to constipation exists.

The harder wheats, such as Sicilian wheat, contain a large percentage of gluten; and from them *macaroni* and *vermicelli* are obtained, which are nearly pure gluten. They are very nutritious and useful foods.

Oatmeal, obtained from the common oat, contains very little gluten, and so cannot be made into vesiculated bread. It contains a large proportion of other nitrogenous material and of fat. As porridge and oatmeal cake it is very popular in the north, and forms a very nutritious diet. The husk ought to be carefully removed from the meal intended for human food, as, although very nitrogenous, it acts as a mechanical irritant.

Barley contains very little gluten, its nitrogenous matter being chiefly albumin and casein; on this account, like oatmeal, it does not admit of being made easily into ordinary bread, but requires the addition of wheat flour. It is not so nourishing, but is cheaper than wheat. Added in small quantity to wheat flour, it keeps the bread moist and improves its flavour.

Malt is barley which has been made to germinate by heat and moisture and then dried. During this process, a nitrogenous ferment called "diastase" is formed, which possesses the power, in the presence of water, of changing starch into dextrine and sugar. *Extract of malt,* containing diastase in an active condition, is extremely useful in cases of impaired digestion and deficient assimilation of food.

Rye is rarely used in this country for making bread. In Germany it is known as "black bread," but its colour and acid taste make it disagreeable, and it is laxative in its action. It is also liable to be attacked by a parasitic fungus (the ergot of rye), and if eaten in this condition may produce severe symptoms.

Maize, or **Indian Corn,** is very deficient in gluten, and so not suitable for making vesiculated bread. Like oatmeal, it is made

According to Wagner's recent researches, the nitrog^{s} matter of bran is chiefly alkaloidal not album^{d}, hence the idea of ~~the~~ its nutritive value of bran, found^{d} on high proport^{n} of N is erroneous

Semolina f. Wheat, millstones being left sufficiently apart to leave the produce in a granular cond^{n}

In bread made f. fine wheat flour estim^{d} that at least 10 % of the starch is convert^{d} into maltose & dextrin; but in case of whole-meal bread propr^{n} is much higher, as shown by dark heavy appear^{ce} of latr, due to the sol^{e} carbohyd^{s}. This property has been ptly overcome by heat^{g} the flour bef baking, in order to dimin. the convert^{g} power of the albumin^{s} matter. The fact that rye meal cont^{s} albumin^{s} wh. act^{s} in acid^{n} those of other cereals expl^{s} the pasty & dark appear^{ce} of bread f. it.

$$10\ \underset{\text{starch}}{C_{12}H_{20}O_{10}} + 6H_2O = 6\ \underset{\text{maltose}}{C_{12}H_{22}O_{11}} + 4\ \underset{\text{dextrin}}{C_{12}H_{20}O_{10}}$$

Homing

Homing cont^{s} all the nutriment of maize

Diarrhœa lactea a very comm^{t} dis^{e} in Bengal - appears from
had^{l} fail^{e} of digest^{e} powers, ow^{g} to the insuff^{t} diet & low fail^{e}
of nutrit^{e} faculty fr. life-long underfeed^{g} Rice has ruined
Bengal as the potato has ruined Ireland (N. Chevers)

Peas, beans, & lentils all known as pulse.

Broad beans shd alw. be eaten bef. the hilum or point of
attach^{t} bec^{s} dark col^{r}, while they can^{t} be boil^{d} with^{t} burst^{g}
their skins. When w. melt^{d} butter, they form a dig^{e} & suffic^{t} dinner.

Bread ab^{t} 8% albumⁿ
Meat 15%
cheese over 30%
pea beans &c 22%

Lentils now lgel. imp^{d}. fr. Egypt - cont. less proportⁿ N than
pulses. Its ash cont as much as 2% of Fe oxide & consid^{e} Ca Phosphate
Also ft advant^{e} over peas in cont^{g} no S but same tend^{y} to liberⁿ of
H_2S in al^{y} canal.

into cakes, called in America, "Johnny cake." It contains much fatty matter, and is largely used for fattening poultry and other animals. Oswego flour and corn flour are maize flour deprived, by a weak solution of soda, of its peculiar unpleasant flavour, of nitrogenous.

Rice contains less gluten or nitrogenous material than any other cereal, and does not admit of being made into bread alone. It is not so nutritious as the other cereals, its chief value as a food depending on the large amount of starch it contains.

The best kinds of rice coming to this country are known as Patna and Carolina rice. Carolina rice becomes more mucilaginous when cooked than Indian rice, and is more nutritious.

Leguminous Foods.—The chief seeds belonging to this group are peas, beans, and lentils. They contain a smaller proportion of starch, and a larger proportion of nitrogenous material than cereals. The nitrogenous material exists chiefly as legumin, which has been called vegetable casein, and from it the Chinese make a kind of cheese. Although leguminous seeds contain more nutritive material in a given weight than cereals, dietetically they are inferior, owing to the fact that they are less digestible, often causing flatulence and other dyspeptic symptoms. Cereals, again, are more palatable than leguminous seeds, and are more prolific, and consequently cheaper. In the absence of animal food, legumens form a useful substitute. They are advantageously diluted with oily substances, or with rice. The farm-labourer's dish of broad beans and fat bacon is founded on strict physiological principles. A mixture of lentil and barley flour or corn-flour is sold under the name of Revalenta Arabica. Green peas, French beans, and scarlet runners are much more easily digested than in the form of dried peas or beans.

Amylaceous Foods.—Amylaceous, starchy, or amyloid substances are contained in many of the preceding foods; but there are some other foods which consist almost entirely of starch. The chief of these are sago, tapioca, and arrowroot.

Sago is obtained from the pith of the stems of various species of palm; a single tree may yield several hundred pounds. Alone it is

easy of digestion, and somewhat nutritive. Boiled with milk it forms a light, nutritious, and non-irritating food. Fictitious sagos are frequently sold, made from potato starch.

Tapioca and **Cassava** are derived from the tubers of more than one species of the poisonous family, Euphorbiaceæ. The juices are removed, and the poisonous principle destroyed by heat. Tapioca only differs from cassava in being a purer form of starch; the latter is more nutritious, and among the Indians takes the place of bread. Tapioca is more soluble than sago, and so requires less time for cooking.

Arrowroot is obtained from the tubers of Maranta Arundinacea. It contains 72 per cent. of starch, and is therefore not highly nutritious, though it is easily digested and non-irritating.

Tous-les-mois is a form of starch obtained from the tubers of a West Indian plant, the Canna Edulis. **Salep** is obtained from the roots of several species of orchids.

Starch is contained in very many vegetable foods. Its proportion in 100 parts is shown in the following list. In barley flour it forms 69·4 per cent.; wheat flour, 66·3; wheat bread, 47·4; oatmeal 58·4; Indian corn meal, 64·7; rye meal, 69·5; rice, 79·1; peas, 55·4; potatoes, 18·8; parsnips, 9·6; carrots, 8·4; turnips, 5·1.

The small proportion of starch present in potatoes is due to the large amount of water entering into their composition, and not to the presence in more than minute quantities of any other constituent.

Other Vegetable Foods.—**Green Vegetables** contain comparatively little nutriment, but form valuable additions to other foods. Cellulose, which forms their main constituent, is a useful stimulant to the alimentary canal; and the salts they contain possess valuable anti-scorbutic properties. The addition of a bulk of comparatively innutritious food to other more digestible foods is very important; every kind of natural food is bulky, thus giving the alimentary canal more mass to act upon. Concentrated nourishment can only be digested in limited quantity, and is very apt to produce

Forms of Starch granules – potato starch gets used instead of the more costly arrowroots

Wheat – inequal. of size of gran., most striking feature; Ger ones shew faintly mark. concent. rings.

Barley – v. sim. in size & appear. to last, but Ger ones more irreg. in form & rings more distinct

Rye – same irreg. in size, Ger gran. still Ger & more flat.; hila stellate

Oats – gran. much smer, & more unif. in size, polyg., no Ger have hila

Rice – gran. still smer, polyg. & almost imperceptible hila.

Potato – gran. vary gtly in size & form. The typ. ones are Ge oyster-shaped, w. mark. concent. rings, & clear tho. sm. hilum at narrow end.

Arrowroot – name ext. fr. Mar. Ar., to design. almost any kind of fine & pure starch, prep. so as to be cap. of substit. for that of Mar., esp. those obt. fr. Cunc. angustifolia, Jacca occanica, Canna edulis, & certain species of Smilax. These rightly called arrow. but substit. or admixt. of sago, pot., tap. & adult.

Maranta – gran. oblong or ovate, rings delic. but well def.; hila most com. shew a sharply mark. transv. slit, wh. v. clear. Behav. w. H_2O & pt. to that of others, swell to 20 or 30 times size & contents escape & form. glutin. unif. mass.

Curcuma – size vari., but Ger gtly exceed those of Mar. often gibbous Hila v indist. often absent.

Canna (tous les mois) like pot. but much Ger & flat

Jacca – like sago gran., but smer. Wedge shaped at end, but appear circ. if seen endwise. Hilum circ. or fissured.

E. Ind. arrow. = Cunc, W. Ind. & Bermuda = Mar.

Sago – gran. Ger trunc., indist. ringed, sometimes stellate hilum at apex.

Tapioca or Cassava – gran. like sago, but smer, & often adher. in groups; hila distinct dus. circ.

Legum. gran. are uniform, w. longit. branch. hilum.

Due consumption of fruit & veget. is a sign of progress in pract. hygiene.

Potato even less nutt. than rice for a sole food. Is only wholesome when the starch granules are healthy, as shewn by burst.g envelopes, formg a floury mass after boilg. Young potat. consistg of immatt. cell-tissue transformg starch are much less digt. nutritts. When starch is changed by disc. or growth, it is extrg indigt.

digestive disorder. Cabbage contains 92 per cent. of water, and 2½ per cent. nitrogenous matter. Carrots contain 6 per cent. and turnips 2 per cent. of nitrogenous matter; parsnips are intermediate between these.

Rhubarb and sorrel contain oxalates and tartrates of potash and lime, to which they owe their tartness. Spinach is cooling and laxative, like rhubarb, but not tart. Sea-kale, artichoke, and asparagus are all wholesome vegetables. Asparagus is somewhat diuretic, and gives a peculiar, disagreeable odour to the urine. Salads, such as mustard and cress, watercress, endive, and the garden lettuce are very useful as anti-scorbutics. Some of them possess a peculiar pungency due to a volatile oil analogous to that contained in horse-radish.

The **Potato** contains 26 solid parts in 100, of which nearly 20 are starch and 2½ nitrogenous matter. It forms one of our best-appreciated vegetable foods, and, as it possesses valuable anti-scorbutic properties, its universal use is, perhaps, the chief cause of the present rarity of scurvy. Alone, it possesses too small a proportion of nitrogenous material to support life, but the addition of butter-milk makes up this deficiency; and these two together form a sufficient diet to maintain life and health for a long time, though so limited a diet would, probably, be ultimately injurious.

The **Onion, Garlic, Leek,** and **Shalot,** all members of the lily family, are chiefly used as condiments. They contain an acrid volatile oil, which gives them a peculiar odour and flavour. By long boiling, this is dissipated (as in the case of the Spanish onion), and the onion is then fairly digestible, as well as nutritious.

Celery possesses a more delicate flavour and odour than the preceding, but even the most tender celery is digested with difficulty; less so, when boiled or stewed, or a constituent of soups.

Only three **Fungi** are, in this country, commonly regarded as safe—mushrooms, morels, and truffles; but there are many others which, if their characters were but known, form nutritious and

delicate foods. The difficulty lies in distinguishing the poisonous from the non-poisonous forms. Dr. Christison says, that a sure test of a poisonous fungus is its astringent styptic taste and disagreeable pungent odour. In any doubtful case it is better to abstain.

Oily Seeds contain a considerable amount of fixed oil, which renders them unfit for persons of weak digestion. The almond, walnut, hazel-nut, and cocoa-nut are common examples. The sweet almond, when eaten unbleached, occasionally produces nettle-rash, and its solid texture and large proportion of fixed oil render it difficult of digestion. The bitter almond contains, in addition, a peculiar principle called amygdalin, which, on the addition of water or saliva, forms prussic acid. The *chestnut* is not an oily seed, but possesses considerable nutritive matter. It is extensively used as a food in Italy and some other countries. In the uncooked condition it is very difficult of digestion.

Fruits are chiefly used as adjuncts to other foods; but the vegetable salts, and the cellulose and sugar which they contain, make them very valuable. **Cucurbitaceous** fruits are used as vegetables rather than as fruits. Vegetable marrow is wholesome and agreeable, but not very nutritive. Cucumber is, on the contrary, a somewhat dangerous food, being a fertile source of indigestion and diarrhœa. The more rapidly grown, and the fresher it is eaten, the more digestible it is.

Stone-fruits or drupes, such as the peach, nectarine, plum, cherry, are rather luxuries than foods, like many other fruits. Before ripening they are unfit for food; when ripening is complete, the acids and astringent matter largely disappear. The *date* contains chiefly sugar, and forms an important food in the East.

Pomaceous Fruits, as the apple, pear, and quince, are more digestible when cooked; and, speaking generally, all fruit not perfectly ripe should be cooked before eating. The presence of vegetable acids in fruit soon converts the sucrose of cane sugar

Dried dates also contⁿ starch. Dried figs contⁿ 54 % sugar and 4 % albuminates.

For breakfast or luncheon well stewd fruit w. cream or custard, v. wholesome. Many can't take it, either bec of the acid & the amt of sugar nec'y to make it palatable. Sugar does not really counteract acid, & its use in it gts tends to retard digestⁿ A small pinch of bicarb sprinkled over the fruit before cook'g v. valu-

By synthesis an artif^{l} sweet^{g} agent, called saccharin, has been discov^{d}, 250 times sweeter than sugar, prep^{d} by a complic^{d} series of react^{ns} fr. coaltar.

Researches of W. O'Sullivan of Burton shew that sugar prod^{d} fr. starch by diastase is maltose. Also that the dextrines[1] prod^{d} thro' action of diastase on starch, col^{d}. red or brown by I. are prop^{ly} changed w. formn of sugar, into a series of lower dextrines, not yield^{g} any color w. I (these called achro-dextrines).

Maltose not v. sweet. One atom less H_2O than grape sugar. Form^{a} is $C_{12}H_{22}O_{11}$. More rotat^{y} power on pol^{d} light than glucose, but reduces less power of pres^{d} CuO. Can be hydrolysed into glucose by prolonged boil^{g} w. dil. acids.

Researches of Musculus & O'Sullivan render necess^{y} the assumpt^{n} that molecule of liquef^{d} starch is a composite molecule $n(C_{12}H_{20}O_{10})$

into dextrose, a less sweet variety of sugar. It is therefore more economical to sweeten after than before cooking.

The chief **Berries** are the grape, currant, gooseberry, cranberry, and elderberry. The grape is the most important, and 1,500 varieties of it have been described. Its juice contains a large amount of grape sugar (dextrose), and small quantities of glutinous material, bitartrate of potash, tartrate of lime, malic acid, etc.

Besides the above fruits, we have strawberries, mulberries, figs, plantains, melons, etc., which are all refreshing and anti-scorbutic. The orange family furnishes us with the orange, lemon, citron, lime, shaddock, and pomelo, of which the orange is by far the most important, and possesses most valuable refreshing qualities.

Sugar forms a valuable food, equalling starch in this respect. It exists in three chief forms, all of which are converted into glucose before absorption into the blood. The chief sugars formerly known were honey, grape, manna, and fruit sugars. Now we have in addition cane, maple, beet, maize, and palm sugars, all consisting of sucrose.

The common sugar or **sucrose** is obtained from the sugar cane or from the beet. (Sucrose = $C_{12}H_{22}O_{11}$; compare starch = $C_{12}H_{20}O_{10}$).

Grape Sugar (dextrose or glucose) = $C_6H_{12}O_6$, H_2O, can be seen crystallised in dried raisins: it only possesses one-third the sweetening power of sucrose. Starchy food becomes changed into glucose by the action of saliva and pancreatic juice in the alimentary canal. Grapes, cherries, gooseberries, figs, and honey contain lœvulose in addition to glucose (glucose = $C_6H_{12}O_6$, H_2O, lœvulose = $C_6H_{12}O_6$). Lœvulose resembles dextrose except in being uncrystalline, and in its effect on polarised light. Many ripe fruits, such as pine-apples, strawberries, peaches, citrons, contain sucrose and lœvulose, the latter being not nearly so sweet as sucrose.

Lactose ($C_{12}H_{24}O_{12}$), or sugar of milk, forms about 4½ per cent. of milk.

The sweetening power of the varieties of sugar depends on their degree of solubility in water. Sucrose is soluble in one-third of its

weight of cold, and in rather more of hot, water. Dextrose is soluble in its own weight of water; lœvulose is more soluble, and therefore sweeter than dextrose. Lactose requires five to six parts of cold, and two of hot, water, and is therefore not so sweet as the other varieties.

CHAPTER IV.

DISEASES ARISING IN CONNECTION WITH FOOD.

Meat from Animals Dying a Natural Death.—Measly Meat.—Trichinosis.—Tuberculous Meat.—Putrid Meat.—Tinned Meats.—Disease from Fish.—Dangers of Unboiled Milk.—Pellagra.—Ergotism.—Starvation.—Scurvy.—Rickets.—Gout.

Disease may arise from the noxious character of some individual article of diet, or from deficiency or excess of some particular food, or of the food as a whole.

Diseases from Unwholesome Food.—I. **Diseased Meat.**—It is said that at least one-fifth of the meat entering the London markets is diseased, and the proportion has been placed by some much higher.

(1) *The flesh of animals dying a natural death* is prohibited from sale, and rightly so, as in some cases it produces serious results; but these do not uniformly occur. Some hold that such meat (where the animals have died from a non-contagious disease) ought to be allowed for sale at a lower price, and thus the temptation to smuggle it into the market as healthy meat would be diminished. *Braxy mutton* (from sheep which have died of splenic apoplexy, a bacillus disease common in Scotland,) is largely eaten in Scotland, after salting and cutting away the most diseased parts, and without evil results; but it rapidly decomposes, and is said sometimes to produce boils, etc. Diseased meat is also dangerous, owing to the *drugs* with which the animals have been dosed before death. There is a case on record, in which tartar emetic, taken by an ox before slaughtering, produced serious effects

Bad meat may ✓. prod^e toxic symp^s due to ptomaines
or ✓. may prove starting point of a specific dis^e = ✓. may be
subdiv^d into a/. in wh. charact^s less of typ^d fever formed,
b/ acute gastro-intest^l symp^s. Five distinct epid^cs described
under a/. (See San. Rec. July '88)
In order to give typ^d anim^s must have been suff^y p. it; exist^e of
typ^d in bovine race by no means gen^y admit^d. May hold that typ^d is
not the specific dis^e usually reg^d as, or that bac^l. other than typ^d bacil. may cause
symp^s simul^g those of typ^d.

great outcry agst Amer.n pork, &c. 8% cont.s trichina. But no case of Tr. or cation.t has been traced to Amer.n pork. & ll. Colin's expts have shewn that you can.t give an anim. trichinosis even if you feed it with imported Amer.n pork cont.g trichina. This because all trich.æ in salt.d pork com.g f. Amer.a are kill.d. Salting destroys trich.æ if sufficly persisted. (Cobbold)

Dr Lewis & Cobbold made expts shew.g that trich.æ killed at temp. of 140°F. Later expts shew that 120° sufficl to kill. Where large masses of meat may take 2 or 3 mos for time to penetrate to int.r

alternate carniv.s & herb.s animals

Bothr. latus f. the Cysticercus of pike & other fresh-water fish.

Trich. spiralis passes entire existe in carniv.s animals.

Devel.t in alim. canal acc. to Harley only reqs 2 ds. In abt 2 mths Trich.æ becs impacted in muscles, & in 2 mths more the cyst calcifies, & in 2 mths more the worm suffs the same fate.

All the cases in Germany have been derived f. home-fed pork, imperf.ly cooked, & not f. Amer.n pork.

If diar.æ traced to imperf.ly fed pork, give purgat.s, thus leaving less trich.æ to penetr.e tissues.

Sexl matur.e male measd only $\frac{1}{18}$" & fem. $\frac{1}{8}$" long, Eggs only $\frac{1}{1270}$" long diam.r cont.g embryos are prod.d viviparously

A genus of paras.s descd as Trichinæ. Epid.c on 2d Nth. Fr.S. "Cornwall" reveal.d presence in boys of a new species of free Nematoid (Pelodera strigera)

Case descd in Lancet May 11. 89 in wh. 26 yrs after a pat.t had suff.d f. appnd severe nurse Rh— trich.æ fd imbed.d p.m. in M.s. some rabbits fed on dis.d tiss.s W. result that when kill.d in 3 wks trich.æ fd in M.s, & in cast.d 4 longest previous pers.s fed in wh. imbed.d trich.æ found cases of active purpag.s was 13 yrs, observ.d by Virchow after Hamburg epid.c

on 107 people; one person, who died in consequence, had only eaten half a pound of the meat.

(2) Meat may be unwholesome from *the presence of parasites.* Of these the most common is—

(*a*) The **cysticercus cellulosæ**, which is the undeveloped embryo of the tape-worm; that from the pig becomes the tænia solium, that from the ox tænia mediocanellata. The cysticercus of the pig is the most common; it forms a cyst, about the size of a hemp-seed, commonest on the under surface of the tongue. Occasionally one finds in hams oval holes, and opaque white specks, which are the remains of the cysts converted into calcareous matter. When meat containing the cysticercus alive (as in under-cooked or raw meat) is swallowed, it develops into the tape-worm, which consists of a number of flat segments, each capable of producing the ova of new cysticerci, and a minute head at the narrow end surmounted by hooklets. The boiling temperature effectually kills the cysticercus. Another kind of tape-worm common on the continent, called *bothriocephalus latus*, is derived from the cysticercus of fish.

(*b*) The **trichina spiralis** is not a solid worm like the tænia, but possesses an intestine. In pork it forms a minute white speck, just visible to the naked eye, which forms a nest, and in this one or two coiled up worms can be seen by a magnifying glass in active movement. They are effectually killed by the temperature of boiling water; but no form of drying, salting, or even smoking at a low temperature is sufficient for this purpose. Moreover, boiling or roasting does not suffice to destroy the trichina, unless the joint is completely cooked in its interior. When trichinous pork is swallowed, the eggs develop in the alimentary canal in about a week into complete worms, and in three or four days more each female produces over a hundred young ones. These burrow into every part of the body, producing great irritation and inflammation. In one case after death upwards of 50,000 worms were estimated to exist in a square inch of muscle. Most of the cases of trichinosis have occurred in Germany, from eating imperfectly cooked sausages.

In a well-known example at Helstadt in Prussia, of 103 who ate diseased pork in sausages, 20 died within a month.

(3) **Tuberculous Meat**, from animals suffering from phthisis (consumption), has been said to produce the same disease in man; but the evidence in favour of this is very slight, and it could only possibly occur in the case of imperfectly-cooked meat.

II.—**Putrid Meat** has often produced diarrhœa and other severe symptoms. Putrid sausages are especially dangerous, and incipient putridity seems to be more dangerous than advanced. Habit may produce toleration of putridity, and game is commonly eaten "high." The Eskimos bury their meat until it is putrid; and among the Zulus, according to the late Bishop Colenso, the synonym for heaven is "maggoty meat."

The meat from over-driven or tortured animals has sometimes been found to be unwholesome. Occasionally severe symptoms have followed the eating of pork, brawn, or potted meats. Possibly the development of ptomaines (cadaveric alkaloids) may account for this.

III.—**Tinned Meats** occasionally produce severe illness, which has been in several cases fatal. It is important to secure a good brand, and to eat the meat as early as possible after the tin is opened. The poisonous symptoms may be due to the rapid decomposition occurring after opening the tins, or to the imperfect exclusion of air before this. Occasionally, also, in the case of pickled meats, poisoning is due to the action of vinegar on the soldering of the tins (lead and zinc poisoning).

IV.—**Meat injurious from the food eaten before killing.**—Pheasants fed on laurel, hares on rhododendron chrysanthemum, and other animals fed on the lotus, wild cucumber, and wild melon of Australia, have caused dangerous symptoms.

V.—**Fish**, especially some kinds, occasionally produce nettle-rash and other disorders, especially in warm weather. Leprosy has been ascribed to the eating of decomposing fish, but it occurs in countries where a fish diet is impossible.

Shell-fish and crustaceans (as lobster, crab) are very prone to

When putrefactive Bact.ª are sown on flesh of mammals a v. active poison, neurine, is prod.ª; when on fish another poison muscarine wh. closely allied to last but differing chemically & + before thought to be only obt.ª from fly-agaric. Brieger 1st discov.d it as a product of decomp.n of fish.

Devel.t of rotten.s in eggs for epicures is an art in China.

Sausage pois.g due to 1). rancid fat acids, 2). catalytic body, 3). hydrogen.s acids form.n due.g drying or smok.g, 4). ptomaines 5). paras.c bacillus discov.d by Klein & Ballard in Amer.n pois.d ham; or 6). sarcina botulina.

Kerner appears to have been 1st in suspect.g formn of alkaloids by decomp.n of albn. in 1820 vomit.g ontresemble below symps. of sausage pois.g + atropine pois.g. Subseq.ly he regard.d the fat. acids as the active pois.s agent. (Brunton)

All tin.d meats cont.n tin in solut.n (Hehner). This does not seem to be injur.s, e.g. tomatoes (Stewart)

See whether top of tin is flat or depress.d — then no air has entered. If top bulg.g out, then putref.n

Dangers fr. cystic. a trich.a in tin.d meat.

Temp. at wh. putrefe. processes occur & influences
rapidity w. wh. albumi. subst. split up & nature of products
Decomp. maize in winter yields an alkaloid wh. has a
narcotic & paral. actn; in summer it yields, in addition,
another alkd. wh. has a tetanising actn. Putrefe may go
on to a certain extent after intron. of food into alim. canal,
& probably more rapidly than
without. Milk may be apparently sweet & yet really
'on the turn'. Vomg & purging are symptoms of poisoning by
putrefe alkaloids
Even the primary products of dig. ferments, as peptones, are
poisonous. But Brieger has shown that peptone by digestive fibrine
& artifl gastric juice, an alkaloid peptotoxine is obtd.
Brieger has obtd. from flesh, a product of decompn.
neuridine, wh. is harmless: another neuridine wh. is poisonous.
From decomp. fish, muscarine, ethylenediamine (poisn)
& gadinine (innocs). Prof. Selmi of Bologna gave
putrefe alkds. name of ptomaïne. Recent researches show
appears that both vegl. & anim. alkds are constituents in their
chemical constitn. both products of albuminoid decomps
Choline obtd by boiling alkn. of eggs, bile or brain w. Baryta.
Very closely allied to neurine. By oxidg. w. strong HNO_3 is
converted into artifl muscarine. Lethal power of neurine nearly
10 times of muscarine 50 times that of choline Symps are
salivn. diarr. vomg. dyspnœa, paral. & death. Artifl muscarine
has a curare-like actn. unlike od. muscs.
Both the diarr. vomg & p. tainted meat due to alkd. poisn. Yolk of
egg contg lecithin wh. easily converted into choline, thus occasd a
violent poisn. produd in dig.
Carbolic acid in the urine of healthy persons

Last yr Ass. Prof. Hygs. Nelley (Mr. Davies) entered the tabular statement of Hyd. w. 400 cases.

produce evil results. This may be owing to their foul food or to the development of some peculiar animal poison. In some cases, eating only one or two mussels has produced dangerous symptoms.

VI.—**Milk** has been a common carrier of disease. Cows eating the rhus toxicodendron get the "trembles," and their milk produces serious gastric irritation in young children. The milk of goats fed on wild herbs or spurgeworts has produced severe disorders.

The milk of animals suffering from foot-and-mouth disease, although frequently drunk with impunity, occasionally produces inflammation of the mouth (aphthous ulceration). The milk derived from cows fed on grass from sewage farms is, *per se*, as wholesome as any other, and its butter has no more tendency to become putrid than that derived from any other source.

The great danger in respect to milk is of its becoming mixed with tainted water; or of its absorbing foul odours, or the more dangerous, but possibly less perceptible, emanations from drains or sewers, when exposed in an ill-ventilated room. The absorptive power of milk for any vapour in its neighbourhood, is shewn by exposing it in an atmosphere containing a trace of carbolic acid vapour: the milk speedily tastes of the acid.

In addition to its absorptive power for any vapours present, milk tends to undergo rapid fermentative changes, especially in warm weather, or when tainted by traces of putrefying animal matter. Diarrhœa in children is frequently due to such a condition, or to the rapid decomposition of milk in an imperfectly cleaned bottle. It is a wise precaution always to boil milk in warm weather; and it should never be stored in ill-ventilated larders, or where there is a possibility of the access of sewer-gases; nor ought it to be kept in lead or zinc vessels.

Mr. Ernest Hart, in 1881, gave a tabulated account of seventy-one epidemics, traceable to infected milk. Of these, fifty were epidemics of typhoid fever, fourteen of scarlet fever, and seven of diphtheria; and the number of cases of each of these diseases in

Milk f. tuberc. mother Object. M. Galtier at French Académie de Sciences recently (Aug. 8th Sanit. Record) states that milk is result f. phth. cows espl. when udders are tubercl. As a rule only when udder is affd. Tubercl. prod. in q. fig. by inoc. f. the cow's milk.

all the various outbreaks, were estimated at 3,500, 800, and 500 respectively.

In regard to typhoid fever, the contamination of the milk was traced in twenty-two out of the fifty epidemics to the use of water "for washing the milk-cans," derived from specifically polluted sources, and doubtless the water was the real source of the disease. In most of the cases of scarlet fever, it was found that either there was scarlet fever in the dairy, or that persons employed in the dairy were in attendance on patients suffering from the disease. In the case of diphtheria, it is probable that infection of the milk was by absorption of aerial pollutions, or by the admixture of tainted water.

Certain obscure throat affections have also been traced to a tainted milk-supply, and it is probable that other conditions may arise from a similar cause, and that this is a much commoner source of disease than is generally suspected.

Cheese has occasionally produced violent attacks of illness, although no poison could be detected in it. These effects have been ascribed to copper from the vessels in which the cheese has been made, but this view has been disproved in several instances.

VII.—**Vegetable Food** (especially greens) is indigestible if stale, and all mouldy vegetables are dangerous.

Poisonous symptoms have been produced by the admixture of *darnel* (lolium temulentum) with flour.

The eating of *damaged maize* in Italy is the cause of an endemic skin disease, called *pellagra*, which commonly proves fatal. The damaging of the maize seems to be due to the universal practice of paying the landlord in kind, a tithe of the produce of the farm. This leads to the tenant hiding some of his maize in damp holes, and a fungus or mould develops on it which produces pellagra.

Ergotism is due to the growth on cereals (and most commonly on the rye) of a poisonous fungus, the secale cornutum, which produces a deep purple deposit on the grain. If bread made from such flour is eaten for prolonged periods, severe symptoms result;

Dr Ballard 1st traced an outbreak of Typ.d in Islington in 1870 to milk.

That Sc.fever might be caused by infect.d milk was 1st discov.d by late Prof. Bell of St Andrews who investig.d an outbreak there in 1870

In spite of 1883 of Sc.f. in Bloomsb.y, cause was shown to be milk, but all ord.y sources of ext.l infect.n were excluded.

Once of cows on this farm was observ.d by W. Power to have recently calved. This led to exper.ts by Klein, wh. tend to prove that if a cow wh. has recently calved is inoc.d w. matter fr. throat of person suff.g fr. Sc.f., she is affd by an ailment "wh. is transmis.e after the manner of an ac. specif. dis.e to pigs." In view of poss.y of inoc.n at this time, Brid.e report.s that milk shd not then be used for human food.

Origin of gast. intest.l dis.e. fr. over-ripe frot.n fruit.
Potato dis.e due to fungus (Peronspora infestans) permeat.g the tuber.
The pot.s not wholesome due to the changes in starch.

Wine – home made – cases of Pb poisⁿ? – f. home made wine wh. was allowᵈ to ferment in a glazed earthenware washing pan. The pan shewᵈ signs of corrosⁿ "Paint used in glaze" had been taken up by the wine (San. Rec. Aug-88)

Dth fr starvⁿ is really dth from cold

Defic of fat a very comⁿ error in dietaries. Said 40 to 50 yrs ago by an eminᵗ physᶜⁿ that one of causes of gt prevalᶜ of Consumpᵒⁿ was the high price of butter. Dr Hughes Bennett said that 2 gt causes of Tubercˡ – dearness of butter & abundᶜ of pasty cooks

G. Busk shewᵈ that rabbits cnsᵈ dimᵈ., while fibrin & albᵐⁿ increᵈ in flesh; no decr. in K salts. Sanord says that K dimᵈ in scorbᵘ diets similar to urine of patᵗˢ admitᵈ to gt's hospˡˢ cured. Excess K does not cure. Dr Ralfe observed that contin withdrawal of all fresh vegˢ & fruit f. healthy persˢ, caused an absolᵗ & relatᵉ increᵉ of chlorides at expense of alkal-salts. The dimᵈ alkal's of blood prodᵈ dissolᵗⁿ of capˢ Dyspˡ the most comⁿ complicᵃⁿ of Scurvy.

During the siege of Paris, genˡ mortˡ was doubled, but Infantˡ mortˡ was dimᵈ 40 o/o, owing to necessˢ for suckling, & the same result was obsᵈ in the Lancash. cotⁿ famine, when the mothers were kept at home.

in some cases, a dry rotting of the limbs. There have been several epidemics on the continent, due chiefly to eating bad rye bread.

Starvation Diseases.—*Simple starvation* causes death in a period varying with the previous state of nutrition. Usually death occurs when the body has lost two-fifths of its weight, whether this be after days, months, or years (Chossat). A supply of water prolongs the duration of life, to as much as three times what it would otherwise be. In children, a common symptom of *a diet deficient in nutriment* is diarrhœa; it is nature's rebellion against the starchy foods commonly inflicted on children in place of their natural food—milk. Good nourishment doubles the power of resisting disease; this has been abundantly proved in the experience of the Crimean war and other campaigns. Under-fed children in charity schools are very liable to chronic inflammation of the eyes (ophthalmia).

Scurvy is due to the absence of fresh vegetables. The use of the potato and the orange, as well as of lime juice (the juice of citrus limetta), has led to its nearly complete extinction in this country. In former times, it caused more deaths among seamen than all other causes put together, including the accidents of war.

Rickets is chiefly due to improper feeding in childhood. M. Jules Guérin found that by taking young puppies and pigs (representatives of carnivora and herbivora respectively), removing them from the mother prematurely, and giving the former meat and the latter vegetables (their natural foods in the adult condition), he could produce rickety softening of the bones. The substitution of artificial foods (most of them containing starch) for the natural milk—which deprives the infant of a certain proportion of lime and phosphates, of fatty material, and iron—is probably the chief cause of rickets. The time of weaning ought to be settled by the development of the teeth; the suckling may begin to be diminished when the lower incisor teeth appear between the sixth and seventh months. Before this the child cannot digest starchy food.

Relapsing fever generally follows epidemics of typhus fever, and is greatly favoured, if not caused, by starvation.

Diseases Connected with Over-Feeding.—A fire may go out for want of fuel, or from becoming choked with ashes; and it is the latter state of things which occurs in **Gout** and allied diseases. Weakness is commonly complained of, but this is due to excess of food embarrassing vital action; and abstinence and exercise are required to restore the balance. Excess of nitrogenous food—especially if combined with the use of sweet, or strong, or very acid wines, and beer—is particularly prone to produce gout. In these cases, animal food should only be taken once a day, and vegetable food should be allowed to preponderate.

Obesity is favoured by excess of starchy food and sugar, and by copious drinking of water or other beverages. The plan of curing obesity by restricting oneself almost entirely to meat food is not advisable however, as the system tends to become overloaded with effete nitrogenous matter. **Gall-stones** are favoured by rich foods and excess of sugar; also by alcoholic indulgence. **Dyspepsia** is commonly due to over-loading the stomach at frequent intervals; but, on the other hand, it not infrequently leads to the taking of insufficient food, because of the discomfort produced. The result of this is that a chronic starvation results, with impaired vital powers. Dyspeptic patients should abstain from pastry and from tea and coffee, except in small quantities, and not very hot. Alcohol in any form, as a rule, does harm. Not uncommonly mastication is imperfectly performed, and a good dentist may cure the indigestion which has resisted all other treatment.

Advant. of restrict. diet — "he that will eat much must eat little"
"The best part of a feast is that which one leaves."
Louis Cornaro lived to 100, worked hard on diet of 12 oz. solid food & a bottle of thin wine daily. Sidney Smith says 'after assent. will upon what I can live upon, I feel that between 10 & 70 yrs of age I had eat. & drunk 44 horse-waggon loads of meat more than will have preserv. me in health & strength = £7000 (Med. Sc. Lectures)
Human body has ample powers of recuperation
food esp. in earlier ages.

'Robert the waiter' maintd that a gentn shd no more think of consult? his stomach than he wd his portmanteau as to what he shd put into it.

People overfeed? often complain of 'weakness' for which more food is prescribed.

Excess of nitrog? food is elim? as urea, or if metabolism imperfect, as urates, or may pass undig? by faces.
Excess of carbohyd? & fats, prod? obesity, unless impairt of dig?

A dog on a diet of 500 grms pure flesh & 500 of fat daily gain? wt for a month, but began to lose flesh after flesh incr? to 1500 grms witht a corresp? incr. of non-nitrog? food.

Diet of meat comm? supposed the best cure for lack of strength. Ranke finds that an exclus? meat diet, caused weak? & muscl? fatigue, excess nitrog? products seem? to act as a muscl? poison.

Pastry is comm? v. imperf? cooked.

A French writer defines dyspepsia as ingratitude of the stomach.

Wh. wd ordinly prodce an imperf. female or 'worker' bee
It is fed on 'royal jelly', wh. the worker bee as a rule
only gets one meal its first.

Hempseed causes bullfinches & certn other birds to bec. black
the Amazonian natives feed the commn green parrots w. the
fat of ye Siluroid fishes, & birds thus treatd. bec. beautifl
variegated w. red & yellow feathers (Darwin Anims &
Plants under Domestic. p. 26 q. Vol ij)

Hunter is fed on beef boats, steam? & rapid liberty
ships — Draught horse fed on Indn corn & chopd hay.

— Sir Jno. Franklin says. that in his 1st voyage" he gave an Esquim. boy
a qty of tallow candles to see how many he wd eat, & it was not till
he had eaten 14 lbs that he became fright. for his store & gave the boy a
few qts of fat pork to get out of his bargain."
These north. machins grin w. ecstasy at sight of whale blubber, but make
very faces over sugar.

CHAPTER V.

DIET.

Influence of Diet on Animals.—Circumstances modifying Diet.—Times for Meals.—Vegetable and Animal Foods.—General Rules as to Diet.—Determination of Diet.—The Naturalist's Theory.—Theory of Income and Outcome.—Examination of Dietaries.—Calculation of Diet.

The importance of a duly proportioned and sufficient dietary is shown by its great influence on health and character. An ill-proportioned or deficient diet is certain to lead to failure of health. The anatomy of an animal may be modified in the course of generations by altered diet, as well as its character; thus, the alimentary canal of the cat has increased in length to adapt it to its omnivorous habits. In the case of the bee we have a still more remarkable instance. If by any accident the queen bee dies or is lost, the working bees (which are sexually undeveloped) select two or three eggs, which they hatch in large cells, and then feed the maggot on a stimulating jelly, different from that supplied to the other maggots, thus producing a queen bee.

In making the railway from Paris to Rouen, it was found that two English were equal to three French navvies; on examining for the cause it was found that the former were fed on large quantities of meat, while the latter ate chiefly soup and lentils. The diet of the Frenchmen was altered to the English standard, with the result that the inequality in work soon disappeared.

The food of mankind varies naturally with—

I.—*Climate.* A cold climate leads to increased oxidation, and consequently a large amount of fatty matter can be eaten without producing nausea. Witness the difference between a Laplander's and a Hindoo's diet.

The *season* of the year has likewise some influence. Vital processes are more active in spring than autumn, and more food is consequently required in the former season.

II.—*Occupation.* Although muscular exercise is not associated with an immediate increase of elimination of urea, yet as a matter of experience more nitrogenous food is required and can be oxidised by hard workers than by idlers. The trappers on the North American prairies can live for weeks together on meat alone, accompanied by copious draughts of tea. They are constantly in the open air, undergoing fatiguing exercise, in a dry and rare atmosphere.

III.—*Sex.* As a rule, women require about one-tenth less food than men, but probably this rule hardly holds good in the case of women engaged in laborious work.

IV.—*Age.* Infants require only milk, and the less they have of any other food before a year old the better. Children under eight require chiefly milk and farinaceous food; at ten, half as much as for a woman is required. It is important to remember that vital processes are more active in early life, and that food is required not only to carry on the functions of the body, but also to furnish the materials for growth. Young men up to twenty-five engaged in laborious work require much more food than older men engaged in the same work.

After the age of thirty-five or forty, the tendency is to take too much food. All the tissues of the body are established, and excess of food (especially nitrogenous food) is liable to produce tissue degeneration by loading the system with partially oxidised matter, and may lead to gouty diseases. It is much safer to take too little than too much food after this period.

Times for Eating.—The best arrangement seems to be to have three meals, each fairly nutritious, and containing all the constituents required. The Romans only had two meals daily, prandium and cœna. This is common among the French at present, but it tends to lead to overloading the digestive organs at one period, while starving them at another.

An ordinary full meal has usually passed from the stomach in four hours. Fresh food ought never to be introduced before this period; it is advisable to allow an interval of five hours between meals for the healthy, so as to give time for the digestive organs to rest.

The diet shd be regul^d by the appetite, by the palate, by common sense. (Austin Flint)

Luigi Cornaro, centenarian, tells us that his diet consist^d of 12 oz. of food a day & 14 oz. wine. That he made himself seriously ill, when on recommg a friend, he temporarily increased it to 14 oz. food & 16 of wine (See Aesop. 40)

Dr Lankester tells story of overlooker of gang of navvies who made a point of going round at dinner hr & discharged any man who did not eat his full qty.

Dr Parkes mentions farmer who said "he dont afford to give his labourers less wages" as "less wages produce less work

Food in stomach is still outside the system.
Impute of slow eat[ers] eg. table d'hôte - thus people can't
get outside of their food as soon as at home.

Dr B. Yeo on Food in Health & Dis[e] (Cassell)

Hardly sufficiently realis[d] that the principal rules of diet are
to be sought in diet[ic] customs of soc[y] rather than in
physiol[l] ded[ns] customs have grown up by a process of survival

Teeth of man said not to be of carniv[s] type - but little of carniv[s] adapt[n]
for seiz[g] prey. Stearine top like flask of bones. Man eats his meat cook[d]
Cooked meat as eas[y] masticd as hd rapple.
Consumpt[n] of meat has incr[d]. more than 40 o/o in last 50 yrs. Awe
may regard this w. equan[m] w. diminish[g] sickness rate.
Attempts of "Bread & Food Reform League" found[d] on a misconcept[n]
the pleasant. char[r]s of dietary of higher races is its variety. We supplant[t]
bread by meat, fruit &c. Even if bran included in bread only 2 o/o mineral matter
in total dry substce, while meat pork milk &c cont[n] 5.6 or more o/o of mineral
mat[s] + phosphs in total dry substce. - Dr Meyer shewed experimentally that fine white
bread farinas completely digd + absorbd than coarse bread. (B M J Sept. 27. 95)
— To prove neces[y] 4½ oz albumn. req[d] by moder[e] worker, 200 oz of
porridge req[d]. (Vaeher M.Sc. Leet).
N. Hofmann quoted by Bauer (Yeo / Swiss o/o prop[n] digd. standing[g] of amin. dry
albsubst[s]

	Veg. digested	animals undigested	Dig[n]	annual unity[y]
Of 100 pts of solids			86.9	13.1
" " albumen	75.5	24.5	81.2	18.8
" " carbo-hyd ratios	46.6	53.4	96.9	3.1
	90.3	9.7		

Yeo - Dig[n] of veg[e] food more complex than of animal food.
Amin. food more stim[g] than veg[e] & satisfies hunger eas[ily]. more completely & for longer time.
Liebig fatty of bear kept in anat[l] Museum at Giessen who was quiet & gentle when fed
entirely on bread, but vicious & dang[s] after a few ds meat. Even same grow
fierce & attack men after having been given flesh food. But vast[y] diff[t]
food all fr. veg[e] Kingdom! Comp[e] horse on oats & beans & same on hay &
bran mash

and for the absorption of food. The practice of taking tea with the chief meal, or a "meat tea," is bad. Tea is better taken an hour or two after food, and ought not to be made a meal of.

Regularity in the times of taking meals is important, as the digestive organs acquire habits like other parts of the body. Work ought not, if possible, to be resumed immediately after meals, nor active exercise of any kind. These tend to abstract blood from the digestive organs, and so diminish the efficiency of digestion.

Vegetable and Animal Foods.—The fact that the food we require can be obtained from the vegetable world, has led to the proposition that vegetable food should be taken alone. It is urged in favour of this plan, that a large amount of suffering to animals would be prevented. Also that animal food is not so economical as vegetable, land being more economically employed in producing corn than in feeding cattle. Thirdly, there is the indubitable fact that health can be maintained for prolonged periods on vegetable food (including nuts, cereals, fruits, etc.)

On the other hand, the chief objections to a purely vegetable diet are that the undigested refuse is greater than with an equal quantity of animal food; that a longer time and more exertion are required in digesting the most nutritious vegetable foods, such as legumens, while other vegetable foods do not contain a sufficient proportion of nitrogenous material. Also, if one lived entirely on vegetable food, a greater bulk would be required, and owing to the fact that such food is less easily absorbed, satisfaction to the appetite would not so soon be produced. Animal food has a great advantage as regards convenience. Man is not an eating machine; he requires food which is easily converted into the body substance, and this is supplied by the flesh of animals, milk, and eggs, with a due proportion of non-nitrogenous food; sheep and oxen work up indigestible vegetable materials into easily assimilable mutton and beef.

There is no doubt, however, that under the ordinary conditions of town life, there is considerable danger of indulging in an excess of nitrogenous food, and vegetarians will therefore do good by

shewing that meat is not absolutely necessary, and can often with advantage be largely replaced by vegetable food.

If we include milk, cheese, and eggs in the vegetarian diet, the objections to it in a large measure disappear; and it would be well if it were much more widely known, especially among the poor, that on these, together with vegetables, health can be maintained with the addition of little or no meat.

The Determination of Diet.—The first principle in making a dietary is that it **must be mixed** containing all the necessary constituents, proteids, hydro-carbons, carbo-hydrates, water, and salts. No one of these alone will support life for any considerable period. Carbo-hydrates (sugar and starch) can be most easily dispensed with; fats, on the other hand, are essential for the maintenance of health.

The next point is to ascertain **the proportion** in which these different foods are required. *Salts* are commonly taken with other foods, common salt being the only one taken alone. About 150 to 200 grains of salt are required by an adult per day. The amount of *water* required varies with the season of the year, the amount of exercise and perspiration, and other factors. As a rule, not more than two pints of water are required per day, and still less if fruit is freely taken. We may therefore confine our attention to the carbonaceous and nitrogenous foods, and try to ascertain the amount of each of these required. This question has been approached from three standpoints :—

1st.—There is what we may call the *Naturalist's Theory.* This assumes that not only does milk contain all the necessary constituents for the maintenance of life, but in the proper proportion for the adult. It is evident, however, that although the milk of various animals is very similar, yet that their habits in adult life vary greatly, and their diet varies similarly. And it is found that nitrogenous matter exists in milk in a preponderant proportion over the fat and sugar, according to the estimate of the requirements of the system, as ascertained by the other methods. This is in accordance with what would be expected, when it is remem-

$C_{72} H_{112} N_{18} S O_{22}$

Nitrogen

Amt elim.d as urea is abt 1/8 gr. per lb wt of body. This is an adult in state of perfect repose.

bered that in early life the tissues have to be built up, while in adult life they have merely to be kept in repair.

2nd.—*The Theory of Income and Outcome.*—The excreta represent the oxidised condition of the food taken into the body. If, therefore, we estimate the amount of carbonic acid eliminated from the lungs and skin, and the amount of urea and uric acid from the kidneys by the urine, we can easily calculate the amount of carbon in the carbonic acid, and of nitrogen and carbon in the urea and uric acid. It is convenient to confine the calculation to carbon and nitrogen, for, although hydrogen is contained in carbonaceous and proteid foods, and is eliminated as water, it is also taken as water for mechanical purposes; and, consequently, the eliminated water does not represent simply oxidised hydrogen. The number of grains of carbon and hydrogen eliminated being ascertained by the above method, if we know the per-centage composition of the various foods, it is easy to calculate the amount of each required, in order to supply the necessary carbon and hydrogen. Some addition must be made to the amount of food required, as thus calculated, for the fæces contain a certain amount of undigested matter, and nearly every food is but partially digestible. A margin must, therefore, be allowed.

According to Dr. E. Smith the average amount of daily losses during idleness are—for an

	GRAINS OF CARBON.	GRAINS OF NITROGEN.
Adult man	4,300	200
Adult woman	3,900	180
Average adult	4,100	190

These amounts are represented by about 22 ozs. of carbonaceous food, and 3 ozs. of nitrogenous food.

3rd.—*Result of Examination of Dietaries.*—It is found that the results obtained by examination of the food taken by men under

various conditions strikingly agree with those obtained from an estimate of the excretions. Dr. Letheby has summarised these results in the following table.

Daily Requirements of the Body (Letheby).

	NITROGENOUS FOOD.	CARBONACEOUS FOOD.	CARBON.	NITROGEN.
During idleness, as determined—	ozs.	ozs.	grs.	grs.
By dietaries... ...	2·67	19·61	= 3,816	180
By excretions ...	2·78	21·60	= 4,199	187
Average ...	2·73	20·60	= 4,005	184
Routine work, as determined—				
By dietaries... ...	4·56	29·24	= 5,688	307
By excretions ...	4·39	23·63	= 4,694	96
Average ...	4·48	26·44	= 5,191	302

Dr. Lyon Playfair found as the result of elaborate analysis the amount of food necessary for—

	NITROGENOUS.	CARBONACEOUS.
Subsistence only	2·0 ozs.	13·3 ozs.
Quietude	2·5 ,,	14·5 ,,
Moderate exercise	4·2 ,,	23·2 ,,
Active work	5·5 ,,	26·3 ,,
Hard work	6·5 ,,	26·3 ,,

Thus, under the three first conditions of life, the proportion of nitrogenous to carbonaceous food was one to six; for active work, one to five; for hard work, one to four. The proportion one to five of nitrogen is ample for persons having moderate exercise. Speaking generally, the amount of nitrogen required is 300 grs.;

Frankld's & Playfair's estim.ⁿ of energy of var.ˢ foods falls [illegible] to pound : bec. (1) metabolism in body not ident.ˡ w. oxid.ⁿ. out of it, the impulse to metab. appear.ˢ rather to proceed f. cells themsˢ, the O combin.ᵍ rather w. prod.ᵗˢ of split.ᵍ up of food stuffs than dir.ˡ & prim.ˡ w. the latter.
(2) Little or no relᵗⁱ betw. ease of oxid.ⁿ in air of a subst. & its changes (in body
(3) Metab. not complete in body.
(4) Frankld's estim.ˢ of relᵗⁱ energy of eq. pts of diff.ᵗ foods not confirm.ᵈ by exper.ᵗ & experᵉ. Have not to consid. ease w. wh. a body burnt, but w. wh. dig.ᵈ & assim.ᵈ

The amᵗ of excretⁿ of urea dep.ᵈˢ on amᵗ of albⁿ ingested, & not on amᵗ of musc. actⁿ.ᵍ, as Liebig thought.
Waste & repair of tissˢ subj. to much less change than com.ˡʸ thought : hence Playfair's tables give far too great extremes.

The nitrog.ˢ tissues from the appar.ˡ not source of energy & se-tab.ᵍ gl. am.ᵗ exercise req.ᵗ lger am.ᵗ nitrog.ˢ food, &c. the appar.ˡ wears out in use.

Acc. to Pres —	Moleschott's.	English soldier's diet
	grms	grms
albumin	130	113
fat	84	38
carbo-hydrates	404	482
salts	30	23

Moleschott's stand. diet — albs. mat. 4.587 ozs avoir.
fat " 2.964 "
carbohyd. 14.250 "
salts 1.058 "
22.859 "

Reck. a 5 p. food to cont. 50% H2O, then 23 ozs = 46 ozs solid food
add 50–80 ozs H2O.

Acc to table p. 48 — to get 4800 grs C
wd req. uncookd beef 4 11/16 lbs, uncookd fat beef alt 3 lbs.
cooked beef 2½ lbs — Alter this inaccuracy in another edit.

of carbon, 4,800 grs., or a proportion of one to sixteen. This, at first sight, looks as though Dr. Playfair's table were incorrect; but the discrepancy disappears when we remember that nitrogenous food contains a large proportion of carbon as well as nitrogen.

It is found, in accordance with the above results, that an average healthy male adult, of average weight and height, and performing a moderate amount of work, requires $4\frac{1}{2}$ ozs. of nitrogenous food, 4 of fats, $14\frac{1}{4}$ of carbo-hydrates, 1 of salt, total, $22\frac{3}{4}$ ozs. (Moleschott). This is equivalent to a little over 40 ozs. of moist solid food. If we add 40 to 60 ozs. of water, we have a complete diet.

Estimation of Diet.—Reckoning 300 grains of nitrogen, and 4,800 of carbon, as the amount required, it is found that this is yielded by a combination of $\frac{3}{4}$ lb. meat and 2 lbs. of bread, that is 44 ozs. of solid food. If one subsisted on beef alone, $2\frac{2}{3}$ lbs. would be required to furnish enough carbon, and there would be a considerable surplus of nitrogen. Similarly, if one lived on bread alone, to get 300 grs. nitrogen, $3\frac{1}{3}$ lbs. of bread would be required, and this would supply a large excess of carbon.

Again, if one lived on eggs alone, which, averaging $1\frac{3}{4}$ ozs. in weight, yield 2 per cent. nitrogen, or nearly 18 grains, in order to obtain 300 grains nitrogen, 17 eggs would have to be eaten.

It is evident from the above instances that the most economical diet is that which contains both nitrogenous and carbonaceous substances, and that no one article of diet furnishes these in a suitable ratio. By combining bread with meat, one obtains the highest amount of nutritious matter with the least amount of waste matter. Similarly, a combination of butter-milk with potatoes, or of broad-beans and bacon, to take common examples from the diet of farm-labourers, furnishes a useful and economical meal.

If one has a table such as the following from Parkes, showing the number of grains of carbon and nitrogen in an ounce of various foods, it is easy to calculate the amount of such food necessary, and so to combine them as to have no waste of either nitrogenous or carbonaceous material.

Table showing the number of Grains of Water, Nitrogen, Carbon, and Salts in one ounce (= 437½ grains) of Various Substances.

	WATER.	NITROGEN.	CARBON.	SALTS.
Uncooked beef	328	10·35	64·	7
Uncooked fat beef ...	275·6	9·6	98·3	16
Cooked beef	236	19	117·7	13
Salt beef	215	20·4	69·7	92·3
Salt pork	192	18·	85·	99·7
Fat pork	170	6·8	192·	10·1
Dried bacon	65·6	6·1	273·8	12·7
White fish	341	11·5	52·4	4·4
Poultry	324	14·5	62·	5·2
Bread	175	5·5	119	5·6
Wheat flour	65·6	7·6	169	7·4
Biscuit	35	22·7	183	7·4
Rice	43·7	3·5	176	2·2
Oatmeal	65·6	8·7	172	13
Maize	59	7	176	6
Peas	65·6	15	161	10
Potatoes	324	1	49	4·4
Carrots	398	·4	18	3·
Butter	26	·2	315	11·8
Egg	321	9·3	71·5	4·4
Cheese	161	23	162	23·6
Milk	380	2·75	30·8	2·6
Cream	289	1·9	93·5	7·9
Skimmed milk	385	2·8	25·	3·5
~~Sugar~~ Pemmican	31	24·3	273·5	8·
Sugar	13		187	1·

CHAPTER VI.

THE PREPARATION AND PRESERVATION OF FOOD.

Objects of Cooking.—Methods of Cooking: Roasting, Boiling, etc.—Cooking of Mixed Dishes.—Cooking of Vegetables.—Bread.—Potatoes.—Kitchen Utensils.—Cooking Ranges.—The Preservation of Food.

Objects of Cooking.—Food is required to restore the waste elements of the tissues, and to supply oxidisable material, by

In ord. cooking the chief agent is heat— the art of cooking is to a ge select the skilful appl^n of heat.
Heating by 1/ radiat^n or 2/ direct contact 1/. seen in roast^g grilling braising. toast^g baking, 2/. in boil^g frying & stewing.
We do not really boil food— we use a water bath as a means of heat^g

Cookery of water & milk too much neglected.
Salutaris water a good cooked H₂O.

Cookery a moral agent (Brunton). "A hungry man is an angry man.

means of which the heat and other forces of the system are maintained.

The food may be taken in its crude and unprepared condition, as directly derived from the animal or vegetable world, or after it has undergone a preparatory process of cooking. Man is the only animal who cooks his food, and has been distinguished from the lower orders of creation by the title of the "cooking animal." Many foods, in the uncooked condition, are almost entirely incapable of digestion by him—such as the proteid and farinaceous materials contained in the seeds of cereal and leguminous plants, and in the tubers, roots, and succulent stems of various vegetables. But cooking, as a preparatory help to the digestion of food, is not equally required by all foods. Thus, fruit is commonly taken uncooked, and does not undergo any important alteration on cooking. Salads are taken uncooked, but not for their nutritive properties so much as for a relish to other foods, and for their quasi-medicinal properties. Milk, again, may be taken cooked or uncooked. The oyster is the only animal which is eaten habitually, and by preference, in the uncooked condition; and it is interesting to find that there is a physiological reason for this universal custom. The large fawn-coloured liver, which constitutes the delicacy of the oyster, is little else than glycogen, associated with its appropriate ferment diastase (W. Roberts), so that the oyster is almost self-digestive. When cooked, the ferment is destroyed, and digestion of the oyster becomes much more difficult.

Cooking is intended—1. *To make the food softer*, and in part to mechanically disintegrate it, thus rendering it more easily masticated and digested. In fact, cooking, in the best sense, is an artificial help to digestion; and digestion may well be said to commence in the kitchen.

2. *To produce certain chemical changes.* Thus, starch is partially converted into dextrine; gelatin is formed from the connective tissue of tendons, etc.

3. *To destroy any noxious parasites* present in the food, or to

obviate any ill effects from *putrefactive changes.* Diseased meat probably only produces bad effects when imperfectly cooked.

4. *To make the food more pleasant* to the eye and agreeable to the palate. The improved savour in cooked meat, for instance, has a very appetising effect, and consequently makes digestion much easier.

The Cooking of Flesh.—1. **Roasting** is, perhaps, the most perfect way of cooking meat. It exalts its flavour more than any other method. In roasting, place the meat at first sufficiently near a brisk fire, so that the albumin on its surface may be readily coagulated, and the juices retained in the interior of the joint. After about fifteen minutes, the joint ought to be removed somewhat further from the fire, and allowed to cook slowly. Frequent basting is desirable to obtain a good result. Brown meats, such as beef, mutton, and goose, require a quarter of an hour per pound weight; veal and pork require about ten minutes additional, to ensure the absence of redness. White-fleshed birds require a somewhat shorter time. The time required in roasting will be a little more if the joint is large, or the fire not very clear. To ascertain if the meat is done, press the fleshy part with the finger; if it remains depressed, it is done; if not done, it retains its elasticity. At the first incision, gravy should flow out, of a reddish colour.

The changes undergone during roasting are, that the connective tissue uniting the muscular fibres is converted by the gradual heat into gelatin, which is soluble and easily digested; the muscular fibres, consequently, become more separable, and the myosin of which they consist is rendered more digestible. The fat is partly melted out of its fat cells, and partly combines with the alkali from the blood-serum. Empyreumatic oils, developed by charring of the surface of the joint, are carried off when it is roasted in front of the fire; and so, to a large extent, is acrolein. Acrolein (C_3H_4O) is always produced by the destructive distillation of neutral fats containing glycerine, and is the cause of the intolerably

Everything in the way of food shd first please the eye, then the nose, & then the mouth.

Classifn of Methods of Cooking Flesh — (Priestley Manl H. Lect)

A. Whole mass of meat to be cookd & eaten.

(a) Heat applid by expose to radt heat { 1. roasts 2. grilling 3. baking.

(b) " " " " contact w. hot H_2O { 4. boiling

(c) " " " " oil { 5. frying

(d) " " " " steam { 6. steaming

B. The sol. pts to be dissd out in H_2O & the rest rejected — 7. broths soups & teas.

C. The sol. pts to be dissd out & the rest rendd suitle for eating — combing of A & B { 8. stewing

In cookg of Ge fds, "basting" prests char. of surf.

Employt means supply devel. or generg by heat.

The varᵗ. sapid todorous subst.ˢ devel.ᵈ by roastᵍ are collectᵈ called osmazone.

Comᵈ. in Soldrei's Dietary (1889) object to frozen meat for soldᵗˢ. as it loses 10 o/o more in cooking than fresh meat.

M. Williams has a dreadful animosity to the word "simmering". Dont allow H₂O to rise above 160°. as it will then remᵛ. tender. Meat shd alw. be boiled in an inner vessel (see note p. 853) surrᵈ. by H₂O. Simmering temp. is the same as boiling temp. The temp. of inner vessel does not rise above 160°.

pungent odour accompanying the process. Osmazome, a peculiar extractive matter, on which the flavour and odour of meat depend, is developed better by roasting than by any other method of cooking.

It is useful to remember, in buying beef or mutton, that 20 per cent. must be allowed for bone and 20 to 30 per cent. for the loss during cooking. Thus, a joint of sirloin of beef, weighing 12 lbs., lost in roasting 44 ozs., of which 27 ozs. were water and 17 ozs. fat or dripping. With boiling, if well done, there is not so much loss.

2. **Baking** of meat in a closed oven does not produce so good a result as roasting in front of an open fire. The oven ought always to be very hot before the meat is put in, in order to rapidly coagulate its surface. Baked meat commonly has an unpleasant flavour, owing to its saturation with empyreumatic oils, which escape in open roasting. The unpleasant flavour may be prevented by covering the meat with a layer of some non-conducting material, as a pie-dish or a crust, no empyreuma being then formed. Baked white of egg, as in the common dish of fried ham and eggs, is one of the most indigestible forms of albumin obtainable.

3. **Boiling** of meat requires the same time as roasting. If the flavour and juices are to be retained, the joint ought first to be plunged into soft boiling water, and then, after three minutes, allowed to stand aside to simmer in water at 180° Fahr. The preliminary boiling forms a coating of coagulated albumin over the joint. Where there is no thermometer to guide the cooking—after the preliminary boiling for three to five minutes, add three pints of cold water to each gallon of boiling water, and retain at the same temperature for the rest of the process, *i.e.*, at about 170° Fahr.

The use of soft water for cooking purposes is always advisable; otherwise a longer period must be allowed. A preliminary boiling for a few minutes renders water much softer, and the addition of a little carbonate of soda has a like effect.

When meat is inserted in water at a temperature below its

boiling point, the juices are gradually extracted, while the meat is left a mass of hard strings, in many cases equally wasted whether eaten or not. A nourishing soup is produced, but the meat is almost valueless. In order that soups and broths may be nutritious, the less heat is employed in their preparation the better. If a soup is strained to make it clear, much of the most valuable part is removed.

4. **Stewing** is a process intermediate between boiling and baking. It possesses the great advantage over dry baking that no empyreumatic gases are produced, and there is no charring. The temperature of the stew-pan ought never to be above 185° Fahr.; at this heat the roughest and coarsest kinds of meat are made tender. The only objection to stewing is that the meat becomes saturated with fat and gravy, and is too rich for weak stomachs. It is advisable to stew lean meats only.

Hashing is a process of stewing applied to meat which has been previously cooked. The consequence of this double cooking is, that the meat becomes tough and leathery. A modified hash, in which the meat is simply well warmed throughout, is very preferable. Tinned meats (American mutton, beef, etc.), are not uncommonly hashed. This is a bad plan; the meat has already been over-cooked during the process of tinning. It ought to be eaten cold with its own jelly and a salad, or simply warmed through.

5. **Frying**, unless carefully done, renders meat difficult of digestion, each fibre becoming coated with fat, and empyreumatic and other rancid acids being freely produced. The art is to "fry lightly," that is, to burn quickly and evenly, so that no charring is produced. Two methods of frying are described. In the first, the substance to be fried, as an omelette or sole, is placed with a little fat or oil in a frying-pan. In the second, the substance to be fried is immersed in fat; for this purpose a frying kettle is required. The fat in all cases must be heated before the meat is inserted, in order that the juices of the latter may become encased in its

In boiled meat juice is ret.d in itself; in stewed meat juice is taken out of meat, but served up with it.
In raising meat just cov.d w. a strong liquor of veg.e & anim. juices in cov.d ves.l w. as little wast.e as poss.e is permitt.d
Braising combines advant.s of stewing & baking. A braising pan is a stewpan w. a closely fit.d lid constructed & should have embers, so that the meat can be cook.d f. above as well as f. below. Fav.te mode of cooking w. French & Savoury viands put into braising pan w. meat are term.d "the braise".

Lard is the worst mat.l for frying, oil perhaps best. Oil & butt.r req.e to be heat.d slowly as they burn quickly. Fresh sweet drippings & the clarif.d kind.s of saucepans are as good as anything that can be used. (1) frying pan. really sauté-pan. (2) frying kettle. Both shd be kept scrupl.sly clean.

The second is the proper plan exc. for pancakes & omelettes; & is really not so wasteful of fat as the first.
When fat 1st put on fire it splutters f. escape of H_2O. If subseq.t sole or cutlet put in same frizzling & crackling occurs. Water in animal food is made to boil violently & suddenly. Int.n of food req.s heat d. a little over 212°. (Due to press.e of steam in getting out.) When a sole is fried in a bath of fat, the inner part is really being steamed.

Take some White of Egg & carefy warm in a glass vessel.
At abt 134°F it begs to change, little films of opaque matr
being formd in it; at 160°. it ceases to be liquid, & can be
invertd without spilling; but still is a jelly & trembling
On heatg to 212°. it loses the transparcy it had as a jelly & becs hard:
if kept at this temp. long enough it becs so hard as to make an
admirl cement. A good cement for broken china is to smear with
white of egg, put it togr & heat in an oven.
Same effect shewn by stewg a beef steak in boilg or "simmering" water.
It is midway betwn meat & gutta percha in case of masticn

interior. By means of fats or oils a much greater heat can be applied to meat, than by water; as the former do not boil below 500 – 600° Fahr. The higher the temperature of the fat, the less digestible the fried substance becomes.

6. **Broiling and grilling** are really processes of roasting applied to small portions of meat. In the latter process, it is important that the gridiron should be hot before putting anything on it. An external coagulation of albumin is produced, as in good roasting and boiling.

We may mention here the results of Dr. Beaumont's experiments on Alexis St. Martin, as to the time required in digesting an egg prepared in different ways. He found that an egg whipped and diluted with water required $1\frac{1}{2}$ hours; fresh, raw, and undiluted, 2 hours; fresh, roasted, $2\frac{1}{4}$ hours; soft boiled or poached, 3 hours; hard boiled, $3\frac{1}{2}$ hours; fried, $3\frac{1}{2}$ hours. As eggs consist largely of albumin, they may be taken as fairly typical of all nitrogenous foods.

The Cooking of Mixed Dishes.—It will only be possible to give a few instances of common errors in preparing compound dishes, though the subject is by no means unimportant. An egg, for example, may be a light and easily-digested food, or almost as hard and impervious to the digestive juices as leather. In a custard or just coagulated in a poached egg, it is the former; baked half an hour in a pudding, it is the latter, and is useless as regards nutritive properties, besides being likely to produce indigestion. Spices, if mixed with a dish before it is boiled, lose nearly all their flavouring power, while they remain irritating. They ought to be added near the end of the cooking process. A soup containing vegetables, as well as meat juices, should be prepared in two parts. The vegetables require prolonged boiling; gravy is spoilt by this.

Similarly, the jam in a tartlet, if inserted before baking, loses its proper fruity flavour; and oysters baked in a beef-steak pie are indigestible, and almost useless.

THE COOKING OF VEGETABLE FOODS.—**Bread** is either vesiculated or unvesiculated; the latter being what is called unleavened bread. Vesiculation of bread has usually been produced by *fermentation* of some of the sugar of the flour. The starch first becomes dextrose, and then the growth of the yeast plant in the dough splits this up into alcohol and carbonic acid gas. The carbonic acid percolates the substance of the dough, rendering it porous. When it has "risen" sufficiently, the dough is placed in the oven. The heat of the latter kills the yeast plant, thus preventing any further fermentation, but at the same time expands the carbonic acid gas in the bread, rendering it still more porous.

It is objected to this plan of making bread, that some of the sugar is wasted in producing carbonic acid. To remedy this, *another plan* is sometimes adopted, as first proposed by *Dr. Dauglish.* In it the dough is charged with carbonic acid dissolved in water under considerable pressure. The gas escapes in the substance of the dough, and on baking expands as in the ordinary method of making bread. Bread made in this manner, is called "aerated bread."

A modification of this plan is commonly employed on the continent, in which a mixture of hydrochloric acid and carbonate of soda is used, thus generating carbonic acid in the dough. This plan is not good, among other reasons, because the hydrochloric acid sometimes contains arsenic.

Ten pounds of flour ought to make thirteen to fourteen of bread. The use of stale bread is much more economical than of newly-made bread; besides this, it is more digestible. Newly-made bread is more palatable than stale, but is more cohesive, and does not crumble into separate particles like stale bread. The consequence is, that it is less digestible, being less easily penetrated by the saliva and other digestive juices. The effect of *toasting* is to render bread more friable, and consequently more digestible. It ought, however, to be thin and eaten soon after it is made; when thick and kept too long, it becomes tough and leathery.

3 stages in histy of head baking

1). unleavd. head. 2). use of leaven, 3). use of yeast.

London system of head making (Dr Graham) is prob? the best.

3 parts - 1). prepn of ferment, 2). prepn of sponge, 3). prepn of dough

1). A sack of flour (abt 280 lbs) - 6-8 lbs of best potat? taken, washed boiled & made into a thin paste; then cold H2O add? till temp. low? to 85°. Then 2 lbs flour add? & 1 quart good brewers' yeast stirred in. Then ferment? begins. Yeast acts on alb? of wheat, wh. then act on starch & maltose & dextrine & peptone bod? are prod?

After abt 6 hrs, the head falls & ferment is allow? to rest for 2 hrs.

2. One fourth or 1/3 of flour put in trough, ferment is add? thro' a sieve wh. ret? potat. skins, the H2O in ferment & sponge being abt 30 quarts. Abt 3 lbs of salt also add? - wh. acts as a check to ferment esp? to the degrad? of alb? Sponge being made in abt 5 hrs it heaves CO2 being given off & in abt 1/2 hr this is rep? After this rem? flour & water (up to 60 quarts) is add? & thoroughly mixed. Dough then left for 1 hr, weigh? & put in oven at temp. 400 - 450°. Temp. of head itself abt 212°.

Bowrick's baking powder bod. bicarb & Tart. Acid & rice powder.
Mc Dougall's " " acid Ca Phosph? & K_2CO_3.

Nevill's head baked by hot H2O & rais? by incorp? w. dough & Am. Carbon?, wh. dissip? by heat, - is sweeter than ord? head.

Potato not put in for cheapness, but bec. it is one of best of starches & therf. one of best means of prep? alb? sugar food for active & stimulus of yeast growth. By its means also amt of yeast is greatly incr?

It is in the sponge state, in wh. there is the most active ferm? that inf? flours turn out so badly, bec. they prod? more & more sol? alb?, wh. give a high colour to the final product.

Liebig's bak? powder - acid phosph? Ca, bod. Bic & KCl.

Rusks may be made by cut? loaves of head into slices & bak? in slow oven until brown. Ord? rusks made f. dough like that for tea cakes. Moist? expel? by dry?

Colour of brown bread due not so much to bran matr, as to prodn of maltose &c f. the starch by actn of the cerealin, a nitrogs ferment present in outer coats. If this destroyd. by prelg heat the dry flour, a v. fairly white bread can be made f. whole meal.

— outer coats of grain are practly indigle Chemly no diffce betwn. sawdust & arrowroot, yet the mere fine divn of woody fibre does not appear to make it more digestible.

Pastry less perfs cookd. than ord. bread

D'Arsonval says that in good milling - 1/. corn must be degerminated as germ is an active hydrating & diastasic body - 2/. bran must be thoroughly cleand bec. cerealine of bran has this injurs actn on ferment, but it prods. longer chain of maltose & dextrine, tritord also too large of gold albumd. into bread, wh. dust starch gives high colour a miller tests wheats by appearce, wt per bushel, country where grown, hardy by grinding & baking some.

Cellulose capsule bursts at high temp. Albumate granulose At temp of abt 300° F starch bec. dextrin or British gum Seen on back of every postage stamp. Used in arts, Calico printg &c.

Rice shd not be boiled, but mixed & steamd. as it yields to boilg water nitrogs mat & salts. This does not apply to boilg in soups (A. J. Church).

Pure white bread is not so nutritious as that made from seconds flour, nor as that made from whole-meal. The entire removal of the bran, except for the delicate, is objectionable; as it contains a considerable amount of fat and phosphates. Where the branny particles cause indigestion or diarrhœa, the so-called wheat meal bread, in which the bran is much more finely divided, may be tried.

Pastry is less easily digested than ordinary bread. The lard or dripping added render it more flaky and less easily pulverised; and, in addition, the fat coats over the starch cells; and thus the action of the digestive juices on the pastry is impeded. Puddings made with suet are considered to be more digestible than those made with dripping or lard.

Potatoes, when boiled, ought to be inserted in boiling water. If put into cold water, and then the temperature gradually raised, much of the starch is changed into a gelatinous condition, and mixes with the water. When starch cells—whether in potato, bread, or any other food—are heated to the boiling point of water, they burst and liberate the starch granules in their interior, thus rendering them capable of being acted on by saliva. This is the chief object of cooking starchy foods. When starchy foods are boiled with water, a further change occurs, the starch granules being dissolved and converted into gelatinous starch. In this condition the starch is still more digestible. If the boiling is prolonged, dextrine (~~soluble starch~~ = $C_6H_{10}O_5$) may be produced, which must not be confounded with dextrose (*i.e.* glucose = $C_6H_{12}O_6$).

Potatoes ought be steamed rather than boiled, on account of the possible loss of some starch in the latter process. Potatoes are more digestible when mashed; when underdone, they are very objectionable.

Peas and **beans** ought to be boiled slowly and for a long time; otherwise they are very indigestible. If old, they ought to be soaked in cold water for twenty-four hours, then crushed, and stewed. Hard water must be avoided in the cooking of peas and

beans as well as of other vegetables, as the lime-salts form insoluble compounds with legumin.

Green vegetables require thorough and prolonged cooking. This deprives them of much air, and renders their tissues softer and more easily attacked in digestion. The members of the cabbage tribe and carrots can hardly be boiled too long. Soft water ought always to be used; this is one reason why steaming is preferable. Before boiling, all vegetables should be well washed in cold water. A little vinegar will remove any insects present.

Cooking Apparatus.—The apparatus required in cooking may be divided into kitchen utensils and cooking ranges. It will only be necessary to mention the most important of them.

Among kitchen utensils the **frying-pan** holds an important though much abused position. It is essential that it should be kept thoroughly clean, and that any given dish should not taste of its predecessor. Fat used for frying fish should not be used for any other purpose, unless the fish has been most carefully surrounded by bread crumbs.

The **gridiron**, if carefully employed, is a valuable means of cooking chops or steaks, etc. The bars of the gridiron should be kept perfectly clean; they should be heated before the meat is put on them; the meat should be turned by means of proper tongs, and never pierced by a fork; and the fire should be bright and clear.

The **saucepan** is useful for various purposes, such as boiling and stewing, and is an essential item in kitchen utensils.

A **digester**, of which Papin's digester is perhaps the most perfect form, is a strongly closed vessel in which substances may be boiled under pressure, the steam not being allowed to escape. By this means a much higher temperature can be applied, and all the gelatin extracted from bones, etc.

The **spit** is used for roasting large joints, and it has the great advantage over the oven, that empyreumatic oils are dispersed, and that the process of cooking is under the cook's eye, who can baste at frequent intervals.

Of all green veget^{s}. spinach is the ~~easiest~~ dig^{d}. bec^{s} a pulpy boil^{g}. Asparagus shd be tied in bundles & placed upright w. green bundles out of H_2O, so that they may not be overdone.

advant. in mov.ᵃ shelves, plate warmer &c Lge no. of pots can be
Kept boil.ᵍ at same time. Close dampers after cooking over, use
only dry. coal or cinders.

The **Dutch oven** is of great use for broiling small pieces of meat, and it combines the advantages of roasting and baking.

The chief forms of cooking ranges are the open range, the closed range or kitchener, the gas stove, and the charcoal stove.

An open fire range ensures good ventilation, and is consequently healthier than any form of closed range. On the other hand, it consumes an inordinately large amount of fuel; it is liable to produce smoke and dust, and only a very limited number of dishes can be cooked at the same time. It has been estimated that with an ordinary open fire-place, seven-eighths of the heat produced ascends the chimney and is entirely lost. More modern arrangements have diminished this loss, but it is still very great.

The best argument in favour of an open range is, that it allows the roasting of meat in front of the fire, a method of cooking which is unequalled by any other.

Kitcheners are, if properly attended to, economical of fuel; but if the cook is ignorant or careless, may burn more than an open range. They are advantageous, in that there is no danger of the downfall of soot during cooking, and that several different things can be cooked at the same time. The chief objections to them are, that they make the air of the kitchen hot and dry; that if there is any boiling over, commonly there is not sufficient ventilation to carry off the smell; that they require more care in management than an open range; and that in using them one cannot constantly baste a joint, as in roasting it before an open fire.

Gas stoves are very cleanly, and always ready for use. The consequences of tardy attention to fuel are not felt with them; and the amount of heat can be exactly and immediately regulated. When a constant fire is required, gas stoves are more expensive than other forms; and meat baked in gas stoves is said occasionally to have an unpleasant flavour. Much will depend on the ventilation of the stove (as also in the other forms).

Charcoal stoves are extensively used on the continent, and produce great heat without any flame. The fumes from burning

charcoal (largely composed of carbonic oxide) are extremely dangerous, unless there is free ventilation.

The economy and utility of the different ranges vary greatly with the management. A good cook may produce good results from any of them. Probably the most useful form is a combination of an open range and kitchener.

THE PRESERVATION OF FOOD.—All kinds of food tend rapidly to decompose and putrefy. Putrefaction only occurs when a warm and moist substance is exposed to the air. The problem of preserving any food, therefore, may be solved (1) by keeping it at a very low temperature, (2) by desiccating it, or (3) by boiling it in some liquid, so as to drive out all air, and then fastening it in an air-tight case.

Milk is commonly preserved as condensed milk, and in this condition is very valuable. A pure condensed milk is now supplied, prepared without the addition of sugar or any antiseptic, but boiled so as to deprive it of any disease germs. Milk may also be desiccated, and in this condition is very nutritive.

In addition to the household methods of preserving fruits, large quantities of fruits—both moist and dry—are now imported, protected by syrup or sugar, in sealed canisters; and they retain the original flavour almost unchanged.

The preservation of meat is effected by—

1. **Drying.**—This must be done rapidly. It is a process which is best applicable to fish, but has been applied also to beef. Dried Hamburg beef is used for making sausages, and is very nourishing. Pemmican, largely used by Arctic voyagers, consists of a mixture of meat and fat, dried and powdered along with some spices; it is generally eaten with some kind of meal.

2. **Cold.**—A sufficiently low temperature to destroy putrefactive germs, is now used as a means of bringing fresh meat from the United States weekly, and less frequently from Australia and New Zealand. A considerable amount of such meat is sold in the market as English meat.

Use of Saccharine.

Obs. look at int: of canister to see if it is light & crystl: shew? act: of veg: acids.

Pemmican cont: 35% albm: & ~~50~~ 50% of fat. In last Arctic Expedn men on boat Expedn fed only on it, devel? scorbutic diar?. If necess? to take this Sts Expedn shd be taken to get veget: food. The part? mastic? contents of stom. of reindeer are largely taken by Esquimaux & contents of stom. of cow or bullock eaten by Caffres in S. Africa, when veg: food cant be got.

If rigor mortis begun bef. freez?, putrefn begs soon after thaw? & is rapid. If meat frozen bef. it has bec. cold, rig. mortis occurs after thaw? & no ster tend? to decomp: than ord? meat.

Freez? arrests putrefn if already begun, & evidently conceals its odour. Thus bad cond: of fish often not discov? until cook?.

Smoking less effic^{s} than salt^{g} in preserv^{g} meat. Salt^{g} too may simply hold in suspense life of org^{sms}. Thus in convers^{n} of amer^{n} salt^{d} pork into Amer^{n} hams in this country - a process of resalt^{g} & subseq^{t} dry^{g}? - the specif. germ (a bacillus) has been again rend^{d} harmful.

dry^{g}
freez^{g}
smok^{g}
salt^{g}
ex
antis
coat
press
& air-tight

Salicylic Acid used esp^{l} to preserve wines, but in France a very strong enact^{t} agst its use

alb^{n} coags at temp^{s} betw. 60° C (140° F) & 77° C (170.6 F)
acc. to degree of concentn

3. **Salting** may be done with brine or saltpetre (nitrate of potassium); the latter does not decolourize the meat like the former. According to one plan (Morgan's), the brine is injected through the capillaries from the aorta directly after killing the animal. The objections to salted meats are that half the nutritive material, in the form of albumin and salts, is removed, while the remaining meat is harder and more difficult of digestion; also that the flavour of the meat is altered, and the excessive amount of foreign salts is injurious.

4. **Immersion in antiseptic liquids** or gases, as sulphite of soda, is objectionable, on account of the addition of extraneous, and not altogether innocuous, salts. Boro-glyceride, a compound of boracic acid and glycerine, is tasteless and non-poisonous, and is valuable in preserving meat from tainting during a hot season.

5. **Coating with fat or gelatine** has only succeeded in conjunction with the exclusion of air. This process is especially applicable to fishes, as tinned sardines. In a modified form, it is useful in coating potted meats, etc.

6. **Pressure,** by means of which the juices are extracted, is useful in preserving meat; but the resulting substance must be regarded as meat *minus* some of its most important constituents.

7. **Heat and Air-tight Cases.**—This plan has been found very useful, and is commonly adopted; tinned meats prepared according to this method being imported in large quantities. They are cheap, and might be adopted with great advantage to a much larger extent by the poorer classes. In the process of preparation, the cases are packed with meat and filled up with gravy, and then closed with a cover which is hermetically sealed, except at one point. The case is then heated to 250° Fahr., in order to drive out all air, and destroy any putrefactive germs present. The open point is sealed while the gravy is still boiling, thus making the case completely air-tight. Albumin is coagulated at 200° Fahr.; the higher temperature, which it is found necessary to employ, over-cooks the meat and renders it rather less digestible.

CHAPTER VII.

CONDIMENTS AND BEVERAGES.

Use of Condiments.—Condiments Proper.—Spices.—Flavouring Agents.—Acids.—Aërated Waters.—Mineral Waters.—Tea: Constituents, Mode of Preparation, and Effects.—Coffee: Constituents, Mode of Preparation, and Effects.—Cocoa: its Varieties and Preparation.—Minor Stimulants.

CONDIMENTS, ETC.—The name condiment is used in various senses by different writers. In its strictest sense it is a substance containing a volatile oil or ether, which may be taken with salt, and the object of which is to excite the senses of taste and smell, and consequently produce an appetising effect. This definition excludes *spices*, substances allied to condiments, but usually taken with sugar, as cinnamon, ginger, etc.; also *flavouring agents*, such as vanilla; and *acids*, such as vinegar and lemon-juice. If we use it in its widest sense, to include these various groups of substances, we find that all condiments are taken with the object of improving the taste or flavour of food, or of assisting its digestion; but that they are not foods in the sense of supplying any elements towards building up the body or maintaining its heat. The only partial exception is lemon-juice, the salts of which have a quasi-medicinal use, in addition to their utility in exciting the nerves of taste.

Taste is usually a compound sensation, the organs of which are the nerves of taste (in the tongue) and smell (in the nose). True taste is confined to the appreciation of sensations of bitter and sweet; but the flavour of meats is nearly entirely appreciated by the sense of smell. This is shown by the fact that meats appear tasteless and insipid, during "a cold in the head." In the appreciation of acid, astringent, and fiery substances, the sense of touch is also employed. The excitement of these different nerves results in

Mustard usl adult? w. wheat flour & a little turmeric. If sold as such is bet+ diluted. Fr. Iodi detects starch.

Pepper freq? adult. w. so-called pepper dust, or woody & mint. dirts

a stimulus which is carried up to the central nervous system, and causes, by reflex action, an increased flow of the digestive juices. Hot substances, like cayenne and ginger, also cause an increased flow of gastric juice, by directly congesting the mucous membrane. This action is not so desirable as that through the influence of the nervous system. All natural foods are sapid and possessed of flavour, and thus stimulate the nervous system; but any local irritating effect ought to be avoided.

1. **Condiments** proper comprise chiefly mustard, pepper, cayenne, garlic, onion, capers, mint, sage, morels, mushrooms, truffles. The last three on the list are also foods, but are more commonly used as condiments.

All these act as stimulants to the digestive organs, and in small quantities aid digestion. The active principle of mustard and horse-radish is sulphocyanide of allyl. Horse-radish is not so wholesome as mustard, the scraped root being apt to adhere to the stomach like the skins of grapes, and produce indigestion. Pepper contains an acrid resin, a volatile oil, and an alkaloidal substance, called piperine. Cayenne contains an analogous substance, called capsicin. Cayenne, unless in extreme moderation, is harmful, as its small particles adhere to the mucous membrane of the stomach, and may set up considerable irritation. *Catarrh.*

2. **Spices** are those condiments which contain an aromatic oil, and which harmonize with sugar. They are, as a rule, less irritating to the stomach than those of the pepper group. Cinnamon, cloves, camphor, ginger, and curry powder are the chief of these. Curry powder really belongs to both the first and second divisions. It is much more commonly used in hot climates than in this country. When genuine, it is said to contain turmeric, cardamoms, ginger, allspice, cloves, black pepper, coriander, cayenne, and a few other substances.

3. **Flavouring agents**, such as vanilla, lemon peel, fruit essences, and oil of bitter almonds, are used to give a pleasant flavour to various dishes. The oil of bitter almonds is dangerous, owing to

the uncertain, but often large, amount of prussic acid contained in it. Its place is being largely taken by nitro-benzol, which is rather less poisonous.

4. **Acidulous** substances are taken chiefly because of their sharp and agreeable taste. Vinegar is the chief acid employed. In small quantities it does not stop digestion, but, by exciting the nerves of taste, may be of actual service. With salads it is invaluable; also for use with shell-fish and for pickling fish, etc., in warm weather. In large quantities it diminishes the power to assimilate food, and for this reason has been proposed as a remedy for obesity. In order to remedy the latter, however, it must be taken in injurious quantities. Citric acid and lemon-juice are useful for their refreshing properties, and the latter also because of its alkaline salts.

Oils, such as salad oil, have been sometimes classed under condiments, but as they have great nutritive properties, this is hardly accurate. For the same reason, **salt** is not classed under this head.

Beverages.—Water is the universal beverage, and for healthy persons is preferable to any other. All other beverages necessarily contain it as their basis.

It will be convenient to consider first aërated and other natural waters; then tea, coffee, and cocoa; and finally, alcohol.

1. **Aërated Waters**, of which soda water may be taken as the type, contain carbonic acid in solution, which gives to them their characteristic sharp taste and sparkling character.

So-called **Soda Water** is prepared on a large scale as follows:—Carbonic acid is obtained by the action of diluted sulphuric acid on chalk, sulphate of calcium being left behind. The carbonic acid is forced into water, which dissolves about five times its volume of the gas. This preparation is simply a solution of carbonic acid in water under pressure; the true soda water, however, consists of a solution of thirty grains of bicarbonate of soda in a pint of water, saturated with carbonic acid at a pressure of seven atmospheres.

Soda water acts as a sedative to the mucous membrane of the

Best vinegar is made f. wine, ord^{y} f. malt 0.1 % c
H_2SO_4 allow^{d} by excise. Is slightly anti-scorbutic
Rend^{s} cell tiss^{e} of pickled veget^{s} hard & indig^{e}.
Less than 3% $C_2H_4O_2$ indicts dilut^{n} w. H_2O (Soc. Analyst)
Ord^{y} a little cloud^{y} w HNO_3 & $BaCl_2$: heavy if sulphs
adult^{n} w. H_2SO_4.
Traces of Cu prod^{e} blue colour w. sol^{n} NH_3 – brown ppt w K_4FeCy_6
Cu esp^{y} in veg. used for pickles – detect^{d} by insert^{n} bright blade
of steel knife.
Sp. gr. below 1015 indicts add^{n} of H_2O.

30 gns ad. 01

stomach, and is therefore useful for vomiting. Mixed with milk it renders the latter much more digestible for two reasons:—1st—It neutralises any acids present, which have been produced by partial fermentation and souring of the milk. One of the chief reasons why cow's milk is apt to disagree with babies is, that it tends to become acid, while human milk is alkaline. 2nd—The dilution of the milk renders what clot is formed much less dense and heavy.

Potass Water is prepared by passing carbonic acid gas under a pressure of seven atmospheres into a solution of thirty grains of bicarbonate of potass in a pint of water. It is antacid in its action, and is very useful in certain gouty conditions. The carbonic acid it contains, as in the case of soda water, has a sedative influence on the stomach.

By means of an apparatus called a seltzogene or **gazogene**, simple carbonic acid water can be prepared at home. A solution of tartaric acid acts on bicarbonate of soda, and the carbonic acid obtained is dissolved under pressure in water. It is very useful as an addition to milk; and with various fruit syrups and water forms a most agreeable beverage.

In addition to the above, there are many other aërated waters, which are used partly as beverages and partly for their medicinal properties. Of these, perhaps seltzer and apollinaris waters are the most popular.

The accompanying tables give the composition of these two favourite waters:—

Analysis of Seltzer (Bergmann).—Sp. gr. 1·0027.

Each Wine-Pint contains—	
Carbonic Acid	17 cub. inch
Carbonate of Soda	4 grs.
Carbonate of Magnesia	5 ,,
Carbonate of Lime	3 ,,
Chloride of Sodium	17 ,,
	29 ,,

Analysis of Apollinaris Water made by Professors G. Bischof and Mohr, and Drs. C. Bischof and Kyll.

FIXED CONSTITUENTS OF 10,000 PARTS.		
	Old Analysis.	Mean of Eight Analyses Made During the Year 1877.
Carbonate of Soda	12·57	9·555.5
Chloride of Sodium	4·66	3·764.5
Sulphate of Soda	3·00	2·124.25
Phosphate of Soda...	Traces	—
Salts of Potash	Traces	—
Carbonate of Magnesia	4·42	3·775
Carbonate of Lime...	0·59	2·608
Oxide of Iron, with Alumina ...	0·20	0·068.5
Silicic Acid...	0·08	0·137
	25·52	22·032.75
VOLATILE CONSTITUENTS.		
Free and semi-combined Carbonic Acid		27·76
Combined Carbonic Acid		8·07
		35·83

Lemonade is commonly a very dilute solution of sulphuric acid, flavoured with oil of lemons, and impregnated with carbonic acid. It occasionally contains an injurious amount of lead, especially when kept in syphon bottles. Home-made lemonade, obtained by squeezing the juice of a lemon into water, sweetening to taste, and then, if desired, impregnating with carbonic acid from a gazogene, is much more wholesome.

In addition to aërated waters, there are other mineral waters, employed chiefly for their medicinal properties. These are chalybeate, saline, or sulphuretted.

Chalybeate Waters owe their value to the iron they contain.

Pb diss? from pewter fittings, or fr. Pb pipes

1% proof spt allow? in temper? beverages by Excise.

This may exist as carbonate of iron, held in solution by excess of carbonic acid, as in Tunbridge Wells and Harrogate waters; or as sulphate, as in the waters of Sand Rock (Isle of Wight), Brighton, etc.

Saline Waters contain various salts, and may be sub-divided according to the nature of these. Some contain sulphates of magnesia and soda, as those of Seidlitz, Carlsbad, Püllna, and Friedrichshall. Some contain chiefly carbonate and sulphate of lime, as those of Buxton and Bath. Some contain chiefly chlorides, as those of Baden-Baden and Kreuznach; while others contain a large amount of alkaline carbonates, as those of Vichy and Ems.

The following table, from Sir H. Thompson's work, gives a comparative synopsis of the chief saline contents per pint in some important mineral waters, omitting common salt and other less active agents, which are also present :—

	SULPHATE OF SODA	SULPHATE OF MAGNESIA	CARBONATE OF SODA	OTHER INGREDIENTS
Saline :—				
Püllna	154 grs.	116 grs.	—	—
Hunyadi Janos ...	150 ,,	148 ,,	—	—
Friedrichshall... ...	58 ,,	49 ,,	—	Little Iron.
Marenbad (*Kreuz*)	48 ,,	—	9 grs.	
Carlsbad (*Sprüdel*)	25 ,,	—	13 ,,	
Franzenbad	30 ,,	—	6 ,,	
Alkaline :—				
Vichy (*Celestins*) *about*	3 ,,	—	47 ,,	Little Iron.
Vals (*Magdeleine*) *about*	—	—	65 ,,	

The following table gives a more detailed analysis, by Schwartz, of the constituents of a pound (7,680 grains) of some of the chief German mineral waters :—

CHEMICAL INGREDIENTS	Hunyadi	Friedrichshall	Kissingen	Seidschütz	Püllna	Seidlitz
	Vienna Grains					
Sulphate of Magnesia ...	137·98	39·55	39·50	84·16	93·08	104·00
Sulphate of Soda	128·97	46·51	46·59	46·80	123·80	—
Sulphate of Potash ...	1·67	1·52	--	4·09	4·80	—
Chloride of Sodium ...	11·54	61·10	61·10	—	--	—
Carbonate of Soda ...	13·20	—	—	—	—	—
Carbonate of Lime ...	6·04	0·11	—	—	0·77	8·00
Oxide of Iron and Argillaceous Earth ...	0·08	latent	—	1·19	—	—
Silicic Acid	0·09	,,	—	0·03	0·17	—
Carbonate of Magnesia	—	3·99	—	4·98	6·40	3·00
Sulphate of Lime	—	10·34	—	10·07	2·60	8·00
Chloride of Magnesium	—	30·25	30·20	2·16	19·66	3·00
Nitrate of Magnesia ...	—	--	—	25·17	—	—
Bromate of Magnesia ...	—	0·87	latent	—	—	—
Chloride of Lithium ...	—	—	0·09	—	—	—
	299·57	194·24	177·48	178·65	251·28	126·00
Carbonic Acid, free and half combined	8·02	5·32	5·09	latent	latent	—

Sulphuretted Waters contain sulphuretted hydrogen in solution, and commonly an alkaline sulphide. They are readily recognised by their odour. Harrogate and Aix-la-Chapelle waters are instances of this kind of mineral water. They are useful chiefly as stimulants to the skin and in rheumatism.

Tea.—Tea is the leaf of an evergreen shrub which is cultivated in China, and to a less extent in Japan, British India, Ceylon, Java, and other countries. In 1871, the consumption of tea in the United Kingdom was 3 lbs. 15 oz. for each individual.

The finest tea consists of the first young leaf-buds. The chief

Tradit^n relates that a cert^n Prince Darma, migr^d. f. Ind^a to China & their liv^d. in open air, vow^d his days to fast^g & his nights to vigils. One day overcome w. fatigue, he fell asleep. Was so shocked at his lapse f. duty, that he determ^d. to sacrifice the offend^g members, & cut off his eyelids & threw them on the ground. Next day was surprised to discov. that a new shrub had sprung up in the place. He last^d the leaves, f^d them exhilarating & recom^d. to his followers.

Tea - lanceol^{te}. leaf w. serr^{te} edge ; veins not reach^{g} edge of leaf.
Soak leaves in hot H_2O & caref^{y} unroll. Can be rend^{d}. transpt by enclos^{g} betw 2 cover glasses, & after plac^{g} wt on upt glass stings heat^{g} w. alk. sol^{n} $KMnO_4$. afterds heat w. stmg HCl, wh. dissolves manganic oxide, leav^{g} char^{d} skeleton of leaf.
Exhaust^{d} leaves only recog^{d} by anal^{s}is.
Ferrug^{s} part^{s} may be coll^{d} by a magnet test^{d} by HCl + $K_4Fe Cy_6$ — are add^{d} chiefly to exhaust^{d} tea to deepen infus^{n}
Sand recog^{d} by microsc^{e}
Rob^{d} lge excess NaCl in salvage teasp. medks.
Exhaust^{d} tea rolled up w. gum spaced to imit^{e} 'superior', sold as 'lie tea'. In facing black tea is mix^{d} w. plumbago & green w. china clay, indigo, & turm^{c}.
The vast extens^{n} of tea cult^{n} in Ind^{a} & lower price rend^{s} adult^{n} less profit^{e} & theref. less frequ^{t}

Aq^{s} extract of tea at least 30 %, of pure coffee 25-30 %, of chic^{y} 65-70 %.

Black tea subj^{d} to a process of ferment^{n} bef. dry^{g} (W.)

gathering of leaves takes place later in the year; and a third gathering, when the plant is somewhat exhausted, supplies an inferior quality. The flavour of tea depends largely on the nature of the soil and situation, on the time of year when the leaves are gathered, and on the mode of preparation. A genuine Congou tea may be obtained for two shillings a pound or less, while two guineas per pound may be given for the Russian caravan tea; the difference in price being to some extent justified by the difference in flavour. The amount of theine in both is the same, viz., about three per cent. Where expense is no consideration, ordinary Congou may be mixed with some of the choicer varieties of tea, such as Souchong, Kaisow, or Orange-flavoured Pekoe.

There are four leading constituents in all the varieties of tea, viz.: (1) volatile oil, (2) theine, (3) gluten, (4) tannin.

(1) The **Volatile Oil** gives the aroma and flavour to each particular tea. It is this which causes the headache, trembling, wakefulness, and restlessness, occasionally produced by tea. These effects generally follow the use of green tea and fresh new tea, which contain a larger amount of volatile oil than ordinary black tea. Green tea is prepared from the young leaves, and is dried more rapidly than black tea, which may explain the larger amount of volatile oil contained in it.

(2) **Theine** is an alkaloidal crystalline principle, rich in nitrogen. Its composition is represented by the formula $C_8H_{10}N_4O_2$, H_2O, and it is identical with the caffein of coffee. It is allied to quinine in composition, and in large doses would be poisonous. The theine in tea may amount to three or four per cent.; in coffee it is less than one per cent. (0·8). There is no difference in the amount of theine in black and green tea.

Theine is the most important constituent of tea and coffee. It will be convenient here to consider its effects on the system. Moderate doses increase the strength and rapidity of the heart's action; the activity of the brain is usually increased at the same time. The excretion of solids by the kidneys is increased, so that

tea forms a useful diuretic in some forms of dropsy. The effect on the tissue-changes of the body is somewhat doubtful. It is generally stated to arrest or diminish the waste, or rather the oxidation, constantly going on in the system, and so diminish the amount of food required to repair this waste. This is, however, very doubtful; we cannot conceive the likelihood of the development of force without a corresponding expenditure of material, and that is what would be the case if theine increased the activity of various organs while retarding their waste. The experiments of Conty and Guimarès on the action of coffee, confirm this view. They find that this (and tea has the same essential constituent) is not a preventer of tissue waste; but that the nutrition is improved by it, because, when not taken in excess, it increases the appetite and the assimilation of nitrogenous food.

(3) **Gluten** is contained in tea leaves, and gives them a positive nutritive value; very little of it is, however, obtained when an infusion of tea is made. The addition of soda to the water extracts more of it; and the Japanese grind the leaf to powder, and after making an infusion with boiling water, drink powder and all.

(4) **Tannin** exists in tea to the amount of 15 to 20 per cent. It is a powerful astringent, and possesses a bitter styptic taste, and a constipating effect on the bowels. Not much of it is extracted from the leaves, unless the tea is allowed to "brew"—that is, stand near the fire for a considerable time before being drunk.

The Mode of Preparation of Tea is of great importance. According to the plan pursued, tea may form a pleasant, refreshing, and stimulating beverage, or a liquid capable of exciting severe indigestion. The Chinese put the tea leaves in a cup, and having poured hot water on it, drink the resulting infusion after a very short time, without mixing any other material with it. The Russians drink it with a squeeze of lemon, and with or without sugar. We add cream or milk and generally sugar, and so render it more nutritious, though the delicate flavour is somewhat veiled. There can be no doubt that the Chinese plan of infusion for a

The talk abt alcoh. arrest? waste of tiss?. & same for tea, is nonsense. compar? to not? of squar? circle or perfect motn. Life is flux, change, metamorph. (Brinton) The waste of the system is the measure of its work.

Ash of tea should be over 8% (Soc Pub. Analysts)
Cl? in tea leaf fused w. fresh mixt. turns green.

Acc. to Sir W. Roberts inhibt effect of tea on dgn can be prevd by add 10grs of Na Carb to 1oz. dry tea leaf.

Heat a powerful stimult to heart: but practice of drinking hot tea apt to prodc gastric catarrh.

short time is the best, as it ensures the extraction of the aromatic and stimulant principles of the tea without the tannin.

In making tea it is important to use a tea-pot which is quite dry, in order to avoid mustiness; to pour a small quantity of boiling water into the tea-pot and then out again, so that the infusion may be made at the temperature of boiling water; to use moderately soft and boiling water, pouring it on the tea-leaves; and not to infuse longer than five minutes, keeping the tea-pot under a "cosy" during this process. For persons of weak digestion, the best kind of tea is that obtained by pouring boiling water on the leaves, and then immediately pouring the resulting infusion into another vessel. In all cases where tea has to be kept a considerable time, it should be poured into a second tea-pot, the leaves being left behind.

Indigestion is not an uncommon consequence of tea-drinking. It is not always due to the same cause. In some cases it is due to the liquid being drunk too hot; in others, to the tea itself (aromatic and alkaloidal parts); and in others, to the tannin; while in some cases it is certainly due to the mode of drinking the tea.

The most injurious material in tea is probably tannin; and it has been already stated that this is only present in very small quantities when the tea is properly made. Tannin retards digestion, and produces constipation. Badly-made tea ought, therefore, never to be taken with a substantial meal. The tannin coagulates albumin, and prevents its solution by the digestive juices. For this reason "high teas" and "tea-dinners" are objectionable.

The practice of drinking tea in small sips, with bread and butter, etc., is a prolific source of indigestion. The bread ought to be moistened by the saliva, and thus its digestion helped; but when the tea infusion usurps the place of the saliva, the stimulus to the nerves governing the secretion of saliva is gone, and the secretion becomes deficient. Tea ought only to be drunk at the end of a meal, and, in fact, it would be much better if "tea" were not made so complete a meal, as it commonly is at the present time

among the middle and lower classes. The practice of drinking tea with every meal is inexcusable.

For quenching thirst during active exercise, and rendering possible prolonged exertions, tea is unsurpassed. On the continent, and wherever the drinking-water is unreliable, weak tea or some other beverage ought to be substituted. The mineral waters, such as Apollinaris and Seltzer, come in useful here, and are much safer than the water which is commonly offered to travellers.

Coffee.—Coffee is the seed of the berry of the *Coffea Arabica*, belonging to the same class of plants as yields the Peruvian bark. Each berry contains two seeds, or beans as they are sometimes incorrectly called. The coffee is prepared by roasting the seeds until they assume a reddish-brown colour, in which process they lose 15 per cent. in weight and gain 30 per cent. in bulk. During the process of roasting, a volatile oil, having a powerful aromatic smell, is developed. This is not produced in such large quantities from fresh seeds; the best time for roasting varying, however, for different varieties of coffee. Thus the small Mocha seeds will yield a full-flavoured coffee within a year of their being collected; the larger American coffee, if roasted within a year, develops but a poor aroma, but if kept for seven or eight years becomes quite as aromatic as the Mocha. A mixture of one part of Java and two parts of Mocha coffee seems to yield a more aromatic beverage than either of the two alone (Brunton).

The amount of **Volatile Oil** in coffee is much less than in tea. As it is elicited during the process of roasting, it is essential that this should be done with great nicety and care. It is performed in an iron cylinder made to revolve over a fire. After the roasting, the sooner the seeds are ground the better the coffee. When it cannot be immediately used, it should be kept in closed canisters, and not in paper or open jars.

In addition to the volatile oil, which is contained in roasted coffee in the proportion of about 1 part in 50,000, coffee contains **caffeine**, of which there is $\frac{3}{4}$ to 1 per cent.; and an

Coffee

1. aroma excellent
2. taste, aromc not bitter
3. no caking on firm pressc.
4. sinks slowly on water, & hardly colrs it (13-16 % fat)
5. aq. extt 25 - 30 %
6. Ash abt 4 - 4½ %
7. silica unweighable
8. microsc. — hexagl. thick walled cells - spiral vess contins if present : no scalarif vess.

Chicory

1. aroma poor.
2. taste heavy & bitter
3. caking on pressc w. fingrs
4. sinks on water & colours rapidly (large caramel).
5. aq. extt ~~at least 30 % (food & tonics)~~ 65 - 70 %.
6. ash 6½ - 7½ %
7. silica abt 1 % (chic root)
8. microsc. — scalarif. vess & laticifs tubes.

Caffein $C_8H_{10}N_4O_2$

Inasmuch as abt 3 times as much coffee as tea used to prodc a cupful of beverage, caffein is eq. to or gtr than theine.

Microsc. exam^n quite char^c differ^s fr pt of coff. bean
fr m. ang^r cells, cont^g in raw state oil globs. In roast^d
outline rec^s less clearly def^d., oil globs broken up, while shrivel^d
contents form ang^r dark masses at one side of ea. cell. Frag^ts
of the thin memb. cont^g in cleft of bean, shew^g long oblique
fusif. cells side by side v char^c No starch gran^s.
In chicory ye oval cells, n^t ang^r n polygl.; also
char^c laticifers res^g in scalariform mark^gs

No limit fix^d by law as to prop^rs of coff & chic^a. Use of fancy names
as "French coffee", constit^s the art^e a "preparat^n" within mean^g of the act
as "French coffee", constit^s the art^e a "preparat^n" within mean^g of the act
Same appls to date coff. malt coff - &c. Prop^rs of chic^a shd be
stated in mixt^s.

Percolator - invent^d by C. Rumford, an upr. cylind^l res. perf^d at bot^m In this pd
coff. is placed & cov^d w a perf^d disc, hav^g a stem by wh. it can be pres^d down, so as
to compact the coff & allow boil^g water to percolate thro. the mass & fall into
the res. below.

astringent acid, called caffeo-tannic or caffeic acid, which differs from ordinary tannin in that it does not blacken a sclution of an iron salt. This acid is somewhat altered by roasting, but retains its astringent properties. Also 13-16 p.c. fat, diminished by roasting.

The chief adulteration of coffee is **Chicory,** which is thought by some to improve the coffee. It is generally harmless, though in some people it produces heartburn and diarrhœa. Chicory is prepared from the root of the wild endive, belonging to the same tribe as the lettuce and dandelion. It contains a volatile oil and a bitter principle, but nothing analogous to theine or caffeine. It is therefore of no utility as a stimulating or refreshing agent. Its presence can be detected by shaking a little of the suspected coffee in a wine-glassful of cold water. Coffee swims on the surface, and gives little or no colouration to the water; while chicory sinks, and gives a deep red tint.

The leaves of the coffee plant contain nearly as much theine as those of the tea plant, and are said to be preferred by the Sumatrans to the seeds. They are prepared by roasting in the same way as tea. When insufficiently roasted, they tend, like green tea, to produce sleeplessness.

The Preparation of Coffee ought to be effected as in the case of tea—by making an infusion and not a decoction, *i.e.*, by pouring boiling water on the coffee and allowing it to stand, but not continuing the boiling. Continuance of boiling dissipates the delicate aroma.

Inasmuch as coffee contains a much smaller per-centage of theine than tea, more of the former must be used to obtain a beverage equally refreshing with tea. One ounce to a pint of boiling water is barely enough (Dr. V. Poore). The best plan is to make a strong infusion of the coffee, and mix this with an equal part of boiled milk. The coffee ought, if possible, to be freshly roasted. The Arabs seem to have little regard for the aroma, as they make a decoction of the unroasted seeds, and consume this with the grounds.

The colour of coffee is no guide to its strength. Many of the black coffees owe their colour to the caramel (burnt sugar) they contain. A mixture of coffee and chicory gives an infusion of higher specific gravity (1020·23) than pure coffee (1009·10), but is much more liable to upset the stomach.

Coffee has similar properties to tea, with some minor differences. (1) Like tea, it is restorative and sustaining in its action, but seems to act more quickly than tea, probably on account of the absence of tannin. (2) Unlike tea, it does not tend to produce perspiration, but rather a dry hot skin. (3) With some it is decidedly laxative; while tea, especially if badly made, has an opposite effect; but this is not always the case. (4) It seems to have a greater power of antagonising the effects of alcohol than tea; and besides this, is a valuable antidote, after the action of an emetic, in poisoning by opium or arsenic or alcohol.

The effect of coffee on digestion varies somewhat. As a rule, it is not so prone to disorder the digestion as tea, but this is not universally true, and in some persons it always produces biliousness. When taken in excess, it produces—besides indigestion—palpitation, restlessness, irritability, sleeplessness, and a condition of general nervous prostration; in fact, similar symptoms to those produced by a prolonged over-indulgence in tea.

It is curious, that while the consumption of tea is rapidly on the increase, that of coffee is steadily diminishing. This is partly owing to the greater expense of coffee—a larger quantity being required to form a good beverage; partly to the greater difficulty in preparing good coffee; and to some extent to the adulteration with chicory, dandelion, etc.

Cocoa.—Cocoa, or more properly cacao, is obtained from the seeds of the Theobroma Cacao—a native of the West Indies, Mexico, and the central parts of America. Its name Theobroma was given it by Linnæus, and means the "food of gods." The fruit is a large leathery capsule, having nearly the form of a cucumber. It contains from 25 to 30 seeds, each about the size of

Use of coffee after dinner is a tacit admiss. of alcoh: excess.

Pall Mall Gazette (Nov. 10. 87) states that consumpn of Copper per head in U. States is 7¾ lb, in Germ.y 5-lbs, in France 2¾ lb & only 15 oz. in this country. On Continent head of household will get up in morn.g & grind the coffee, regard.g it as a specialty, like the making of a salad.

Chic.y is a root wh. can be bought at abt. £16-17 per ton, while Cof. is a bevy at abt £95 per ton.

an almond. Before using, these are roasted like coffee berries, and a peculiar aroma is developed in this process as in the case of coffee. The beans or seeds are then manufactured into three different products. (1) They are simply deprived of their husks and broken to pieces; this forms **Cocoa-Nibs.** (2) They are ground, husk and all, between hot rollers, into a paste, and mixed with starch and sugar; this forms **Cocoa.** (3) They are shelled and then ground into a paste, as in making cocoa; sugar and some seasoning, usually vanilla, being subsequently thoroughly mixed; this paste is **Chocolate.**

The purest form is the cocoa-nibs. When these are boiled in water, a brownish decoction is formed, with the fat as a scum at the top; this may be removed, and the decoction flavoured with milk and sugar. In this form, cocoa can be taken by invalids with weak digestion, who would be nauseated by the fat of ordinary cocoa or chocolate.

The shells or husks, which are separated from the beans before the preparation of chocolate or cocoa-nibs, contain theobromine; hence they yield on boiling a stimulant beverage, which may be used instead of tea or coffee, and possesses the advantage of being cheaper.

The best cocoa is prepared as above; but the lowest quality contains the husks of the beans, with hardly any of the beans in it; a somewhat better, though still inferior sort, is made from the smaller fragments of the nibs, and a good deal of husk. In some cases the cacao butter is removed during the process of preparation, and starch or sugar substituted. This form is less likely to disagree with dyspeptics than ordinary kinds of cocoa.

The usual way of preparing cocoa is to put a large tea-spoonful of the powder into a cup, mix it thoroughly with a little boiling water, and then fill up with water, and add sugar and milk to taste. A still more nutritious beverage is obtained if a larger amount of milk is employed. An equally stimulating and less heavy beverage is obtained by infusing the nibs, and removing the fat.

Chocolate is made into a beverage by scraping down the cake, and then mixing, as in the case of cocoa, with boiling water or boiling milk. It is taken on the continent as a thick paste; in England it is made more liquid.

Cocoa presents some striking resemblances to tea and coffee, and some points in which it is very different. The following table of the composition of the whole bean, as given by Johnstone, brings these out:—

Water	5
Starch, Gum, etc.	22
Gluten, etc.	20
Oil (Cacao-butter)	51
Theobromine	2
	100

It resembles tea and coffee in possessing an alkaloid, theobromine, which has like properties with theine; but differs in composition and mode of preparation for drinking. The starch, gluten, and oil render cocoa highly nutritive; and the fact that it is made into a decoction enables these substances to be taken in the liquid.

The action of the **Volatile Oil** (not the cacao-butter) developed during roasting, is probably similar to that of tea and coffee, though it is less in amount. The bitterness is greater than that of coffee, but the astringency less than in either tea or coffee.

The **Concrete Oil**, or fat of cocoa, forms about half its weight. It is white, and not apt to turn rancid, and possesses an agreeable flavour. The starch and gluten with the cacao-butter, render cocoa a most nutritious article of diet.

Theobromine is a white crystalline alkaloid, the exact analogue of caffeine or theine. The latter, in fact, is methyl-theobromine—that is, theobromine *plus* the theoretical group CH_2. Recently theobromine has been artificially converted into theine.

So rich in nutritious matter is cocoa, that it bears a close

In ~~Extracts~~ of Cocoa 20% of cocoa butter is the minimum admiss (Soc^y P. Analysts)

In 3 diffᵗ contins. f. time immemᵗ. beverages made
f. theine-contᵍ plants — tea, coffee, paraguay tea,

resemblance to milk, the typical animal food. The resemblance and the difference are well shewn in the following table from Johnstone:—

	DRIED MILK.	DRIED COCOA BEAN.
Casein or Gluten...	35	21
Fat	24	51
Sugar or Starch, etc....	37	22
Mineral or Saline Matter... ...	4	4
Theobromine	—	2
	100	100

The presence of theobromine gives an exhilarating and stimulating influence to cocoa, which is not possessed by milk. The excess of fat in cocoa is liable to derange weak digestions: this is commonly obviated by abstracting some of it, and substituting sugar.

Minor Stimulants.—The almost universal use of beverages containing theine, or some analogous principle, leads one to infer that they supply a generally felt want. It has been commonly supposed that they produce their supporting and exhilarating effect by diminishing tissue-waste, but we have given some facts throwing doubt on this conclusion. In moderate doses, they assist the assimilation of other foods, and probably increase respiratory processes. Their main influence, however, is on the nervous system; and their remarkable effect on this is, doubtless, the reason why they are so universally used. Theine-containing substances may be described as both sedative and exciting. They are sedative, in that they allay nervous irritability, and tend to "take the edge off" the disturbance caused by outward circumstances; and they are exciting, inasmuch as they are known to form an admirable antidote to the stupefying effects of opium or alcohol. The wakefulness from tea is an instance of the same

thing, while the allaying of sensations of cold and hunger by a cup of tea is an instance of the sedative effect.

In addition to the stimulants belonging to this group, which have been already named, there are a few others in less frequent use.

In Brazil, **Guarana** (from *paullinia sorbilis*) is used as a substitute for cocoa; it contains theine, however, not theobromine. The quantity of theine in it is twice as much as in good black tea, and five times as much as in coffee. Like green tea, a cup of guarana infusion is sometimes extremely valuable in nervous headaches.

In Peru, the natives use the leaves of the **Coca** plant *(erythroxylon coca)*, which must be carefully distinguished from cocoa. It is chewed somewhat in the same way as the betel-nut. It contains two alkaloids—cocoaine and hygrine, as well as tannin. In its stimulant action it resembles tea and coffee.

The **Cola-nut** is used in some parts of Western Africa as a stimulant. It is about the size of a pigeon's egg, and has a bitter taste. The natives of Guinea generally take a piece of the seeds before each meal, and sometimes nibble it throughout the day.

Kava is prepared from the root of a kind of pepper. The natives of the Fiji islands commonly indulge in it. Its effects resemble those of coffee. In large doses, it destroys the power of walking, and may possibly produce impairment of vision.

The leaves of the *Thea Paraguayense*, *Thea Gongorrha*, and *Thea Theezans* are made into the beverage commonly known as **Paraguay tea** or maté.

The leaves of the **Hydrangea Thunbergii** are made into a beverage, which is designated in Japan "the tea of heaven."

Peruvns deified the Coca tree, its leaves were afterds used by the Incas for money. Acc? to Sazeau the power of fast? impart? is autophagous.

Kola nut fr. the Stercularia acuminata. Cont?. consid? caffeine & less amt of theobrom. & tannin.

Cannabis Ind? = haschisch - smoked & drunk by Malays

Amanita muscaria - (Fly Agaric)

Opium

Tobacco

Betel-nut (Areca Catechu) eat?. w. quicklime & pepper rolled up in a sm. palm leaf. Makes saliva blood-red.

Chief forms of zymogenic actⁿ or fermentⁿ are
1. alcohˡᶜ 2. lactic. 3. viscous 4. acetic.
5. ammoniˡ. 6. butyric. 7. putrid fermentⁿ
Alw. due to microbes destitᵉ of chlorophyll & gen. anaerobic
obtᵍ O. necessˡ for their growth & actⁿ f. the oxidˢ compdˢ in the
liqᵈ in wh. they grow. But the micrococ. of meat & the
phosphorescence of putrid meat & fish are aerobic.

In 1836 Cagniard de la Tour discovd the yeast plant.
Fermentⁿ of grape juice is alw. accompd "spontaneously"
with[t] addⁿ of yeast, bec. the necessˡ ferment grows as a
parasite on the ripe grape & stalks by vine.
If never left this fermentⁿ to chance, it wd be slow bec.
qty of yeast f. air is small & unsatisfˢ bec. other organisms
wd also fall in & prodᵉ other fermentⁿ. Weeds wd
choke the yeast plant. By cultivⁿ weeds are kept under.
Now microscᶜ examⁿ of yeast. Boston brewer has learnt
money value of preventive medᵉ as applied to wort.
Bactª wh. are apt to infest breweries wl not live at a temp.
in wh. the yeast plant will flourish, hence practice of
fermentᵍ at a low tempᵉ is becᵍ constˢ soˢ in Germany.

Cells of yeast plant abt $\frac{1}{3500}$" wide. Cell wall, protopl. vacuole & nucleus.
Multiplˢ by budding & spores. Mix a drop of yeast w. Oi of fld cntᵍ sugar
ashes of yeast-plant & a little NH_4 Fattˢ. – after a few hrs myriad cells prodᵈ. Therefore
yeast cells can manufᵉ protein & cellulose from mineˡ salts.
During fermentⁿ incˢ tempᵉ. Distill clearingˢ after fermⁿ until $\frac{1}{4}$ passes over into
receiver. Distillˢ freed f. H_2O by addⁿ of Ca O. allowᵍ to stand 24 hrs & then redistillˢ. – this
is pure alcohˡ. Acc. to Pasteur out of 100 parts by wt of sugar wh. enter into fermentⁿ
95 parts decompᵉ into alcohˡ. & ~~H₂O~~ CO_2, 4 parts go to form succinic acid & glycerine
& 1 parts disappˢ have ᵍ serv. as nourishˢ for yeast-plant dur. its growth.

CHAPTER VIII.

FERMENTED DRINKS.

Properties of Alcohol.—Effects produced by moderate quantities of Alcohol.—Effects of Immoderate Quantities.—Circumstances Modifying the Action of Alcohol.—Is Alcohol Advisable as an Article of Diet?—The Varieties of Fermented Drinks.

PROPERTIES OF ALCOHOL. — When a saccharine solution is subjected to the influence of warmth and moisture, and exposed to the air, it rapidly undergoes a process of **fermentation.** The most favourable temperature is about 70° Fahr. The ferment or agent exciting the change in the sugar is derived from the atmosphere; it is a minute fungus (torula cerevisiæ), the spores of which are constantly floating in the air. When once fermentation has started, exposure to the air is no longer necessary; the process continues in closed vessels. The essential change occurring in the vinous fermentation is that grape sugar ($C_6H_{12}O_6$, H_2O) becomes split up into alcohol (C_2H_5OH) and carbonic acid (CO_2). Thus—

$$C_6H_{12}O_6 = \begin{cases} C_2H_6O \\ C_2H_6O \end{cases} \text{Two of alcohol.} + \begin{cases} CO_2 \\ CO_2 \end{cases} \text{Two of carbonic acid.}$$

There are other fermentations allied to the vinous. Thus the **Acetous** fermentation results in the conversion of alcohol into vinegar, as in the souring of beer or wine. The **Lactic** fermentation leads to the conversion of milk-sugar into lactic acid, with consequent souring of the milk.

Putrefaction is a process allied to fermentation, occurring in more complex and nitrogenous bodies, and accompanied by the formation of various fœtid products.

Alcohol, or more correctly ethylic alcohol, is a colourless liquid, having a pleasant vinous odour, and evaporating rapidly on exposure to air. It burns with a bluish sootless flame, and is a capital solvent for resins and other substances. Absinthe is a strong spirit,

containing oil of wormwood in solution. Proof-spirit is a mixture of about equal parts of water and alcohol. The fermented drinks containing alcohol may be classed as (1) malt liquors, (2) wines, and (3) distilled spirits. The relative properties of these will be considered afterwards; in the next two sections will be considered the effects of diluted alcohol in whatever form it is taken.

Effects of Moderate Doses of Alcohol on the System.—In studying the physiological effects of alcohol, one has to guard against the fallacy that these are the same, only differing in degree, whatever the dose may be. The effects of large doses of alcohol are almost exactly the reverse of those produced by small doses. It will be necessary to define, therefore, what we mean by a moderate dose. By a moderate dose, we understand the amount of alcohol which can be taken without any alcohol being eliminated in the urine. Dr. Anstie found that 1½ ounces of absolute alcohol, taken in the twenty-four hours, caused its appearance in the urine; and Dr. Parkes and Count Wollowicz obtained almost precisely the same result. Anything below some quantity between 1 and 1½ fluid ounces per day can be disposed of in the system, and is probably oxidised like ordinary foods.

It is important to know how much alcohol, in the form of alcoholic beverages, corresponds to this **maximum dose** of absolute alcohol. The stronger ales and porters contain 5 per cent. of alcohol or more. If 5 per cent., then 30 fluid ounces, or 1½ pints would contain 1½ fluid ounces of alcohol. The light French wines and Burgundies and Rhine wines brought to this country seldom contain less than 10 per cent. of alcohol; consequently, ¾ pint would contain 1½ ounces of alcohol. Ports and sherries, as sold here, contain 20 per cent. or more of alcohol; therefore, 7½ fluid ounces would contain 1½ ounces of alcohol. Many ports and sherries, however, contain 24 to 25 per cent. of alcohol; 6 ounces would, therefore, form a safer limit. Spirits contain 40 to 60 per cent.; if we suppose it to be 50, then 3 fluid ounces contain 1½ ounces of alcohol.

Physl. effs in moderate defined by D. Austie as that effs wh. prod. no after recoil results fr the stimult than happens on the ingestn of any other true food.

Odour of breath due to ethers not alcohol.

Contrad. results as to amt. claim. Due to varying doses used in expers. A man may be rend. tempy diabetic by alcohol & symps at once. D Hammond & that when tats. an ample diet & daily loss wt, addn of alcohol rend. this & cond. it into an act. gain. D. Austie in "Stim to & Narcotics" cited a no. of cases in wh. pers lived a considerable time on it alone & w. a gr of food so small as to be utterly inadeq without it

Fermentn is naturly stopd in a saccharine solutn when alcohol reaches 14%: any above this amt must be subsequ addd. In Prussia thousds of acres of land in wh. potat cultivd, refuse being used for spirit distillg.

It will be understood, therefore, that in describing the effects of a moderate amount of alcohol on the system, we mean an amount below 1½ ounces of absolute alcohol per day, freely diluted, and taken as a rule with meals.

1. **Effect on the Stomach.**—In very small quantities, alcohol seems to stimulate digestion in the same way as mustard. But like all other artificial helps to digestion, it is best avoided in the healthy condition.

2. The **Effect on the Liver** is similar to that on the stomach—a temporary redness and congestion being produced; this effect soon disappearing if the dose is small and well diluted. But in all cases where there is a tendency to biliousness, even small doses of alcohol are injurious.

3. The **Effect on the Lungs** is somewhat doubtful, carbonic acid having been stated by some to be increased and by others diminished.

4. The **Effect on the Heart and Blood-Vessels** is first to increase the force of the heart's action and the rapidity of the pulse. If the alcohol is taken undiluted and on an empty stomach, these effects are noticed, even before its absorption into the blood, owing to a stimulus being carried up to the medulla oblongata, and reflected thence. The stimulation of the heart is rapidly followed by a universal dilatation of the arterioles of the body, which diminishes the blood-pressure.

5. The **Effect on the Blood** is that its oxygen-carrying properties are diminished, even when only small quantities are taken. This effect is, however, more than compensated for by the increased rapidity of the circulation produced by alcohol; although each relay of blood contains less oxygen, the blood, being brought more frequently to each individual part of the body, supplies as much or more oxygen than in the unstimulated condition.

6. The **Effect on the Nervous System** varies. In persons unaccustomed to its effects, even small doses dull the power of thought and the rapidity of perception. In most cases, however,

it at first produces increased rapidity of thought and excites the imagination, though even here it makes it more difficult to keep to one train of thought. Dr. E. Smith's experiments show that it diminishes the acuteness of all the senses. Its influence, in dietetic doses, on the capacity for mental work, has just been made the subject of a curious investigation by Mr. A. A. Reade. He has collected the experience of some of our most noted men of letters, the results obtained being so opposite as to prevent any general conclusion being made. It is interesting to note that Mr. Gladstone finds his "glass or two of claret at luncheon, the same at dinner, with the addition of a glass of light port . . . especially necessary to him at the times of greatest intellectual exertion;" while Archdeacon Farrar believes, from his experience, that "work may be done more vigorously, and with less fatigue, without wine than with it." The probability is, that in small doses it has no great influence either way, and that much depends on the habits to which the individual has become accustomed.

7. The **Effect on the Muscular System** is never beneficial. Even when only small quantities are taken, the power of controlling delicate movements is slightly diminished. For persons engaged in laborious occupations, a small quantity does not produce much apparent effect, but where the quantity exceeds two fluid ounces per day the capacity for strong and sustained muscular work is manifestly lessened (Parkes). This effect is probably due partly to the dulling of the nervous system rendering the muscles less amenable to the will, and partly to the over-excitation of the heart causing palpitation and breathlessness.

8. The **Effect on the Metamorphosis of Tissues** is probably to diminish oxidation, on account of the diminution of oxygen in the blood, and thus to favour the deposit of fat in the tissues. The diminished oxidation is necessarily followed by diminished elimination; but the decrease when only small doses are taken is hardly appreciable.

9. The **Effect on the Temperature** is probably to produce a

Very little doubt as to toxicity of alc. in system; but its
power of diminishing or destroying its employment as a food to any
great extent in health, thereby increasing its value in disease.

In fever it diminishes tissue waste (1) undergoes oxidation itself
instead of the tissues. (2) lessens oxidation in them, (3)
lowers the temperature itself increases tissue degeneration

The drunkard's excuse - "The neighbours also speak of my drinking, but they never speak of my drought"

This time & the cure for drunken. is to remove thirst.

Bad food & imperfect cooked a com. cause of thirst

Sipping cold H2O has more effect in stimulg heart than swallg hands of water at a draught; but the effect only tempor.

Formerly "a three-bottle man" consid. the type of all that was healthy & vigorous. Glasses then made not to stand. drinkers were often reduced to same cond.

slight lowering, but unless the dose is excessive, this is hardly appreciable. The resistance to excessive cold is diminished by even moderate doses of alcohol, still more by large doses. In the Arctic regions, this has been abundantly proved. It is well known there that indulgence in alcohol is almost certain death when the external cold is great. Dr. Hayes, surgeon of the Kane Expedition (1859), says that he will not only not use spirits, but will take no man accustomed to use them.

Effects of Immoderate Doses of Alcohol on the System.—Bearing in mind the definition given of a moderate dose, one is bound to admit that a large number of individuals exceed this amount daily, apparently without any very serious results. The system becomes habituated to large doses, and if the occupation is a laborious one, they are oxidised in the system. Such, however, are exceptional cases. In the majority of cases evil results are in the end certain to follow. And such evil results are by no means confined to those who indulge in very large quantities of alcohol at varying intervals. In fact these often escape comparatively free, while others who never take a quantity sufficient to incapacitate them for their work, are sowing the seeds of chronic and oft incurable disease. The labourer who has a drinking bout at intervals is thoroughly nauseated, and the condition of liver and stomach induced, enforces abstinence on him for a time sufficient to bring his organs back to a normal condition; while the city merchant who indulges more moderately, but whose organs are almost continuously saturated with alcohol, becomes gouty and prematurely old.

The **Stomach** may become acutely inflamed, when a large dose of alcohol is taken. The chronic irritation of alcohol, especially when taken apart from meals, causes atrophy of the walls of the stomach, and a change analogous to that in the liver.

The **Liver**, when alcohol is daily taken immoderately, becomes seriously diseased. In some cases it becomes large and fatty; in others the chronic irritation excites an overgrowth of fibrous tissue between the lobules of the liver, which, gradually shrinking, squeezes

the liver cells and causes them to atrophy, at the same time obstructing the small branches of the portal vein in the substance of the liver. The consequence of this obstruction is that all the organs from which the portal vein brings blood become overloaded with blood, which is not able to get easily through the liver, and vomiting of blood and dropsy of the abdomen occur at a later period.

The **Lungs** are irritated to a less extent by alcohol in large doses. The tendency to chronic bronchitis is increased, followed by emphysema, and sometimes an overgrowth of fibrous tissue (cirrhosis) like that in the liver occurs.

The **Heart and Blood-vessels** tend to become diseased, owing largely to the gouty condition of system developed.

The **Blood** has its oxidising power diminished. Corpulence is, consequently, a common result of alcoholism. There may also be fatty deposit in internal organs, such as the heart. This must not, however, be confounded with a much more serious condition—fatty *degeneration* of the heart, in which the substance of the muscular fibres becomes partially converted into fat, and which also is sometimes due to alcoholism.

The **Nervous System** is more prone to suffer in chronic alcoholism than any other part of the body, except perhaps the liver. The first effect of a large dose of alcohol is to stimulate the nervous system, as already described. This is followed by a dulling of the nervous faculties, which comes on rapidly in proportion to the amount taken. The phenomena of *intoxication* are unhappily too familiar to require description, mental incoherence and muscular inco-ordination (lack of control over the muscles) being the most prominent features.

When the dose of alcohol is still larger, a condition of profound unconsciousness is produced (*coma*), which may be difficult to distinguish from other forms of unconsciousness.

Delirium Tremens is another nervous condition, which may rarely follow a single debauch, but much more commonly affects

Report of Brit. & Foreign Spts Com^n (Times May 1. 91).

Year End^g Dec 31	Consumption of Home Consumption: British Spirits — Gallons	British Spirits — Gal^s per head	Foreign & Colonial Spts — Gallons	Foreign & Colonial Spts — Gallons per head	Gallons per head of Spts of all kinds
1852	25,200,879	.918	4 866259	.177	1.095
1862	18836187	.644	5193641	.177	.821
1872	26872183	.843	9068329	.285	1.128
1882	28554264	.809	8338578	.236	1.045
1885	26609488	.732	8012656	.221	.953
1886	25954251	.707	8634584	.235	.942
1887	25969776	.700	8163028	.220	.920
1888	25963593	.693	9105528	.243	.936
1889	27183351	.719	9659516	.255	.974
1890	29410431	.769	—	—	—

In Engl^d consump^n per head of spts is a little over ½ gal. annd; in Scotld 1½ gals; in Irel^d 1 gallon.

In distill^n of spts – two kinds of stills used – (1) "pot stills", in wh. fire appl^d to still cont^g the ferment^d liq^r; (2) "patent or coffey stills" in wh. steam used as source of heat.

Whiskey obt^d f. pot stills cont^s more of taste & aroma giv^g matls & more of comp^ds wh. mellow by aging than f. patent stills. In pat^t stills bye-prod^ts are to a lge extent removed. Appears an incred^g demand for whiskey of a milder kind, hence of pot-still & patent still wh. being in lge demand by consumers, thus obt^d a cheaper & milder wh. cont^s less fusel oil & other bye-prod^ts

Cant^e defines whiskey or other spts. though it gen^ly cont^s bye-prod^ts derived from malt or grain. Foreign brandy consists of dil. alcoh. flav^d w. bye prod^ts of grape; British brandy does not cont^n these bye prod^ts

Rum is obt^d f. cane-grow^g countries & flav^d w. bye-prod^ts of cane sugar or molasses.

Bye prod^ts or. om. in ant^s in all these. In all pot. still whiskies there is abt 5/1000 of 1% of furfurol wh. f. its prop^s of col^g chem^l reagents is a useful means of distinq^g pot still wh. from patent still wh. From Expts of Dr Bell, it wd appear that higher alc^s & others do not mater^y lessen or alter by age, tho. the empyreum. body incl^g furfurol undergo a change, wh. may acc^t for change in flavor of old spt. Cask, wood shav^gs or charcoal have an influ^e in abstract^g some of higher alcoh^s but appear to no gt degree.

Blend^g of diff^t spts has bec. a lge trade. In a quest^n of meet^g taste of public & of cheapness. In legal within limits of strength regul^g sale of spts.

Matured Whiskey fetches a higher price vary^g f. 4^d to 1/- per gal. per ann. acc. to the quality – (kept in bond)

In a glass of brandy rum or whiskey the amt of fusel oil is not more than 1 or 2 grains: mixed with water and have no appreci. physiol. effect on system. Gen. opin. that old spts more wholesome than new. tho. no clear suffic. data for this. Canada has passed a Bill to compel bonding for 2 yrs, but Govt act here not record.

Food & Drugs Act '79 prohibits sale of spts less than 25° under proof for Br. whisk. rum & 35° under for gin.

Court came to opin. that Stand. of purity can't be appl'd to spts made in this country or imported.

the chronic toper. In some cases the immediate exciting cause is a mental shock, or lack of food, or a surgical injury. Alcoholic subjects suffering from any acute disease are liable to this form of delirium, and their chance of recovery is greatly diminished.

Insanity of a more prolonged character than that characterising delirium tremens is an occasional result of alcoholism.

Besides the nervous diseases already named, a chronic thickening of the membranes covering the brain and spinal cord, gradually progressing and finally fatal, is often the consequence of prolonged alcoholic indulgence.

This does not complete the list of nervous diseases due to alcoholism. An unstable condition of the nervous system is produced, which is transmitted to the progeny. This may manifest itself in the form of epilepsy, or occasionally in other ways. A craving for alcohol is, unhappily, likewise transmitted; a temperate life is more difficult for the child of drunken parents than for others. The children of drunkards are very liable to scrofula and idiocy.

Various Degenerative Diseases are produced by alcohol. It has been well called by Dickinson the very "genius of degeneration." Such degenerations are by no means confined to the intemperate; they are seen in those who are of what would usually be considered moderate habits. The stomach, liver, lungs, and probably the kidneys, are the main organs to suffer in this way. It is probable that the effect on the kidneys only occurs when a gouty condition is developed. In all these cases there is an overgrowth of fibrous tissue, with atrophy of the proper gland structures.

Gout is the common nemesis of those indulging in alcoholic beverages, more especially wine and beer. It is due to the fact that urate of soda is largely formed in the body in the place of the more completely oxidised urea. This accumulates in the system and produces inflammation of the joints, and other evils—among them the gouty kidney, named above, which is always ultimately fatal. Rigid arteries are likewise commonly due to

alcoholism and gout. If one of these bursts in the brain, apoplexy results.

Longevity is diminished by immoderate indulgence in alcohol. Mr. Neison's statistics shew that if a man becomes intemperate at 20 years of age, he shortens his life by nearly 30 years, and if at 30, by 22 years. The effect of moderate quantities of alcohol on longevity is much more difficult to decide. Mr. Vivian's statistics, derived from the records of the United Kingdom Temperance and General Provident Institution, are, perhaps, the most reliable on this point. It was found that in nine years (1866-74), 1,110 deaths were expected, according to the calculations of the actuaries, among the section containing only total abstainers, but only 801 deaths took place; while in the general section, containing moderate drinkers, 2,002 deaths were expected, and 1,977 actually occurred. Thus, ~~nearly 30~~ 29 per cent. less than the calculated number died among the teetotallers, while only ~~1¼~~ 1¾ per cent. less than the calculated number died among the moderate drinkers.

These results, although valuable, must, however, be accepted with some degree of hesitation,—first, because the numbers are somewhat small, and, therefore, other factors may have caused the difference; and second, because although the second section was supposed to consist of moderate drinkers—and particular enquiries are always made on this point before insurance—it is by no means certain, in fact, it is very improbable, that a large proportion of the moderate drinkers did not exceed 1½ ounces of alcohol per day.

Factors Modifying the Effects of Alcohol. — 1. **Age and Sex.**—There can be no doubt that, until adult life is reached, total abstinence from alcohol should be enforced. The delicate nervous system of children is easily disturbed by it, and it appears in some measure to retard growth. Another argument against giving alcohol before adult age is reached, is still more important. It is at this period of life that habits are chiefly formed, and a craving for alcohol may be insidiously produced, destined to have most baneful results.

Statistics of United Kingdom Temperc. & gen.l Provd. Instit.ns
for 22 yrs — 2 sect.ns of insured, abstainers & gen.l public.

	Temperance Section		General Section	
	Expect.d Deaths.	actual Dths	Expect.d Dths.	act.l Dths
1866-70	549	411	1008	944
1871-75	723	511	1268	1330
1876-80	933	651	1485	1480
1881-85	1179	835	1670	1530
1886-87	553	390	713	700
	3937	2796	6144	5984

(B.M.J. June 88)

This does not prove what supposed, because

1). total abstainers so bec healthy & not vice-versâ.

2). a man full.y in bad health req.s stimul.ts is relg.d to the gen.l sect.n & excluded f. the returns of the temperc. section. Those in this sect.n shd be kept in a class by themselves

Old people commonly have spirits given them ; as a rule, this is bad. Nothing stronger than light wines should be taken, except under medical advice.

Women, on account of their mobile nervous system, are much more easily affected by alcohol then men, and if they acquire the habit of excess, the hope of reformation is even less than with men.

2. **Exercise** has a most important influence in modifying the effects of alcohol. Those of sedentary occupations and living in towns, cannot oxidise as much as those engaged in active out-door work, and are consequently much more prone to suffer. A game-keeper in the Scotch Highlands may possibly live to a good age, spite of the fact that he consumes an amount of whiskey that would have sent a sedentary man to his grave in the course of a few years.

3. **The Condition of the Stomach** has also great influence. When the stomach is empty, alcohol produces at once a powerful reflex stimulation of the heart, and becomes quickly absorbed into the circulation. Thus intoxication may be produced by a quantity that would have had little effect if taken with a meal.

4. **The State of Concentration or Dilution** modifies greatly the action of alcohol, the local action on the stomach and the reflex stimulation being much greater when it is concentrated, and injurious effects being much more likely to occur.

5. **Cold and Heat** modify the action of alcohol. A smaller quantity of hot spirits and water will intoxicate than of cold ; the heat stimulating the heart, and so making the absorption of the alcohol more rapid. A glass of hot spirits and water will often cause sleep, by drawing the blood towards the abdominal organs. The fact that persons, who have been drinking spirits in a warm room, on going out into the cold air become suddenly intoxicated, seems opposed to what has been already said. But probably this is due to the cold causing contraction of the arteries of the skin, and so driving more of the blood loaded with alcohol to the internal organs and the brain (Brunton).

6. **Mental Occupation** has some influence in modifying the

effects of alcohol. Topers have found that if they try to converse during their debauch—the conversation implying increased functional activity of the brain, and therefore a freer circulation of blood in it—intoxication occurs much more readily, than when the attention is not distracted.

7. **Disease** modifies greatly the effects of alcohol. In some diseases, as in inflammation of the lungs and in fevers, it can be given in large quantities without producing intoxication; and in these conditions it seems to diminish the excessive oxidation which is occurring, and to lower the temperature. In other diseases, especially gout and kidney disease, its use is nearly always followed by bad results.

The Advisability of Alcohol as an Article of Diet in Health. —This is a question which it is very difficult to decide. There are two sets of facts to be dealt with—those obtained as the result of **Physiological** observations (see previous sections), and those which are the result of **Experience.** There can be no doubt that the former are much more reliable than the latter. Experience is very prone to give fallacious results, especially when questions of appetite are concerned. In making a trial of abstinence, the mistake has been commonly made of only prolonging the investigation for a few weeks, and then comparing results. Such a method is, however, very unfair, and is certain to lead to an unreliable conclusion.

The results of experience under certain conditions have, however, been so extensive, as to lead to valuable and reliable results. It has been abundantly proved that prolonged muscular work is best undergone during total abstinence from alcohol; and that the extremes of heat and cold and the exposure and exertions of marching armies, are best borne under similar conditions.

The artificial character of town life is commonly adduced as an argument for the moderate use of alcohol. In the case of healthy workers, this does not hold good; many of our hardest workers and thinkers take no alcohol.

The universality of the habit of taking stimulants is a curious

Easier for many to abstain than to be abstemious
(W. Roberts)

Furfurol in Alcohol (Lancet Oct. 87) - acc. to M. Bacchi at Paris Acad. of Med. all spts used for manufg spirit. liquors contn furfurol. To remove this it is necessy to distill the alcohols acc. to Bay's procedure. Furfurol espy met w in alcs of grain (as oats wheat barley). It is formed by actn of H_2SO_4 on oatmeal or bran. On anim. prod. epileptiform symps. In Ireld & Scotld frequ spirit. in Ac. alcsm, while in France this seq in drinkers of absinthe & liqueurs - in these countries the poisonous not only alcs of grain but also the residue left by these alcs after distillin. It is quite possible that the falsifrs are respons. for some of worst results of alcsm

argument on the same side, though if the habit be bad, this can be no more reason for continuing it than can the prevalence of vice be an excuse for indulgence in it.

The two chief physiological points bearing on the advisability of alcohol as a part of one's daily diet are—its **food properties**, and its effect on the appetite and digestion.

It has been already stated that a quantity of alcohol under 1 or 1½ ounces may become oxidised in the system, and may thus form a source of heat. But in all probability, although it may be regarded as a food, it is a most inconvenient one, inasmuch as it diminishes the oxidation of other foods. It has been aptly compared in this respect to sulphur, which is an oxidisable material, but which, when it is burnt in a chimney, in which the soot is on fire, will put an end to the combustion of the latter. Its value as a food, under normal conditions, is practically nil.

Its **Effect on the Digestive Organs** is two-fold. First, the contact of the alcohol with the mucous membrane of the mouth and stomach, acts as a reflex nervous stimulus, which in moderation excites an increased flow of gastric juice. In cases of weak digestion, therefore, small doses of alcohol may, at times, be useful. The effect of alcohol on the food taken varies with its degree of dilution. Concentrated alcohol coagulates albumin, and so stops digestion; it is doubtful whether largely diluted alcohol has such an effect.

We cannot do better than quote the opinion of Dr. Parkes, the greatest authority on the dietetic use of alcohol, in connection with this subject. He says:—

"But what, now, should be the conclusion as to the use of alcohol in health after growth is completed? Admitting the impossibility of proving a small quantity to be hurtful, and at the same time acknowledging the dangers of excess, there arises an argument which seems to me somewhat in favour of total abstinence. No man can say when he has passed the boundary which divides safety from harm; he may call himself temperate, and yet may be daily taking a little more than his system can bear, and be

gradually causing some tissue to undergo slow degeneration. He may be safe, but he may be on the verge of danger.

"This uncertainty, coupled with the difficulty at present of saying what dietetic advantage is gained by using alcohol, seems to me rather to turn the scale in favour of total abstinence instead of moderate drinking. But if any one honestly tries, and finds he is better in health for a little alcohol, let him take it, but he should keep within the boundary line, viz., that $1\frac{1}{2}$ ounces of pure or absolute alcohol in twenty-four hours form the limit of moderation. I do not then think he can do himself any harm."

The Varieties of Fermented Drinks.—The three chief kinds of alcoholic beverages have already been named—malt liquors, wines, and ardent spirits. In addition, we may mention cider and perry, which are the fermented juices of apples and pears respectively; and koumiss, which the Tartars prepare by fermenting mare's milk, though it may also be made from the milk of other animals.

All **Beers, Ales,** and **Porters** are prepared from malt, which is the germinating grain of barley. The fermentation of the sugar in the barley produces alcohol, the amount of which varies in different cases. In small-beer it may be only $1\frac{1}{2}$ per cent. of absolute alcohol; in stout 6 per cent.; in porter 5 per cent. or more; and in Burton ale, as high as $8\frac{1}{2}$ per cent. The hop which is added to the fermenting barley, gives to beer its characteristic bitterness.

London Porter is coloured with black or roasted malt; **stout** is only a stronger form of porter. Bottled ales are generally stronger than those on draught, and being slightly effervescent, may agree better.

The effect of alcohol in beer is modified by the *hops*, which are liable to produce drowsiness. Beer has a marked tendency to produce obesity, more so than any other alcoholic beverage. Its influence in the production of gout is also very great. Probably its acidity is partly answerable for this, as gout is not produced as a rule by German beer.

Adult^ns of beer – wholesome bitters may be substit^d for hop. &
pt of malt may be repl^d by other saccharine sol^ns, desired tint being
obt^d by caramel, with^t infring^g law. When hop tax in force such substit^ns
were a fraud on revenue. Caramel, molasses, liquor^e also used to give
the creamy char^r Densit^y & col. to stout & porter.
Only unwholes^e bitters, as picrotoxine, colchicine, daphnine, or picric acid,
can be made good of an act^n
Cocculus ind. berries (f. sh. picrotox.), tabsinthe, occ^ly used as bitters to make
more intoxic^g. Alum & H_2SO_4 serve to give a fictit^s "hard" suggest^e of sapo-
NaCl above 60grs per gal. is an adult^n Estim^n KCl if necess (from
impure sugar).
Test for Salicylic Acid in beer – acidⁱᶻ beer w H_2SO_4 agit^n in separat^g
funnel w. mixt^e of ether & petrol ether, evap^n & test residue w sol^n $FeCl_6$.
(Röser's test)

An essent^l distinct^n betwn the beverages distill^d f. sugar itself
& those f. convert^d starch: former, cognac brum, cont^s ethyl alc.
only; latter, as the comm^l brandies, whisky &c, have some of higher alcohols
esp^y amylic, a fusel oil. After lapse of some yrs. the fusel oil
breaks up to a gt ext^t into compar^ly innocs ethers &c.
Amt of fusel oil in whisky depⁿ much on degr. of rectif^n of heat &
of the process. All distil^d drinks not made f. grapes cont^s fus. oil more or less.
Consists of propyl, butyl & amyl alcohols. the last in excess. No smell shd be left on
rub^g a little alcoh. between hands & evap^n. If consid^e dose of alc. prod^s sense of fullness in
head, a persist^t overfil^g cer^l resp^n w. dulness of ideas, then fusel oil.
Cider called apple wine in Germany. In it tart^c acid is repl^d by
malic, tit is decid^ly aperient
Kouniss – ferment^d mare's milk.
Perry f. pears. Mead f. honey (cont^s no other organic acids).

Hops are sun-dried in Germ^y, kiln dried & bleach^d by SO_2 in Engl^d

New wine cont^{s} aldehyde, wh. is v. intoxic^{g}. This bec^{s} subseq^{y} $C_2H_4O_2$. Of wh. traces in all wines.
Ord^{y} British wines as orange, ginger &c, are mix^{ts} of coarse spt & sugar & flav^{g} agents, & not true wines.

adult^{n} of wines – ports, sher^{s} & champagne alw. fort^{d} w. brandy.
Port col^{d} w. elder berries, champag. sweet^{d} w. sugar, & sherries plast^{d}
Pk. Brit. & anath^{s} often often add^{d} to port to simulate age.
Occ^{l} Brazilwood, logwood, & even aniline cols as fuchsin used, wh. mostly
cont^{n} As. Phosmet^{s} found.
Ports & sher^{s} [illegible] manuf^{d} in ferm^{g} by fusc. f. port & spt, cider, w. col^{g} mat^{rs}
& champagnes here f. rhubarb &c.
Fuchsine dyes a skein of silk soak^{d} in the wine rose col, pure wine
mak^{s} it light red. The rose bec^{s} yellow on add^{n} of HCl.

Spirits – prod^{d} 1/. in "pot-stills", in wh. heat of fire appl^{d} to a still cont^{g} the ferment^{d} liq^{d}. 2/. in patent or coffey stills, in wh. a mix^{te} of malt & grain is ferm^{d} w. the aid of heat derived f. steam. 1/. cont^{s} more of subst^{s} giving taste & aroma, as well as of higher alc^{s}. There is an incr^{d} demand for milder & cheaper spts – thus blends of 1/. & 2/). Fusel oil incl^{s} propylic, butylic, amylic & other alc^{s}. A wine glass of spt at proof cont^{s} 1000 grains, rare to find commerc^{l} spts cont^{g} more than 1 to 2 grs of bye prod^{ts} in the glass. This sm. qty (of fus. oil) wd have no apprec^{e} physiol. effect.
Spirit improves in bond, but no scientific reason can be given – yet agreed that old mellowed spts less irrit^{g} to stom than newly distill^{d}. (Rept of Com^{rs} Cust^{s}).

Notwithstanding the apparent stoutness and strength of beer-drinkers, they are decidedly unhealthy. Even slight injuries are liable in them to produce serious or fatal results.

Wines are produced by the fermentation of the juice of the grape. The wine produced may be bottled after fermentation is complete, or at an earlier period; in the latter case, an effervescing wine is produced, such as the sparkling wines of the Rhine and the Moselle, or champagne. When the sugar is nearly all fermented a *dry* wine is obtained, of which Bordeaux and Burgundy, Hock and Moselle, are examples. If some sugar is left in the wine, it is a *sweet* wine.

The difference in colour between red and white wines is produced by allowing the juice in the former case to ferment in contact with the skins, from which the colouring matter is extracted by the alcohol produced. Both red and white wines may be obtained from either red or white grapes. From the skins also are extracted a salt of iron, and a peculiar form of tannin. Tartaric and acetic acids, and tartrate of potass, are present in varying quantities in wines; in old wines the tartrate separates as bi-tartrate of potass, forming with tannin and colouring matter, the "crust" of port and other wines. The "bouquet" of wines is due chiefly to certain volatile bodies, such as pelargonic ether. The proportion of alcohol in various wines has been already indicated. It is, however, a very varying constituent. Most of the wines sold in this country are brandied. It would be a most important reform, if it were required that all bottles of wine should be stamped with the proportion of alcohol they contain.

Wine, like beer, has a strong tendency to produce gout, especially the sweet and strong wines. It has not, however, the same tendency to induce obesity.

Spirits differ from the two last groups, to begin with, in the amount of alcohol they contain. Thus, ales contain from 1 to 10 per cent., wines from 8 to 20, and all kinds of spirits from 40 to 58 per cent. of alcohol. They differ in the absence of the bitter principle of beer and much of the salts and sugar and ether of wines. They

are all prepared by the distillation of some previously fermented liquor. **Brandy** ought to be made by the distillation of wine; and then contains, besides alcohol and water, small quantities of acetic, œnanthic, butyric, and valerianic ethers. But most of the brandy sold is simply made from spirit, by the addition of acetic ether, burnt sugar, etc.

Whiskey is prepared by the distillation of malt, and it contains fusel oil (amylic alcohol), in addition to ordinary alcohol. This is much more injurious to the health than ethylic alcohol. It seems probable that in old whiskey a good deal of the fusel oil becomes changed, probably into ether, and is then less injurious.

Gin and **Hollands** are obtained from barley, and flavoured with juniper berries and other materials. The oil of juniper stimulates the urinary excretion.

Rum is obtained by the distillation of molasses, and is usually kept for a long time in oak barrels. It is said thus to acquire more astringent matters than other spirits contain.

Prolonged indulgence in spirits produces the various organic diseases already described, and owing to the greater degree of concentration they are more harmful than beers or wines. They differ from wines and beers also in not tending to produce gout, and from beer in not leading to obesity. Gout is almost unknown in Scotland among the class of people who commonly drink large quantities of whiskey.

CHAPTER IX.

WATER.

The Uses of Water.—The Quantity of Water Required.—Sources of Water Supply.—Rain-water, Upland Surface, Spring, Well, and River Waters.—Their Relative Merits.

Uses of Water.—Water is a prime necessity of life. In its absence life can only exist in lowly organised beings, and in them only in a dormant state. From a hygienic point of view, the uses of water are four-fold:—(1) It is **an essential part of our food,**

35° under proof allowed by law for gin, & 25° for brandy, whisky & rum

Sterlpt of brandy in market is distild f. potatoes inferm?

Fusel oil (Lanc. June '88) can be detect. in qty not less than ½ % in ord. alcohol by plac. latter in long test-tube, & drop. in a few frags of KI, & agitat. gently. If fusel oil present a light yellow color appears in a few mins. Heat helps the test.

Gin freq. made f. damaged grain of various kinds, in wh. veg. alkal. not infreq. devel. Recent observs of Commiss of Ital. govt have shown that such alkal. often occur in Alcohol.

Arrack in Ind. & China f. rice, Kirschenwasser in E. Europe f. cherry, & Slivovitza f. plum; in Africa a spt obtd f. palm-juice, in Amer. maple & corn f. local sources.

½ B for 1 hour

2½ pints
16
24
24
24
90
= 12 gal

not only serving to build up the tissues of the body (of which 111 lbs. out of 154 lbs. consist of water), but also preserving the fluidity of the blood and aiding excretion of effete matters. (2) It is necessary for **personal cleanliness,** of which the importance can scarcely be exaggerated. (3) **In the household** it is essential for cooking, as well as for washing the house, the linen, and various utensils. (4) By **the community at large it** is required for water-closets and sewers, for public baths, for cleansing the streets, and for horses and other domestic animals, as well as in many manufacturing processes. It is obvious that the water to be used for domestic and general purposes, need not be so pure as that for drinking purposes. Hence, a double supply was proposed for London in 1878, by the Metropolitan Board of Works—the present river supply for general purposes, and a deep chalk-well supply for drinking purposes. The scheme, however, rightly fell through, because of the expense of a double source of supply, and the danger that the impure water would, through carelessness or ignorance, be often used for drinking purposes, when it happened to be nearest at hand.

Quantity of Water Required.—The quantity of water required for all purposes has been variously stated by different authorities. The quantity required for drinking purposes is found to bear a relation to the weight of the individual, being nearly half an ounce for every pound weight, or $1\frac{1}{2}$ gills for every stone weight. Thus, a man weighing 150 lbs. would require $3\frac{3}{4}$ pints. Of this water, about one-third is taken in the food; the remainder, averaging $2\frac{1}{2}$ pints, being required as drink. If we add the water required for other purposes, according to Dr. de Chaumont, 1 gallon is required for drinking and cooking, 2 gallons (not including a bath) for personal cleanliness, 3 gallons for a share of utensil and house washing, 3 gallons for clothes washing; and if a bath be used, $2\frac{1}{2}$—3 gallons more; making a total of 12 gallons, to which 5 gallons must be added if there is a water-closet.

In hot summer weather the consumption is about 20 per cent. above the average of the year; and frost often increases the amount 30—40 per cent. above the average, owing to the bursting of pipes, or the loss from taps left open to prevent bursting.

In the army, 17 gallons is the quantity allowed for each individual. Water companies usually reckon 30—60 gallons, to allow for the water required in drainage and manufactories, and for waste. Professor Rankine estimates the amount required for all purposes as 19—27½ gallons per head per day, or an average of 22 gallons. In large houses, where baths are freely used, often as much as 70 gallons per head is used. In London, with an imperfect intermittent supply, the consumption is 32½ gallons per head daily, of which 7—7½ gallons is used for other than domestic purposes. The following is Dr. Parkes' estimate of the daily allowance for all purposes:—

	GALLONS PER HEAD OF POPULATION.
Domestic supply	12
General baths	4
Water-closets	6
Unavoidable waste	3
Total house supply	25
Municipal purposes	5
Trade purposes	5
Total	35

It has been proposed to put a water-meter to each house, so that the rate may be in proportion to the amount of water used. This has actually been tried in some American towns; but the plan is objectionable for two reasons: 1st—Because it tends to restrict the necessary use of water for purposes of cleanliness. A scant supply of water is always followed by uncleanliness of house

In Hosp^ls at least 40 gal^s per inmate shd be allow^d

Lambeth Water Co^y beyond its share of Thames water, has a collecting ground of some 10,000 acres of Bagshot sands. The wells sunk by New River Co^y along line of junct^n of tertiaries & chalk, those of Colne Valley Co^y at Watford and Rickmansworth are unimpeachable. Extens^n of these borings W. to Reading & Basingstoke & E. to Guildford. Section of tertiaries & chalk alternating prob^y will solve the quest^n

At present Kent Co^y draws 10 mil^n gal^s daily from deep chalk wells. New River Co^y obtains 20 mil^n gal^s f. R. Lea and 5 mil^n f. deep wells S. Lond. Co^y pumps 35 mil^n gal^s f. R. Lee. also have the power of wh. they avail themselves in dry seasons to pump 10 mil^n gal^s f. Thames at Tunbury. The other 5 Comp^s have are permitted to pump daily 20 mil^n gal^s ea. daily f. Thames

The daily demands of Lond. now exceed 150 mil^n gal^s - not more than 20 f. deep wells. At least 240 mil^n gal^s shd be prov^d by a scheme claiming finality

Glasgow takes 40 mil^n g. Loch Katrine - Manc^r & Liverp^l ea. find 20 mil^n. suffic^t for their wants.

Dew-ponds on the chalk downs of S. of Engl^d. - H^2O by its coolness being able to assimilate to itself alge qty of moist^e nightly by condens^n

and person, with its consequent diseases; at the same time drains are not properly flushed, and become, practically, long cesspools. 2nd—The primary expense of the meter, and of its maintenance, as well as of the necessary inspections and book-keeping, have caused it to defeat its own ends.

Sources of Water Supply.—All our drinking water is obtained for us, in the first instance, by a natural process of distillation on a large scale. The sun, acting the part of a powerful furnace, is constantly causing evaporation from sea and land. The vapor produced, being condensed by a lower temperature, returns to the earth as snow, dew, or rain. All these natural products have been at times utilised as sources of drinking water.

1. **Dew** has not often been employed as a source of drinking water; but this has occasionally been done at sea, when better sources were not available, by hanging out fleeces of wool at night and wringing them out in the morning. A much better plan is—

2. The **Distillation of Sea-water.** The water is evaporated in a special apparatus and the vapor collected, rejecting the first part which comes over, as this is always impure. Distilled water is very "flat" in taste, owing to its containing no dissolved gases. It can be aërated by letting it drop a considerable distance from one cask into another, through small openings in the upper one, and by filtration through charcoal afterwards. Non-aërated water is not so easily absorbed into the system as ordinary water, and occasionally causes illness.

3. The utility of **Melted Snow and Ice** is obviously very limited. Moreover, its use is not free from danger, in consequence of the liability to contamination by excreta and other organic matters derived from dwelling-houses. The prevalence of cholera in Russia is an illustration of this fact.

4. **Rain-water** is a much more important source of water supply, and after passing through the soil it constitutes the chief part of the water we drink. The term, however, is usually restricted to the water collected immediately after its descent from

roofs, etc. Its purity depends on three conditions—the character of the air it passes through, the cleanliness of and absence of lead from the channels through which it runs, and the condition of the water-butts in which it is collected. Rain-water is soft; in fact, too soft to be pleasant to the palate. In passing through the air, it carries with it a certain proportion of its constituents; in towns, especially ammonia, soot, etc.; near the sea, it generally contains some salt; and being soft and containing oxygen from the air, it dissolves an appreciable amount of lead from roofs or gutters.

According to Dr. A. Smith, if it were possible to collect rain from the clouds, it would require filtering through the soil before being fit for drink. A certain amount of mineral salts and free aëration are requisite in order that water may be palatable.

The Rivers Pollution Commissioners, in their exhaustive examination of various kinds of water, found that out of eight samples of stored rain-water only one was fit to drink. They came to the conclusion that rain-water, collected from the roofs of houses and stored in underground tanks, is "often polluted to a dangerous extent by excrementitious matters, and is rarely of sufficiently good quality to be used for domestic purposes with safety." Also, that in Great Britain, and more particularly in England, we shall "look in vain to the atmosphere for a supply of water pure enough for dietetic purposes."

The use of rain-water for drinking purposes is only justifiable in isolated country houses where no better source is available; and under these circumstances the greatest care should be taken to prevent contamination with lead or organic impurities.

The amount of water obtainable from rain in any place can easily be estimated, if the amount of rainfall and the area of the receiving surface are known. The average annual rainfall in this country is 30 inches, varying from 20 inches on the east coast to 70 or 80 in the mountainous districts of Wales. In exceptional cases, as in the Lake District, as much as 200 inches have been recorded.

Increment f. birds, veg^n. mat^rs food &c

always highly aerated. O is 30 or more % CO_2 3 4. Spring w. also cont^ns more CO_2 than O (W)

Rain water may be purified by filtⁿ. best in underg^d. tanks of solid masonry w. vault? roofs & lines w. hydraulic cement. Must secure f. contam^n & varying temps (W)

D.G Smith's f^d rain in urban pt. Scotland cont^ns H_2SO_4 0.0121 grains per gal. - in Irvine. 0.334, Manch^r 1.052. Glasgow 1.3236. HNO_3 in Irvine 0.0615 in Glasgow 0.1705. Near sea also cont^s Na Cl.

Mean total solids in 5 analyses was 2.24 grs per gal = 0.032 grms per litre (W)

Prof. Rankine gives fol^g ex^s of available rainfall, -

	avail^e rainfall div^d by total rainfall
Steep surf^s of granite, gneiss, & slate	nearly 1
Moorland hilly pastures	from .6 to .8
Flat cultiv^d country	" .4 to .5
Chalk	0

Mr. Symons gives aver^e rainfall as 32". Rainfall in wettest yr rather more than double that of driest yr. Fol^g approx^e rule is val^e:

Fall in driest yr wl be $\frac{1}{3}$ less than mean fall.

- - wettest - - - $\frac{1}{3}$ more - -

Thus aver^e 24" gives max. 32" & minim. 16".

This calcul^{n} of rain H_2O gives theoret^{l} amt — unavoid^{e} waste.
By Roberts' Percolator 1st rain that falls is reject^{d}.

Hawksley's form^{a} for storage is $D = \frac{1000}{F}$

D = no. of drs' supply to be stored, F mean annl rainfall ($\frac{5}{6}$ of aver^{e})

224 gals water = 1 ton

$60 \times 144 \times 20 = 172800$

1728 c in = 6.23 gals.

$\therefore 172800$ — = 623 gals

= 1.7 gals per day

Suppose the rainfall to be 20 inches per annum, and the area of the receiving surface 500 square feet. Multiply the area by 144, to bring it into square inches, and this by the rainfall, and the product gives the number of cubic inches of rain which fall on the receiving area in a year. One cubic foot, or 1,728 cubic inches, of water being equivalent to 6·23 gallons, the number of gallons of water can be easily calculated. To calculate the receiving surface of the roof of a house, do not take into account the slope of the roof, but merely ascertain the area of the flat space actually covered by the roof. This may be done roughly by calculating the area of all the rooms on the ground floor, and allowing an additional amount for the space occupied by the walls. It has been estimated that, even if a rain-water supply for towns were desirable, the amount collected from the roofs of houses would scarcely average two gallons per person daily—assuming the average rainfall to be 20 inches, and that there was a roof area of 60 square feet for each individual.

5. **Upland Surface Water** is the water collected in hilly districts, as on moorlands, at the head of a river. By its utilisation for drinking purposes, the sources of water for the river are interfered with, and mill-owners and others lower down the stream might have cause for complaint. Any water company using such a source is, therefore, always bound to run into the stream a quantity of water equal to a third of the available rainfall. The limited and regular supply thus furnished to the stream is found to be a practical advantage, as its flow is equalised, and the violence of floods mitigated. The mode in which upland surface water is utilised is as follows:—

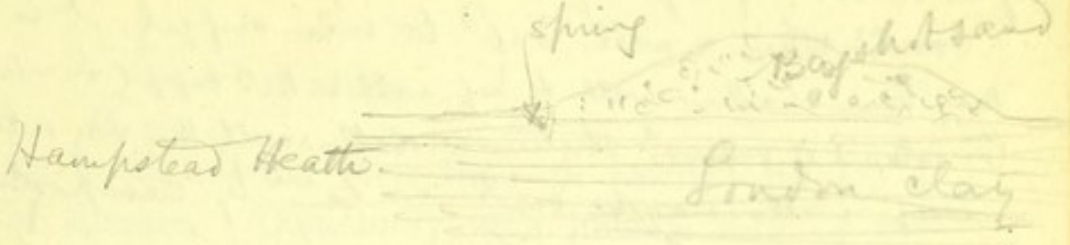
The water from the surrounding hills is collected at the bottom of a valley, in an artificial, strongly-constructed lake; or in a natural lake, as in the case of Loch Katrine (from which Glasgow is now supplied). The danger of the bursting of the reservoir (as in the case of Sheffield) has been urged against this mode of supply, but, with good engineering, this danger is very small.

Upland surface water is nearly always soft. Its use is much more economical than that of hard water. It may be brownish, from the presence of peat, but this is not objectionable, so far as health is concerned.

6. **Springs** supply water which, originally derived from rain-water, has percolated through the soil until it reaches some impervious stratum, and has then run along this, forming underground reservoirs, until it is forced up at some considerable distance by the pressure of its surroundings. The tendency is for the supply of spring-water to fail when most required—in dry and hot weather; it is important, therefore, to estimate the available supply from a spring in summer time, rather than in winter. In its passage underground, water (owing partly to the carbonic acid it has obtained from the air, and from decomposing vegetable matter in the soil), is able to dissolve small quantities of chalk, sulphate of lime and of magnesium, and traces of oxide of iron, aluminium oxide, and silica. Spring-water possesses an equable temperature, generally about 50° Fahr., while impounded or river water is always warm when wanted cool, and cool when wanted warm. The natural filtration to which spring-water has been subjected renders it aërated, and free from all impurities except mineral impurities; while, according to Voelcker, a competent authority, artificial filtration makes water flat. With regard to rain-water, he asserts, "the more you filter, the flatter it becomes."

7. **Wells** may form the best or worst sources of water-supply, according to their depth. There are two kinds—*surface wells* and *deep or Artesian wells.*

Surface Wells are such as do not descend further than 15 or 20 feet. They catch the subsoil or ground-water, which percolates into them from the surrounding soil, and the character of the water they receive will therefore vary with the nature of their surroundings. If there is a cesspool near, this may simply drain into the well; and it is often found that all the soakage from a considerable distance finds its way into the well. In villages and isolated places these



1. Land springs flow f. beds of drift or gravel lyg on an impervs stratum
2. Main springs – form^d in chalk, greensand, sandst. or other regr geol. formⁿ. In 1. flow more irregr & more subj. to seasl variⁿ than in 2.

Can^t depd on it till autic yield known. Yield estim^d by fixg a "notch-board" across the spring or stream – table gives gals per min. corresp^g to depth of notch-board.

Springs often indic^e faults in geol. strata – in such cases (unlike those caus^d by alternⁿ of strata in valleys of denudⁿ) not confined to valleys, but appear on table-lands & high elevⁿs



Wells are artifl springs: (W)

Or if deeper not beyond upr permeable stratum. Such H2O is more dangs than sewe contam^d river H2O.

If neces^y to ret^n a shallow well, a 7 or 8" aerat^d crust of soil may oxid^e the impur^s f. infiltⁿ of org^c matr.

Often it may be rend. safe f. source of impurty by plac^g it on opps. side to wh. the grd H2O movt may be expect^d

If any one cesspool to well pollⁿ of latter wd depd on dirⁿ of flow of underg. H2O. 'Above' & 'below' do not refer to fall of land but to fall of underg. H2O

(1) Lowest point of well shd be below lowest pt to wh p. H2O falls. (2) When seas^l variat^n great, less likely to obtⁿ a

reliable suppl^{g} than if var^{n} small. Inform^{n} on this point can often be obt^{d} by enquiry as to exist^{g} wells.

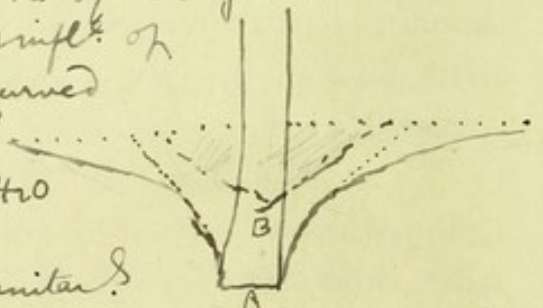
Somet^{s} when a well deep^{d} to incr. suppl^{g} it is altog^{r} stop^{d}. May have shallow well & deep well w. H$_2$O suppl^{g} & intermed^{e} well dry. Or island of imperm^{e} stratum w. shallow well H$_2$O & dry a little dist^{e} away. &c.

Deep wells may be occ^{y} contam^{d} by cesspools, as in case of N. R. Sandst. at Liverpool.

Dist^{e} betw. wells & cesspl^{s} - in Lg. Bd Mod. B. Laws usl to fix 20-30 yds Frankld says it sh^{d} be 200 yds. Case at Lausen - Ty^{d} pass^{d} 1 mile thro. a hill in line of flow of underg. H$_2$O. Dir^{n} of flow of H$_2$O more import^{t} than dist^{e}. Pumpg gt incr^{s} area of drain^{e} of a well, may thus bring a cesspl within infl^{e}. In case of severe pumpg at Liverpool radius was 1 mile. Area ceases to be drain^{d} when an inclin^{n} obt^{d} in wh. fricn of H$_2$O moving thro. pores & fiss^{s} of rock is in equilib. w. the grad^{t} upon the plane.

× Artes^{n} wells are really artif^{l} springs. Somet^{s} the H$_2$O is hot & not well aerat^{d}

× Act^{l} measur^{ts} of slope of H$_2$O tow^{ds} well, shew^{d} it to be a curv^{d} line bec^{e} nearer & nearer horiz^{l} as recd^{g} fr. the well. Real shape of slope diffs gtly fr. what given in Engl. works (R. Field) - 1/. Effect of curv^{e} incline is to make its effect felt much further than if a straight incline. 2/. Rapid rise of curve fol^{d} by gradl flat^{g} further fr. well shews that infl^{e} of pumpg on H$_2$O decr^{s} rapidly at short dist^{s} fr. well, v. slowly at long dist^{s}. Obsern^{s} near A wd give defic^{t} idea of ext^{t} of infl^{e} of pumpg. If H$_2$O sank as low as B curved line bec^{e} shorter. Thus dist^{e} of infl^{e} of pumpg depd^{s} not on depth of well, but on ext^{t} to wh. H$_2$O depres^{d} by pumpg.



Dist^{e} of drain^{e} of a well most import^{t} sanitar^{y} In fine sand & fine gravel where gt resist^{e} to passage of H$_2$O is 15-29 times the depres^{n} In chalk, where fiss^{s}, dist^{e} is 57 times the depres^{n} In v. coarse gravel 60-100 times In New R. Sandst. in wh. extend^{g} fiss^{s} is 143 times depres^{n} Dist^{e} does not incr^{e} so rapidly as depres^{n} Contin^{s} exper^{ts} shew that incline of surf^{e} of gd. H$_2$O does not have so much infl^{e} on dist^{e} the well draws, as might have been expect^{d}

surface wells are much oftener seen than in towns, and are a fertile source of disease. Commonly, one hole is dug in the garden for a well, and another for a cesspool, while there is possibly a farm-yard near at hand—the soakage from the cesspool and farm-yard being drained into the well. A surface well, if allowed at all, ought to be in the middle of a field, remote from the house and its annexa, in a spot where soakage from sewage is impossible. In any case, surface wells not uncommonly dry up in summer time, owing to their being dependent on the subsoil water for their supply.

Artesian Wells are made by digging an ordinary surface well, and lining it with brickwork, thoroughly set in cement, so that the subsoil water cannot enter it; and then boring from the bottom down through the subjacent rock until a water-bearing stratum is reached. Such Artesian wells have been sunk in London, which has a clay and gravel soil over chalk rocks. Rain, falling on the chalk hills which lie to the south and north of London, percolates through the chalk downwards, and then laterally, until it lies in the concave London basin. Here the clay stratum above it prevents its escape upwards; and, being confined under considerable pressure, it rises to the surface, or into an ordinary well, when the clay is tapped.

As an example of the strata passed through in an Artesian boring, the Artesian well bored at Meux' brewery, in Tottenham Court Road, is very interesting. The depth of this well is 1,144½ feet, which is distributed among the different strata, from above downwards, as follows:—

Gravel	22 feet.
London Clay	63½ ,,
Woolwich and Reading Beds (Sands and Clay)	51 ,,
Thanet Sands	21 ,,
Chalk	655 ,,
Upper Green-sand	28 ,,
Gault	160 ,,
Lower Green-sand	64 ,,
Devonian	80 ,,

It was hoped that water would be found in the beds beneath the gault, which come to the surface at Godstone, in Surrey, and are highly charged with water. But in this boring the water-bearing strata were not found, to the great disappointment of all concerned, and the boring had to be continued to the two deepest strata in the above list, which have within the last few weeks been pronounced by Professor Judd to be Oolitic beds.

The deepest Artesian wells are at Grenelle, in Paris (1,800 feet), and at Kissingen (1,878 feet). In the sinking of a deep well, it is well to remember that it may affect and exhaust all the neighbouring shallow wells for two or three miles, as well as all the cesspools. The danger of contamination from the latter is only present when the upper part of the well is not properly made.

For country places deep-well water is much preferable to water from streams, as streams are very liable to be contaminated by the sewage of houses higher up in their course, or even by that of others close by. A good well should be at least thirty feet deep—preferably fifty feet; and there ought to be no drain or cesspool for a considerable distance. The case in which disinfectants were put down a water-closet, and recognised by smell in the water of a contiguous well, one or two hours afterwards, is full of instruction.

An excellent plan to obtain water for villages, in a gravelly soil, is to sink a Norton's Abyssinian tube well for fifty or sixty feet. It is unfortunate that, in the present condition of the law, no compulsion can be brought to bear upon the landlord to supply wholesome water to his houses.

In towns it is, as a rule, preferable to trust to the public water supplied, rather than to any private well.

The water is obtained from a well by a *pump* or a *draw-well.* The former is by far the best plan. The use of a bucket is laborious and tedious, and necessitates opening the well every time water is wanted, thus leading to danger of animal matter or filth getting in.

Parapet of well should be raised at least 1 ft above ground, + paving around W.

Prof. Blake univ. Kansas took sol. Li salt 1/3 to 1 gt water sponged into susp. sources of pollut. in neighb. of well, & after a wk or so exam. some of well water in spectroscope. One bright red band towd. remote red end of spect. Can't be mistaken even if sol. less than 1 in mill. Platinise dipd in water & then held in Bunsen flame. May boil down water first. Test shd direct contam. in one of wells fr. prior 30 ft distant.

or Caterham

some others deeper.

By boring beneath seabottom as at Spithead forts fresh water is obtd f. chalk.

Sand often drawn up into tube & v. troublesome. In some cases has been prevd by ramg gravel down tube. If drift chalk penetd, the H2O pumpd may be milky. Dry well formg a settling reservr wd have avoidd this

Yield of river is estim^{d} by meas^{g} 1/. mean depth, 2/. mean breadth of river, & 3/. vel^{y} obt^{d} by observ^{g} rapid^{y} w. wh. a float passes betw. 2 points of known dist^{e}, – this gives the surf^{e} velr, of wh. $\frac{3}{4}$ gives approx^{s} mean vel^{y} of whole stream.

Multiply product of 1/. 2/. & 3/. in feet by 6.24, ans. of gallons per min is obt^{d}.

1 c ft = 6.24 gals

8. **Rivers** and running streams originate in upland surface water or springs, and their water should be of the same quality. Unfortunately, they acquire a large amount of impurities in their course. Adjacent towns nearly always pour their sewage into them; even where this is not the case, sewage of villages or isolated houses suffices to poison the water. *Figure 1* illustrates the pollution of a mountain stream by the defective drains and overflow from cesspools (shown by dotted lines) of a country house. The house is supplied with water close to the point where the soakage from its sewage pollutes the water, and a small village is supplied with water at a lower point of the stream.

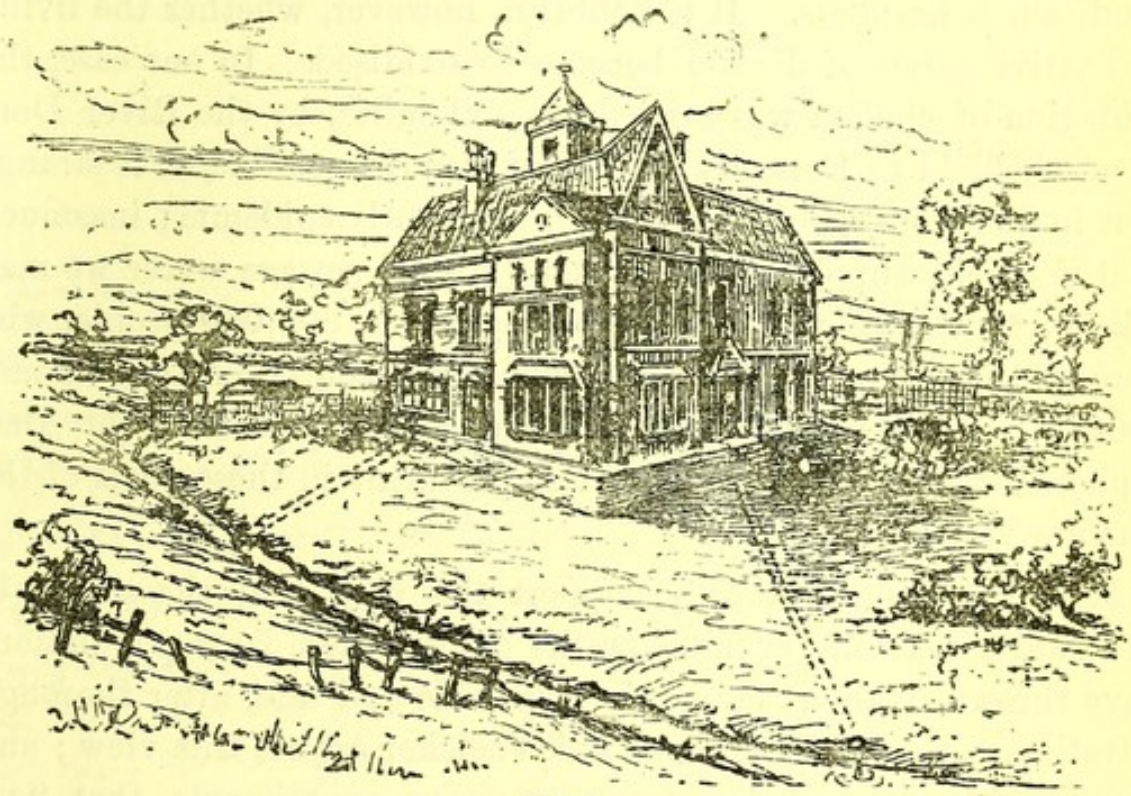


FIG. 1.

Mountain stream, affording a supply to a country-house, and, at a lower point, to a small village. Defective drains and overflow from cesspools (shown by dotted lines) polluting the stream.

If no animal contamination is present in a river, it forms an admirable source of water-supply; being running water, it is always well aërated, and is not usually so hard as spring-water.

Even if sewage has entered a river, it is asserted by some that it

remains a safe source of water-supply, after passage through filtering beds. This is evidently, however, acting on a wrong principle; far better to start with a pure supply than to use one which requires purifying. On the other hand, it is urged that the sewage entering into a river is got rid of in three ways.

1st.—By *subsidence*, the organic matter settling to the bottom.

2nd.—By the influence of *water-plants*, which assimilate ammonia, nitrates, etc., and give out nascent oxygen.

3rd.—*Oxidation.* Doubtless a large amount of the nitrogenous matter does become oxidised in its course down a river, and in this condition is harmless. It is doubtful, however, whether the living and active germs of disease become so oxidised. In one case, the contagion of cholera was carried 15—20 miles, by the River Don, from Sheffield to Doncaster. But if this is possible, it is strange that in London typhoid fever is not constantly epidemic; inasmuch as it is chiefly supplied with water (filtered sewage water we may call it), which has received the sewage from 800,000 people, who live in the towns and villages along the course of the Thames above the Companies' intake. There can be no doubt that typhoid fever is always more or less prevalent in these parts of the Thames valley.

Messrs. Odling and Tidy support the view that the supply of river-water to towns, even below the points where large populations have thrown in their sewage, is justifiable and safe, after thorough filtration. Messrs. Frankland and Voelcker oppose this view; and Dr. Frankland concludes, from numerous experiments, that "no river in the United Kingdom is long enough to effect the destruction of sewage by oxidation;" while Dr. A. Hill says that probably living matter does not get oxidised by flowing down a river, any more than a fish does in a similar course.

Judging by several Parliamentary decisions, the general concensus of opinion is against a river supply below a point at which any sewage has been received. In the case of the Durham, Cheltenham,

1ª by dilution fr. affluent streams & springs in bed of river.

No more org.c matt in the Thames H2O at Hampton Ct than at Lechlade in Gloucestr, 116 ms higher up the river W.
Similarly apparent self-purifn of Seine below Paris probably mainly explicable by dilutn of river partly by affluents & chiefly by springs ris.g up in its bed.

Fr. statistics coll.d in '84 it appears that the sewge of over 70000 people is still delivd. direct into Thames or its tributaries above the intakes for Lond. H2O.
More than ½ the water distribd by the 5½ mil.ns of gls Londoners is still drawn from Thames. This partakes of "an experiment performed on our lives."

London H₂O Companies

1. West Middlesex
2. Grand Junction
3. Southwk & Vauxhall

} Draw H₂O f. Thames at Hampton

4. Lambeth Co? — Draws at Molesey.
5. Chelsea Co? —— " " Ditton
6. East London Co? " " Thames at Sunbury
7. Kent H₂O Co? - f. chalkwell. (& River Lee

and Stockton Water Bills, this point has been raised, and decided in the House of Lords in every instance against the river supply.

Seven out of eight of the water companies, by which London is supplied, derive their water from the Thames and Lea—the exception being the Kent Water Company, which supplies water from deep chalk wells. In each of the seven cases, the intake of water is at a point below where sewage enters the river; and there can be no doubt that, had these companies *now* to apply for the necessary powers, their bills would be rejected by the Legislature.

In regard to the comparative merits of the various waters described, it will be useful to give here the classification made by the Rivers Pollution Commissioners in their sixth report:—

Wholesome	1. Spring Water	*Very palatable.*
	2. Deep-well Water	
	3. Upland Surface Water ...	*Moderately palatable.*
Suspicious	4. Stored Rain Water ...	
	5. Surface Water from Cultivated Land	*Palatable.*
Dangerous	6. River Water to which Sewage gains access ...	
	7. Shallow-well Water ...	

The geological formation of the soil has a great influence in rendering water palatable, colourless, and wholesome by percolation.

The following strata are said by the Commissioners to be the most efficient:—(1) Chalk, (2) oolite, (3) greensand, (4) Hastings sand, (5) new red and conglomerate sandstone.

CHAPTER X.

THE STORAGE AND DELIVERY OF WATER.

Relation of Water-supply to Rainfall and Character of Soil.—Construction of Reservoirs and Conduits.—Cisterns.—Intermittent and Constant Systems of Supply.

The methods of storing and delivering water will vary with its source. In rural districts, deep wells and springs are the best sources of supply; but in large towns they are found to be insuffi-

cient for the wants of a rapidly-increasing population; and they can only be multiplied in a given district within certain limits, as every well drains a large surrounding area. In the Bootle well, at Liverpool, which had 16 bore-holes—some of them 600 feet deep—it was found that, while the supply, when they were all open, was 1,127,920 gallons per day, it was only diminished to 921,192 gallons when they were all plugged but one (Wilson). The supply from surface wells in gravel or sand beds or in chalk districts is liable to fail in seasons of drought; but deep wells in oolite or chalk formations, and in the new red sandstone, generally yield a constant and abundant supply.

In towns, water is usually supplied by private companies, relieving the individual from responsibility in the matter. In some towns, like Manchester, the supply is under the control of the Corporation, and this is found to work advantageously, both as regards purity of water and lowness of rates.

When the water is supplied from upland surfaces, springs, or small streams, **a collecting reservoir** is required. This is generally a natural valley below the level of the source of supply, but of sufficient elevation above the place supplied to allow the water to be distributed by gravity, without any pumping apparatus. The reservoir should be large enough to hold five or six months' supply, and its embankment should be perfectly water-tight, and of great strength.

When water is collected from upland surfaces, it is important to know the amount of rainfall to be reckoned on. If we know the area of the surface which drains towards the reservoir, and the average rainfall, the *total* rainfall is easily calculated. This will, however, differ greatly from the *available* rainfall, owing to the losses from penetration into the ground, evaporation, and other causes. The amount lost will vary, according to the season, from one-half to seven-eighths of the total rainfall. In clay districts very little water sinks into the soil; in limestone, as much as 20 per cent.; in chalk districts, 42 per cent.; and in

Area of drainᵍ of a well is much greater than a circle, radius of wh. is depth of well. Extensᵒ of drainᵍ area shewn also by distᵉ at wh. tides or runᵍ H₂O affect them.

See oppos. p. 293

Water may be found owing to defective caulking of lead jts. In Spence's metal no calkum or other caulking matl is req^d, as it is w. Pb. Cement jts liable to leakage.

loose, gravelly, or sandy districts, as much as 90 to 96 per cent. (Wilson). The amount of infiltration of the chief water-bearing strata surrounding London varies from 48 to 60 per cent. (Prestwich). The amount of infiltration will be less when the ground is steep and the rainfall rapid, and usually less in winter than summer.

Water collected near its actual place of fall, and from uncultivated districts, is always purer than that collected further from its source, and from cultivated land.

From the collecting or impounding reservoir, water is carried by the aqueduct or discharging pipe either directly into the service-pipes, or when the pressure is too great, into a second **service-reservoir,** resembling the impounding reservoir in general structure, and capable of holding a few days' supply.

This must be on high ground, above the level of the highest houses to which water has to be supplied, as water cannot rise above its own level. When this cannot be arranged, the water must be pumped into tanks at a higher level, and distributed from them.

The greatest hourly demand for water being double the average hourly demand, the main conduits supplying a town must have double the discharging power that would be required, supposing the demand were uniform. The first requisite of a supply of water is that it should be abundant, and sufficient in amount for any extra strain on its capacities. Water ought to be laid on to every house, and to at least two floors of the house. Anything preventing free access to water, militates against cleanliness.

Cast-iron is the most serviceable material used in the construction of the main water-pipes; it is coated with pitch, or Dr. Angus Smith's bituminous varnish, or with magnetic oxide of iron (Barff). The service-pipes to each house are generally made of lead, and the ease with which this material can be bent and curved, and carried to the different floors of a house, makes its use very convenient. Another reason urged by the water companies on behalf of lead-pipes, is the facility with which they can be obliterated in case

of bursting, and so any waste of water and flooding of the house prevented. Some kinds of water, unfortunately, act on and dissolve lead; this is especially true of soft waters and those containing organic matter. Shallow wells, being very liable to organic pollution, ought never to have the supply-pipe of their pumps made of lead. With hard waters, lead pipes may generally be used safely. When the quality of the water renders lead pipes objectionable, the use of iron, tin, zinc, tinned copper, earthenware, gutta-percha, and other materials, has been suggested. Of these, cast and wrought-iron pipes are the most serviceable, or pipes composed of an inner lining of block-tin and an outer of lead, so united as to be inseparable by any amount of twisting. According to Rawlinson, "supply-pipes of wrought-iron are cheaper, stronger, and more easily fitted than service-pipes of lead;" but it is urged against them by Parry, that with soft water they become choked by rust in a few years. Cast-iron pipes are rusted less easily than wrought-iron.

When the water-supply is from a river, filtering beds are needed, in addition to the parts of a water-service hitherto described. Moreover, since the river is usually at a low level, the water, after passing through the filtering beds, requires to be pumped into raised tanks, from which it is delivered.

In laying down water-pipes, in the streets and to houses, it is very important to make the distance between them and all drains and gas-pipes as great as possible. There is a tendency for suction of gases or liquids to occur into leaky pipes, even though these contain water, and still more when they are empty; and this forms an occasional mode of origin of disease.

The pipes bringing the water to a house may be kept constantly filled with water, or only for a limited time once or twice a day. The intermittent system of supply necessitates the provision of cisterns or water-tanks, in which water can be stored in the intervals of flow of water.

Cisterns.—Cisterns for the supply of potable water may be

Recent prevale of Pb. pois? in Huddersfield ∫. water (B M.J. Aug 87)
Commissin of chem: experts came to conclus: that the only
true protect: agst plumbism in case ∫water liable to take up Pb
∫. Pb pipes was the exist: of silicates in the water, that no coat: of the pipes was effect: unless it cont: silicates. Exper:
power of H_2O to take up Pb ∫. pipes was removed by pass: the H_2O 1st
over such mat:ls as broken quartz cont silicates.

Block tin pipes ~~coated with~~ lined with Pb (Haines' patent) In these & others like them, the least fault in coat:n sets up electrolytic act: betw: metals W.
acc: to Parkes Zn pipes into contact with Pb waters get as rapidly diss:d.
Lead pipes if used shd not be bent against the grain, so as to
expose the struct: of the metal. W

Prof. Emerson Reynolds states that an alloy of Pb w. 3% of Sn
is not attacked by H_2O, this used w. good results in Dublin & Glasgow W.

Wood^{n} butts are an abomin^{n}.
Pb cisterns are more dang^{s} than Pb pipes, ow^{g} to org^{c} deposit &
effos^{c} to air & warmth.

Iron cov^{d} w. a vitrified enamel is absol^{y} free f. risk. W.

Cist^{ns} shd be placed – 1. secured f. frost & sun.
2. not near W.C. as comm^{y} done to save a few ft of pipe.
3. not beneath flooring of a landing or bath-room.

Ball valves have nearly superseded ball-cocks – less liable to get out of order.

Overflow pipe shd be much lger than supply-pipe in order that
it may disch^{e} same amt of H$_2$O in same time

made of iron, slate, stone, glass, glazed earthenware, or brick lined with Portland cement. Other materials have been used, as timber, lead, and zinc. *Timber* is inadvisable, as it easily rots; *lead* is very objectionable, owing to the solvent action of the water on it. If on entering a house, there is found to be a lead cistern coated over with white carbonate of lead, it is inadvisable to wash it out periodically like other cisterns, as part of the coating will be disturbed and new lead exposed to the action of the water. *Zinc* is also acted on occasionally by water; but as it does not produce severe symptoms like those from lead, it may be used. According to Corfield, *galvanized iron* (that is, iron coated with a thin layer of zinc) is the best material for cisterns. Iron cisterns soon rust; but this may be prevented by giving them a coating of boiled linseed oil before they leave the foundry. *Stone cisterns* are too heavy for use, except in basements. *Slate cisterns* are good, but are apt to leak; the points of leakage are not uncommonly smeared with red lead, which is attacked by the water, and thus lead poisoning results. If the slate is set in good cement (not mortar, as this makes the water hard), it is perhaps the best of all materials for a cistern.

Every cistern should have a *well-fitting lid*, always kept closed; otherwise, not only dust gets into the water and noxious gases, but also decomposing vegetable matters, and even dead cats, birds, etc.

The cistern should be *easy of access.* If it is indoors, the cistern room should be well ventilated; and in any case the cistern should be periodically visited and cleaned out. When the cistern is full, a ball-tap prevents any further flow of water; and if this does not act properly, an overflow pipe carries off the excess of water.

Cisterns badly arranged or neglected are a common source of disease. It is essential that (1) the *overflow pipe* should not pass into any part of the water-closet apparatus or the soil-pipe, as, according to Dr. Cayley, it does in about two-thirds of the cisterns in London houses, and as it is seen to do in *Fig. 2.*

Where the overflow-pipe joins the soil-pipe below the syphon of the water-closet, sewer gas mounts directly into the cistern and is absorbed by the water; where it is joined to the trap of the syphon, on the side nearest the water-closet pan, only the offensive gases from the water-closet can, as a rule, mount into the cistern.

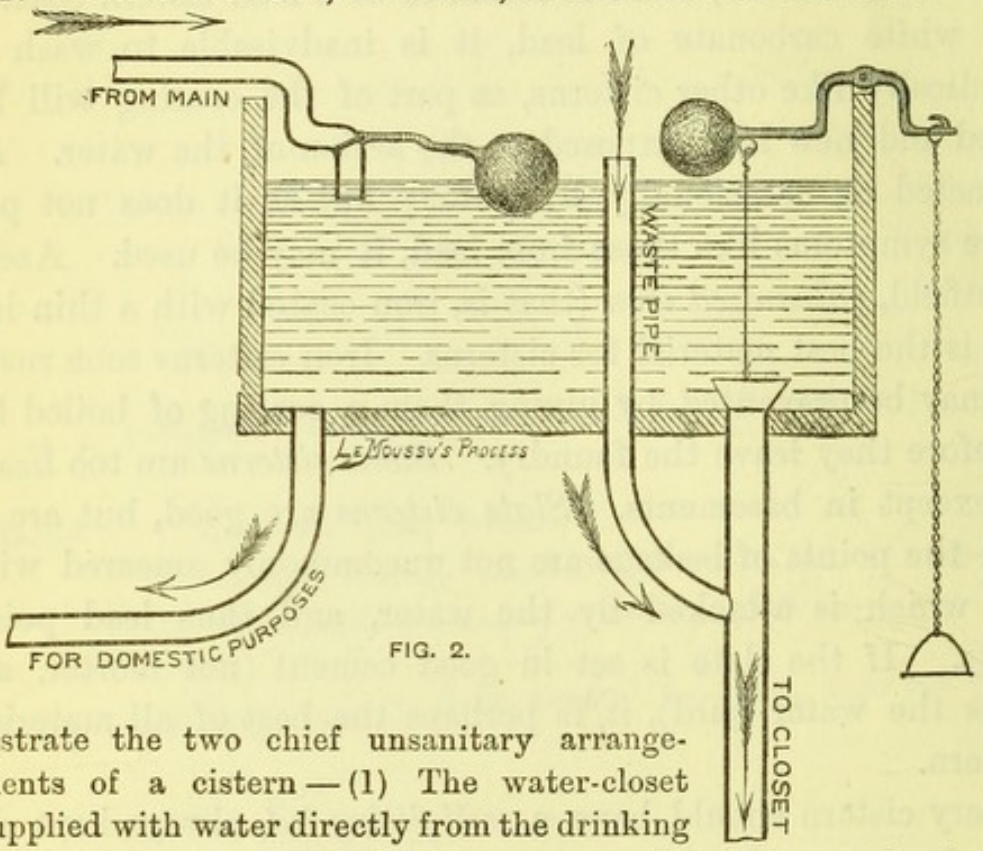


FIG. 2.

To illustrate the two chief unsanitary arrangements of a cistern — (1) The water-closet supplied with water directly from the drinking water cistern; and (2) the waste or overflow-pipe opening into the soil-pipe, instead of into the open air.

(2) *No water-closet* ought to be supplied from the same cistern as supplies drinking water, as the pipe leading down to the closet often carries closet air to the cistern (*see Fig. 2*). A small cistern or service-box should be provided for each closet.

With a constant supply of water, cisterns are only required for water-closets and hot-water apparatus, and possibly occasionally during repairs.

Constant and Intermittent Services.—With an intermittent service of water, during the intervals of supply, water is only obtainable from cisterns, water-butts, etc. The objections against this system are that—(1) The cisterns required are expensive,

Water a very active absorbent of gaseous matts
"How unattractive as a beverage to the poor
inhabts of the City must be this vapid privy-flavoured
stuff" (Simon)

and liable to get out of order and become foul. (2) Their overflow pipes commonly communicate with the soil pipe or some other part of the drainage, instead of opening into the external air. (3) Putrid gases, from neighbouring stench-pipes or other parts of the drainage system, are liable to be absorbed by the stagnant water in the cistern. (4) The chief objection to an intermittent supply is that, during the intervals in which the water-pipes are empty, foul air and liquids from the contiguous soil and drains are liable to be sucked through imperfect joints into the pipes. (5) In case of fire, the supply of water in the cistern is soon exhausted, and no more is obtainable until the turncock is found; thus there is often delay at the most important time. The importance of this evil is shown by the great reduction in insurance rates in Manchester, Liverpool, and other places, on the substitution of a constant for an intermittent service.

Many of these objections to the intermittent service are removable; it may be so arranged that there is no possibility of sewage or other contamination, but the best constructed apparatus is apt at some time to fail.

The only objectors to the constant service are the Water Companies. They urge that the fittings required for this system are expensive and liable to be stolen; and that, when through carelessness or accident, taps are left open or pipes burst, the waste of water is much greater than with a cistern supply. These objections have not been found to hold good where there is a well regulated and properly inspected constant supply. The increased waste, with a constant supply, only occurs where it is adopted with the same fittings and pipes as were used for the intermittent supply. But where the best screw taps and fittings are provided, and judicious regulations for preventing waste are enforced, the consumption of water is less than with an intermittent supply.

One valuable point in the constant system is that, in order to aid inspection and the detection of waste, the waste-pipe is not allowed to open into any part of the drainage; but, under the

name of a "warning pipe," is placed where the escape can be seen. Thus the possibility of sewer-gas being conducted back into houses through overflow pipes is avoided.

Occasionally, with a constant supply, there is not sufficient pressure to supply the upper stories of houses situated on a high level. In these cases, high level cisterns are required, provided with "warning pipes," ending in the open air.

The ADVANTAGES OF THE CONSTANT SERVICE may be thus summarised :—

(1) Owing to the absence of cisterns, the risks connected with stagnant water, and with improper ending of over-flow pipes, are obviated.

(2) The risk of suction into the pipes of external contaminations is reduced to a minimum, since the pipes are never empty.

(3) The pipes are less liable to rust. Air, in the presence of a little moisture, causes rapid corrosion.

(4) There is an abundant supply of water in case of fire.

Of course, when there is a temporary stoppage of supply, as for repairs, some of the dangers incurred by an intermittent supply will arise.

CHAPTER XI.

IMPURITIES OF WATER.

Properties of Pure Water.—Gaseous Impurities.—Mineral Impurities.—Hardness of Water.—Organic Impurities of Water.—Danger of Impurity not in Proportion to its Amount.

PROPERTIES OF WATER.—When pure, water is **colourless**, or bluish when seen in large quantity. It should be quite **inodorous**. If, after keeping it for some time in a perfectly clean vessel, a smell (however slight) of sulphuretted hydrogen is developed, the water is certainly bad. Its **taste** should be pleasant and sparkling from the atmospheric gases dissolved in it. Bitterness generally indicates the presence of sulphate of magnesium (Epsom salts). Saltness is always a suspicious property, except in

A const^{t} supp^{g} not neces^{y} a boundless supp^{g}.

Even w. const^{t} supp^{g} sm. cist^{ns} must be fit^{d} to WCs to ht^{rs} a sun^{dy} flush spec^{l} any possib^{l} of suck^{g} back foul air & H_2O into pipes

May have backwd press^{e} throughout the whole system, in case of accid^{l} empt^{g} of pipes.

Greater strain on pipes of const^{t} supply. Esp^{y} as req^{ts} of some pts of day are spec^{y} great. In case of repairs to mains, corresp^{g} dist^{ts} deprived of H_2O.

In every pract^{l} sense, the sale of water is a monopoly. Cant go to another market for it. Drainage & water-supp^{g} closely inter-depend^{t}; "the effic^{y} of either implies their mutual adapt^{n}" (Simon), therefr. H_2O supp^{g} shd be under control of San^{y} auth^{y}. P.H. Act gives powers to supp^{g} H_2O or contract for it

If any sew^{e} in H_2O, its smell is gen^{y} perceiv^{d} at beg^{g} of boil^{g}.

Any water wh after keeping in warm place becomes putrid & gives off a colourless faint smell, is unfit for use. Effluents of sewage farms do this (W)

18"

Degrees of turbidity

V.S.T.
S.T.
T.
V.T.

H_2S in water gives black w. $Pb(Ac)_2$.
Other sulphides a violet or purple w. Nitro-prusside Na, Wh. H_2S does not.

water obtained in the neighbourhood of salt mines or brine springs, or near the sea. It should be soft to the **touch**, and should dissolve soap easily. It should be bright and **clear**, and contain no suspended matters. Clear water is not necessarily pure, but turbid water is always to be rejected; the only exception being the brownish-tinged water from moors, which is not hurtful. In all other cases, printed matter should be legible through at least 18 inches of water. Thoroughly dissolved organic matter is less dangerous than suspended; the turbidity of water is therefore of great importance. But water may be bright and sparkling and apparently perfectly clear, when it is a deadly poison. The most important of the physical properties of water in regard to health, are the absence of smell and turbidity, and these can be ascertained by even the most inexperienced. The chemical tests for the more important impurities will be mentioned later.

The impurities of water may be classed under four heads—gaseous, mineral, vegetable, and animal.

The gases ordinarily present in water cannot properly be regarded as impurities, inasmuch as they are always present, and greatly increase its palatableness. The dissolved nitrogen and oxygen bear to each other the proportion 1·42 to 1; where sewage contamination occurs, it is probable that the oxygen would be diminished, owing to oxidation of the organic matter; and it has even been proposed to determine the presence of sewage by the absence of oxygen.

The amount of carbonic acid gas in water varies greatly. Impure water from churchyards is often clear, and sparkling from carbonic acid. Such water begins to stink after being kept for a few days. Fetid gases are occasionally absorbed by the water in cisterns, when there is a connection between the overflow-pipe of the cistern and the water-closet, or when the ventilating shaft from the soil-pipe has its open end near the cistern.

Mineral Impurities.—Mineral impurities are dissolved by water in its course through the soil, and so will vary with the

character of the latter. 1. The water obtained from *granitic* formations contains very little mineral matter, often not more than two to six grains per gallon. *Clay slate water* is also generally very pure, as is the water from hard *trap rocks.* 2. The water from *millstone grit* and *hard oolite* is very pure, often containing only four to eight grains per gallon, chiefly calcium and magnesium sulphate and carbonate. 3. *Soft sand-rock waters* usually contain thirty to eighty grains per gallon of sodium salts, with a little lime and magnesia. 4. *Loose sand and gravel waters* vary greatly. They may be almost free from mineral matter, or the solids may be more than seventy grains per gallon, including much organic matter. 5. Waters from the *lias clays* vary somewhat, but commonly contain a large quantity of calcium and magnesium sulphates. 6. *Chalk waters* generally contain from seven to twenty grains of calcium carbonate, with smaller quantities of other salts. 7. *Limestone and magnesian limestone waters* differ from the last, in containing more calcium sulphate and less calcium carbonate, as well as much magnesium sulphate and carbonate in the dolomite districts. 8. *Selenitic waters* contain calcium sulphate in considerable quantities. 9. *Clay waters* usually possess the characters of surface wells, and are objectionable. 10. *Alluvial waters* generally contain a large amount of various salts, including the various calcium, magnesium, and sodium salts. 11. *Artesian well water* varies greatly in composition. It may contain a large amount of sodium and potassium salts, or a small quantity of iron, or calcium salts. (Parkes: Manual of Practical Hygiene.)

It will be necessary to discuss the various mineral impurities in detail. The commonest and most important salt present is calcium carbonate; next to this comes calcium sulphate. These two salts are the chief causes of **hardness of water.** For practical purposes, as regards use in domestic matters and in manufactures, the most important classification of waters is into *hard* and *soft.* The degree of hardness varies within wide limits—from rain-water,

Tert.ry Formns

1. Pliocene
2. Miocene — nearly absent

3. Eocene
   1. Bagshot sands
   2. London clay
   3. Woolwich & Reading beds } Lower Lond. tertiaries
   4. Thanet sands.

Mesozoic Formns

Cretaceous
1. Chalk —
2. Upper greensand
3. Gault
4. Lower Greensand
   Folkestone
   Sandgate & } beds
   Hythe

Wealden series — Hastings sands &c

Oolites
- Kimmeridge clay — scanty & bad H_2O, charged w. Fe S & $CaSO_4$.
- Oxford clay — springs scarce. Deep sinkg. not taken successf.

Lias — H_2O sparing. qual.: often unwholesome.

Triassic
- New Red Marl
- New Red Sandstone — if disintegd. & marly, H_2O like that of clays & hard f. $CaSO_4$: but in sandst. rock is nearer surf. & fair & good quals.

Palæozoic Formns

Permian — Mg limestone &c

Carbonifs
- Coal measures & Millstone Grit
- Carbonifs limest. & slate

Old Red Sandstone

The hard^{s} of H_2O can be demonst^{d} by add^{g} ℥i clear aq. Calcis to a tumbler & then fill^{g} up w. hard. H_2O - Milkin^{s}. is prod^{d} - rain H_2O no turbid^{n}

Lime gives white ppt w. Ca Oxal^{e} : 6 grs per gal. give slight turbid^{n} only : 16 grs a consid^{e} ppt.

which has no hardness at all, to the water from new red sandstone rocks, which sometimes possesses a hardness of 90 degrees; or wells in the gravel, in which it may be as much as 152 degrees.

The following *classification of waters*, according to the degree of hardness, beginning with the least hard and gradually increasing in hardness, is from the sixth report of the Rivers Pollution Commissioners:—1. Rain-water. 2. Upland surface. 3. Surface from cultivated land. 4. River. 5. Spring. 6. Deep-well. 7. Shallow-well water.

Calcium carbonate is the most common cause of hardness, and the hardness produced by it is remediable, while that from calcium sulphate is irremediable. Calcium carbonate (chalk) is rendered soluble in water, by the carbonic acid contained in the latter, a double bi-carbonate being thus formed. The air contained in the interstices of the soil through which water passes, often contains 250 times as much carbonic acid as ordinary air. The water, in percolating through the soil, dissolves this carbonic acid, and thus is able to take up a considerable amount of chalk.

The amount of hardness in any given water is expressed in degrees, one degree corresponding with a grain of calcium carbonate in a gallon of water. **Clarke's soap test** is employed to detect the amount of hardness. It consists of a solution of soap of a known strength. Soft water will form a lather at once with this; hard water will only form a lather after all the calcium salt is neutralised. The amount of Clarke's solution required before a lather is produced, will give an estimate of the amount of hardness.

The amount of soap wasted in consequence of the hardness of water is very great. Thus, in the case of water of one degree of hardness, as every gallon contains one grain of chalk, 7,000 gallons would contain 7,000 grains—that is, a pound. But it is found that every degree of hardness—that is, every grain of chalk—wastes 8 or 9 grains of soap; therefore, a pound of chalk,

contained in 7,000 gallons, would waste about 8½ pounds of soap. But nearly all waters are harder than this, and they not uncommonly possess a hardness of 20° or more. If the hardness be 20°, the waste would be 170 pounds of soap. This quantity would be easily used annually in a family of seven or eight persons, if we include the washing of clothes. The amount of money thus wasted can be easily estimated.

The hardness of water is a matter of considerable commercial importance. A chemical commission of the Metropolitan Water Supply, in 1881, estimated that, where soda was not employed, a saving of about a third of the soap used in London for washing linen would be effected, by using soft instead of ordinary London water, and that the saving in labour would be even more considerable. In Glasgow, water possessing 1½° of hardness has been substituted for water of 8° of hardness; and it has been estimated by manufacturers in that town, who use soap in immense quantities, that the consumption of soap has been reduced by one half.

Not only does soft water require less soap, but it is much more suitable for making tea and soup, and for boiling meat and vegetables—both time and fuel being saved. The reason why better tea is made when a little carbonate of soda is added to the water, is that the chalk is by this means precipitated. Five ounces of tea made with soft water, will be as strong as nine ounces made with hard water. It has been stated that nearly one-third of the tea used in London is wasted, owing to the hardness of the water employed in making it.

Carbonate of calcium (and of magnesium) are precipitated from water by boiling it; carbonic acid being driven off, the neutral salt falls to the bottom of the vessel. This is the origin of the "fur" inside kettles, which lessens their conductivity to heat, and renders necessary a greater consumption of fuel.

The chalk may also be removed by adding to the water, while still in the reservoir, some milk of lime—that is, quicklime made into a milky solution with water. This is done on a large scale at

10 gals of H₂O of hard & Thames H₂O causes the waste of nearly ¼ lb soap, when used for wash^g.

Clark described water as hard above 6°- below this as soft. Rate of mortality in hard water districts lower than in soft-water districts. Mem. that ⅘ of strata of earth is limestone or carb^t lime (Sir R. Rawlinson).

Temp^{y} hard^{s} of H$_2$O is remov^{d}. 1/. by boil^{g}, as in every Kettle in London. 2/. by add^{n} of CaO. This done by (a) by Clark's process in wh. milk of lime used, & settling reserv^{s} are req^{d}; (b) by Porter Clark process, in wh. clear Aq. Calcis add^{d} in closed vessels, & then passes into a filter^{g} machine, wherein the ppt of pure $CaCO_3$ forms the medium of filtr^{n} — the clear water pass^{g} direct to the service tanks thro 2nd pump^{g} being req^{d}. The $CaCO_3$ is removed fr. the filter daily.

add^{n} of CaO to cure hard^{s} amiss^{te} of Scin. similibus curantur

If too much CaO add^{d}. $AgNO_3$ turns sol^{n} brown.

Maignen's "anticalcaire" removes $CaSO_4$ as well as $CaCO_3$ (W)

x. It may however be removed by add^{n} of washing soda, as well as $CaCl_2$ & Ca nitrate: hence its use for washing purposes & for boil^{g} pots. The Mg. salts are not removed by boil^{g} or soda, contrary to what is usually stated. This is proved by the fact that the fur inside kettles does not usually cont^{n} Mg salts

W. gives total hard^{s} of Bala lake as 0.2°, Loch Katrine 0.0, & Manchester (Thirlmere) 2° to 3°; Thames & New River 12° to 16°.

Caterham, Canterbury, Colne Valley Water-works, etc. The reaction may be expressed thus :—

Calcium bicarbonate + calcium oxide = calcium carbonate + calcium carbonate.

The calcium carbonate, as it is precipitated, carries down with it organic and other matters, thus clearing and purifying the water. The quantity of lime required has been ascertained by Dr. Clarke. He found that by adding one ounce of quicklime to a hundred gallons of water, for every degree of hardness, the water becomes soft and clean in twelve hours.

A mixture of animal charcoal and quicklime is now sold for use in a special form of filter (Maignen's), by which the water is both filtered and softened at the same time. Of course, the filtering material requires to be changed occasionally, and thus a more efficient filtration is ensured than with any fixed apparatus.

The hardness due to calcium sulphate is not removable by boiling or chemical measures. It is, therefore, called **permanent hardness**, to distinguish it from the *temporary hardness* of chalk waters, which is removable by boiling.

The amount of hardness varies greatly in different waters. In the deep wells in magnesian limestone, it varies from 14°—57°; in the deep wells from chalk beds, it averages 27°. In the water from Bala Lake, Wales, the temporary hardness is 0°·1, the permanent hardness 0°·3; in the Loch Katrine water there is no temporary hardness, 0°·9 permanent hardness; in the water from the Thames, above Reading, temporary hardness 12°·8, permanent 8°·2, total 21°; from the Thames, above Hampton, temporary hardness 17°·9, permanent 6°·6.

The amount of permanent hardness is always great in water from clays, as the London, Oxford, Kimmeridge, and Lower Lias clays; or in places where there are large deposits of calcium sulphate, as at Montmartre, near Paris (hence the name Plaster of Paris, given to desiccated calcium sulphate). Water from fissures in the clay often contains, also, a large amount of organic matter.

Chlorides are always present in small quantities in water. In the Thames water at Kew, there is ·847 grain per gallon of chlorine, in the New River water 1·1, in Ullswater ·7 grain per gallon. As a rule the presence of 1 grain per gallon indicates contamination with some animal refuse, unless the water is derived from new red sandstone, or brine springs, or from the neighbourhood of the sea. But this is not universally the case, as the Trafalgar square pump-water contains 16½ parts of chlorine in 100,000, and yet is regarded by Frankland as one of the best of waters. We may state the importance of chlorine in water, thus: its absence or the presence of only a minute quantity indicates with a fair degree of certainty the absence of animal contamination, though, on the other hand, in exceptional cases the purest waters may contain more chlorine than the same bulk of sewage.

Nitrates in any water are always suspicious; but their import varies with the circumstances under which they occur. A minute quantity of ammonium nitrate is present in nearly all waters; and the water of deep springs, which is as a rule perfectly free from sewage, may be highly charged with nitrates. Again, if in water containing nitrates, any vegetable growths are present, the nitrates will speedily disappear, having become assimilated by the plants. The absence of nitrates is therefore no proof of the absence of sewage (Wanklyn). Nitrates represent a completely oxidised condition of the nitrogenous matter of sewage. Sewage in an unoxidised condition might possibly therefore contain only a trace of nitrates.

Lead is an occasional accidental contamination of water. It is usually derived from the action of water on the lead pipes or cistern in which it is contained. The purest and most oxygenated waters act most readily on lead; as also those containing organic matter, nitrates or nitrites. According to some authorities, waters containing chlorides also act on lead, the chloride of lead being sufficiently soluble to produce poisonous symptoms.

Hard waters have the least action on lead; a coating of insoluble

1 gr. of Cl per gal. gives a slight haze in 4, 5 a marked turbid^{y}, & 10 grs a consid^{e} ppt w. HNO_3 + $AgNO_3$.

i.e. 11.55 grs per gal.

Phosphate - add HNO_3 stir w. glass rod, then add am. molyb^{te} & boil. Yellow col. & ppt on or boil^{g} in rich phosph^{s} (W)

Possib^{y}. of origin of nitrates from fossils (Elkin)

Wanklyn "does not look on the the presence of consid^{e} qts of nitrates in water as any bar to its employ^{t} for domestic use", though he thinks that any H_2O cont^{g} them shd be except^{l} free fr. org^{c} matt in order to be safe.

Frankld reg^{d} nitrates as evid^{e} of 'previous sew^{e} contam^{n}' in the sense of Pembrey: but D^{r} Ashby & W. Hehner have shewn that such poll^{n} may be v. recent, when bacter: agency is active. (W)

Nitrif^{n} has been shewn by Warington (Chem Soc. Trans^{s} Journal, vol. 33. p. 44) to be oxid^{n} taking place appar^{y} in presence of a ferment whose oxid^{n} is appar^{y} more rapid the more putrescible the org^{c} matt. Thus a bad H_2O may have v. little alb^{d} of NH_3, but excess of nitrates

Test for Nitrates — (1) sol^{n} Brucine 1 grm to 1000 c.c. Aq dest — eq. qts of suspect^{d} H_2O & bruc. sol^{n} in test tube - pour pure H_2SO_4 down side of tube ½ gr HNO_3 per gal. gives mark^{d} pink & yellow zone.

(2) $Fe SO_4$ & H_2SO_4 test.

(3) add to the H_2O & H_2SO_4 prep^{d} as for (1) a drop or two of 2½ % Acid Pyrogallic sol^{n}: slight acid^{y} w. H_2SO_4 : a zone of pink bec^{g} purple at junct^{n}

Test for Nitrites - boil 20 ptly wt of starch w. 500 H_2O : filter when cold & add 1 pt of K.I. Mix this sol^{n} w. the H_2O to be exam^{d} & add dil. H_2SO_4 blue color^{n}: Make compar^{e} test w. Aq. destil. as H_2SO_4 may cont^{n} HNO_2 or H_2SO_3

Actⁿ of pure waters on Pb. (B.M.) Jan. 40 Moore suggⁿ that least variⁿ in actⁿ of Pb in waters stored by Dr White at Sheffd might be owd to slow org. matr. Suggⁿ Kirkes took 3 samples rain water & put in 2 small pieces of Pb. These exhibd at time diffᵗ degs of fermⁿ & deterioⁿ thro' storage. Cultivⁿ of ⅓ c.c. of 2a. after 2 days shewd tht in the case cultⁿ must-coll? of bactª there had been most solvent actⁿ on Pb.

D.P. Frankels says addⁿ of Na Carb to water is v. effics in prest Pb solvt actⁿ. In addⁿ filtⁿ of water thro. any forms of anim. C bactª guarantees Pb absence. (San Corpus Pbs)

Waters from the green sands of Hanet beds diss. Pb. Fe. Zn. Iron & org. matr acts on Pb - thus in cisterns cleaning receptes & metal tanks in W.

Or may put suspect? H_2O in porcel. dish, stir w. glass rod dip? in Am_2S. If black ppt, add HCl. If it contins, then Pb or Cu.

Ferrous blue w. K_3FeCy_6 Ferric w. K_4FeCy_6 after acidg w. HCl.

Mag. - add am salt to throw down Ca; filter then add some drops of sol'n of Na_2HPO_4 am Cl & Am OH
Cryst ppt of triple phosphate within 24 hrs.
As, Zn and Cu detectⁿ in water after concentⁿ

No means of distinguishg veg. from anim. org. matr. Frankel's method of estimg relat propn of org. N. & C. has failed to do this
Peat imps org. matr in H_2O, and seem sometimes to have a laxative effect on new-comers, but this soon passes off.
A Drink of H_2O like Caesar's wife, shd be above suspicⁿ

carbonate of lead being formed on the interior of the pipe, which prevents any further action. Thus the use of lead pipes for water containing carbonates or sulphates, or calcium phosphate, is comparatively safe. Hard water containing carbonic acid gas under pressure will dissolve a certain amount of carbonate of lead: this explains cases of lead poisoning from soda water contained in syphon bottles. It acts in the same way as in the case of calcium carbonate, a double carbonate being formed. There is no danger of such a soluble carbonate being formed in the case of ordinary hard water.

Lead is dissolved much more easily by water if other metals are in contact with it, as iron, zinc, or tin, galvanic action being thus set up. Zinc pipes containing some lead are very dangerous, especially with the distilled water used on board ships.

In order to *ascertain the presence of lead in water*, first boil the water down to half its previous bulk in a glass vessel, then add to the suspected water a few drops of hydrochloric (muriatic acid), and pass through the liquid some sulphuretted hydrogen gas (prepared by the action of hydrochloric acid on iron sulphide.) If a brown tint appears after the gas has been passed a short time, lead is probably present, and may be confirmed by other tests.

Traces of **Iron** are sometimes present in water, giving it an astringent taste. Such water is apt to turn brown; and tea made from it is very dark.

Sulphate of Magnesium (Epsom salts), may be present along with calcium sulphate. If in considerable quantity, it makes the water bitter.

Organic Impurities.—Organic impurities may be either vegetable or animal, the latter being by far the most dangerous. The water from moorlands is often brown, but this is not noxious. Growing plants, again, may be beneficial to water; a certain amount of active oxygen is produced by them, which will oxidise, and so render harmless, any nitrogenous matter present. It must be remembered that water thus oxygenated, easily corrodes lead pipes. Decaying

vegetable matter is objectionable in water, and is apt to set up diarrhœa, and in some marshy districts ague.

The most important organic impurity of water has an animal origin—from sewage; the liquid or solid excreta (*i.e.*, the urine or fœces) from drains or cesspools or the soil gaining accidental access to the water. Besides sewage, the eggs of various intestinal worms are occasionally swallowed with water; and in a few cases, even leeches. Dr. Parkes records that in a march of the French soldiers, near Oran, in Algiers, over 400 men were at one time in the hospital, suffering from the effects of swallowing leeches. In some cases, organic matter in water is derived from the putrefying bodies of dead cats, etc. In one case known to the author, the water of a reservoir, in which a drowned man lay for six weeks, was drunk without any apparent bad effects. But whatever the source of the dead organic matter contained in water, it nearly always (1) contains nitrogen as an essential constituent; and (2) tends under the influence of warmth, and therefore especially in summer, to undergo fermentative and putrefactive changes. The putrefaction is probably produced by minute Bacteria, called "septic organisms;" and in this condition of active putrefaction, water is extremely dangerous. Putrefaction and oxidation are Nature's methods of getting rid of noxious matter, and the ultimate result of these processes is the formation of nitrites and nitrates. These are quite harmless in water, except as an indication that the water has been polluted, and that possibly a certain proportion of the nitrogenous matter may still remain unoxidised, and powerful for evil. A preliminary stage to the formation of nitrates in impure water, is the formation of ammonia from the same organic contamination; so that one may meet with a water which contains (1) *nitrates* and *nitrites*, representing completely oxidised and harmless contaminations; (2) *ammonia*, representing an intermediate stage of organic matter, and still dangerous; and (3) *unchanged organic matter*. (4) *Free nitrogen* may be dissolved from the air, but is quite harmless.

NH_3 nitrates, nitrites a Cl, indicate veg. contam.; nitrates animal. Changes in relative proportions of nitrates & nitrites show the presence of Bacteria, some of which reduce & others the process.

1. O a Permang. process aims at measuring pollution of H_2O by rapidity & extent of decomp. of weak K. Permang. sol.

2. Frankld's process - Objections 1/. necessitates boiling & evap. to dryness - so possible some vol. matter lost.
2/. Said that error of experiment is greater than total of the measured.
that presence of alge amt. nitrates altogether vitiates the result.

3. Wanklyn's process - Objections - 1/. by boiling with alk. permang. said that not all the N. evolved as NH_3. & 2/. that qty of NH_3 obtd is influenced by degree of concentration & rapidity of distillation

The amount of nitrogen present in the first three of these forms is taken as an estimate of the amount of organic pollution.

The **Presence of Nitrates or Nitrites** is not in itself dangerous, but important as indicating a former contamination. As already stated, their absence is not a certain proof of the absence of sewage contamination, nor can their presence be taken as a proof to the contrary, unless the *source* of the water is taken into account. They give a peculiar freshness to water, and along with carbonic acid gas, make churchyard and similar waters, pleasant to the eye and agreeable to the palate, although extremely dangerous.

The **Presence of Ammonia** commonly indicates putrefied but unoxidised organic matter. In very minute quantities, it may occur, unaccompanied by albuminoid ammonia or excess of chlorides, in soft water and probably even in rain water. As a rule, a potable water should contain very little of it. It can be separated from the water by distilling with carbonate of soda, and its presence determined by Nessler's test. This consists in adding a liquid obtained by dissolving iodide of potassium in a solution of corrosive sublimate (Nessler's solution) to the suspected water. If free ammonia is present, a yellow or brown colouration is produced.

When a considerable amount of free ammonia is present in water, urinary contamination has probably occurred. Urine contains urea (N_2H_4CO), which when putrefied becomes carbonate of ammonia. It also contains a considerable amount of chlorides; the presence of the latter would therefore support the conclusion deduced from the presence of much ammonia, though ammonia is a far more certain evidence of sewage contamination than chlorine.

The **Presence of Unchanged Organic Matter** is especially dangerous. It may still persist even after all the ammonia present has become oxidised into nitrates. It is this persistent organic matter which is to be dreaded in drinking water. Its amount can be estimated by first calculating the amount of urea and ammonia by means of carbonate of soda, and subsequently distilling the water with a solution of potassium permanganate (Condy's fluid)

and caustic potash. By this means the nitrogen of the organic matter is separated as ammonia, and its amount can be estimated by Nessler's solution. Owing to its being derived from nitrogenous matter, this ammonia is called **Albuminoid Ammonia**, to distinguish it from the free ammonia separated by carbonate of soda. According to Wanklyn, ·06 or ·07 milligram of albuminoid ammonia per litre (*i.e.*, ·06 or ·07 parts in one million parts of the water) is the limit distinguishing clean from unclean water. The same authority states that the Southwark and Vauxhall and the Lambeth Companies supply water yielding an average of ·14 milligram of albuminoid ammonia per litre.

The following analyses, from "Water, Air, and Disenfectants," by W. N. Hartley, give examples of good and bad waters:—

IN 100 MILLION PARTS OF WATER.		
LONDON WATER SUPPLY. 1872.	FREE AMMONIA.	AMMONIA FROM ORGANIC MATTER.
New River Company, Oct. 2 ...	2	8
,, ,, *Nov. 21* ...	1	6
East London Company, Oct. 10 ...	1	4
,, ,, *Dec. 4* ...	1	18
Kent Company, Feb. 7	1	2
,, ,, *Nov. 20*	1	2
Manchester Town Water	1	6
,, ,, ...	1	7
Edinburgh	0	7
Glasgow	0	8
Chester	0	7
Scarborough	1	6
Birkenhead	0	2
Chelmsford	8	2
Leek	0	2
Lytham	0	1
Guildford New Supply	0	1

Drs Frankld calculs that .0032 pts per mill^{n} (i.e. litre) shd alwys be deduct^{d} as repres^{g} amt of N. as NH_3, nitrites + nitrates, fd in rain H$_2$O. This must vary consid^{ly}

i.e. .0049 grains per gallon = .07 pts per mill^{n}
(or mgms per litre)

Dnavel^{g} on this point of doubtful utility.

6 Hyp^{d} germs harmless, but q dangerous!

It is evident from these analyses that, even in the most impure waters, the amount of impurity is very small, so that a very delicate and exact analysis is required.

The following **qualitative test** is of considerable value, as indicating the presence of organic matter, though not estimating its amount:—Fill a tall colourless glass vessel nearly full with the water to be examined, and add as much solution of potassic permanganate (one grain to two ounces of distilled water) as will give a distinct pink tinge to the water. Then fill another vessel of equal size, with distilled water, and add the same amount of the permanganate solution. Watch the two liquids for a time, noticing any difference between the tints that may appear. If no browning and decolouration of the first specimen occurs, as compared with the second, it proves the purity of the water; if a slow decolouration occurs, it shows the presence of vegetable matter; if a rapid discolouration, it proves the presence of organic matter having an animal origin, or of sulphuretted hydrogen, iron, or nitrites. Sulphuretted hydrogen is rarely present, and can be easily recognised by its smell; iron or nitrites are readily distinguished by their appropriate tests. In the absence of these, the rapid decolouration is a certain indication of animal contamination.

To obtain a complete **quantitative analysis** of water, at least two gallons are required. According to Dr. Parkes, in wholesome waters the total solids should not exceed eight grains per gallon, except in the case of chalk waters, and then should not go beyond fourteen grains per gallon. In "usable" water, the total solids should not be over thirty grains, unless they are chiefly a mixture of sodium chloride and calcium carbonate, when they may run up to fifty grains per gallon without any apparent bad effects.

With regard to the organic matter present in water, chemical analysis alone cannot ascertain the safety or danger of drinking any given specimen. The amount of organic impurity present in water, which is competent to produce disease, may be extremely small, while it may be considerable in another water, which can be

drunk with impunity. All that chemical analysis can tell us is, that so much nitrogen is present; but whether it is derived from the excreta of healthy persons, or represents the nitrogenous matter of the germs of cholera or some other disease, we cannot ascertain by chemical analysis. According to Dr. Frankland, "water mixed with healthy sewage is quite wholesome to drink, and probably half the population are drinking such water." It is when the sewage is undergoing active putrefactive changes, and still more when it contains the living germs of disease, that it is dangerous.

Dr. Cory has made experiments with different waters, proving that the stools of healthy individuals or of typhoid fever patients can be added to water, without their exact character being capable of determination by chemical analysis; and that an amount of organic matter capable of producing specific disease was undetected by the same process.

Many of the diseases propagated by water are due to microscopic bacteria, the presence of which would have a scarcely appreciable effect on the composition of water as determined by chemical analysis. Professor Huxley put the matter extremely well in a recent discussion on river-waters at the Chemical Society. He asked the president if there was any known method by which, if a drop of Pasteur's solution were placed in a gallon of water, its constituents could be estimated. The answer was that "it was doubtful;" when Professor Huxley proceeded to shew that every cubic inch of that gallon of water would contain from 50,000 to 100,000 bacteria, and *one drop* of it would be competent to excite putrefaction in any substance capable of undergoing it. He added that, "for purposes of health, we may regard the human body as such a substance, and we may conceive of a water containing such organisms, which may be as pure as can be as regards chemical analysis, and yet be, as regards the human body, as deadly as prussic acid."

The case with regard to the value of chemical analysis for estimating organic matter in water may be stated thus: the

He add^{d} 1g. Ent^{c} 7. stood to 1 gal. H_2O. = subseq^{t} .014 part per mil^{m} of alb^{d} NH_3 fd. Doubtful if his pollut^{g} agents were uniform in compos^{n} & diffus^{n}

Analysis may give val^{e} positive, but not negative evid^{e} as to pollut^{n} (Ashley)

Microsc^l. – spiral vess^l., muscular & elastic fibres easily identified.

Collect sediment in conical glass. Sand particles are angular, clay round & smooth, both unaffected by acids, unlike chalk. Living organisms indicate presence of org^c pabulum. Rhizopods & Infusoria harmless in themselves, but shew presence of org^c matter. Low vege^e organisms in H_2O are 1/. algæ & diatoms, 2/. fungi. 1/. are in nearly all running streams, 2/. req^e N^s C^s & phosph^s pabulum & evidence impurity. The so-called sewage-fungus of Heisch, growing in grape-like clusters of spherical bodies, the growth giving off butyric acid recog^d by smell, is not quite char^c of sewage.

Little infusoria in presence of hydrozoa, rotifers & Entomostraca. Anguillulæ req^e so much org^c impurity for nourishment that they are v. suspicious. Eggs of Entozoa, Guinea worm. Bilharzia &c.

Biolog^l examⁿ water – (1). Heisch's method – sugar added to H_2O, when amt of fungoid growth or effervescence again observed. But this depends rather on amt phosphates than org^c matter. Filtered thro animal C. made H_2O appear more impure.

(2) D. A Smith's Hydrogen process – add sugar as above, & determine gaseous products the vol. of H. evolved in the fermentation which nearly always occurs. Vol. of H. to be a measure of the bacterial life in H_2O. But if any Bacteria at all in H_2O, then qty of fermentative products will not depend on orig^l no. of Bacteria but only on proportion of nutritive matter available for their growth.

(3) Koch's process – all the waters under examⁿ are equally supplied w. abundant food, so all Bacteria tissues afford an eq. opportunity of establishing colony of its own, by which result is visibly changes in gelatine. Thus a test both of no. & nature of Bacteria in H_2O.

absence of organic matter in any larger proportion, than nearly always occurs in pure water, does not necessarily prove that a given water is safe; nor does the presence of organic matter in larger proportions prove that the water is necessarily bad. One is helped in many cases by a knowledge of the *source* of the water; and it is possible that *microscopic examination* may in the future give more reliable results than chemical analysis. Koch's gelatine process, by means of which the organisms of water are collected and examined, is especially full of promise.

Figure 3 shows a number of organic impurities in water derived from the Thames at Richmond and from an impure cistern, including both animal and vegetable organisms.



FIG. 3.
Organic Impurities found in Water, magnified 220 diameters.

CHAPTER XII.

ORIGIN AND EFFECTS OF THE IMPURITIES OF WATER.

Origin of the Impurities of Water.—Effects of Mineral Impurities.—Effects of Organic Impurities.—Typhoid Fever and Cholera in relation to Water.—Effects of an Insufficient Supply of Water.

Origin of Impurities of Water.—The classification proposed by Dr. Parkes will be followed. He divides the impurities into—

1. **Those Received at the Source.**—The character of water varies with the geological structures through which it has passed; with its origin from the subsoil or cultivated land, or deep wells, or graveyards, or near the sea, etc. It cannot be too distinctly urged that it is a mistaken policy to commence with an impure water and proceed to purify it. Inorganic impurities are of much smaller consequence as regards health than organic; hence the great advantage of deep well water over river water.

2. **Impurities of Transit from Source to Reservoir,** acquired during the flow in rivers, canals, or other conduits. These impurities have been broadly divided by the Rivers Pollution Commissioners into "**sewage**" and "**manufacturing;**" the former including the solid and liquid excreta, the house and waste water, etc.; the latter including the refuse from manufacturing processes, as from dye and bleaching works, tanneries, etc.

3. **Impurities of Storage,** whether in wells, reservoirs, or cisterns. Organic impurities are commonly received at this stage. A well, for instance, drains the soil around it in the shape of an inverted cone, with a very broad base.

4. **Impurities of Distribution.** Lead, and occasionally other metals, are dissolved by certain waters. If the pipes are left empty, as with an intermittent supply, sewage may be drawn into them, and sewer gas may penetrate into their interior; in a few cases coal-gas has similarly found its way into the water pipes.

Effects of Impure Water.—1. **Effects of Mineral Impurities.**

Acc. to Dr. Leach of Glasgow, experience of use of soft water was that dyspep. complts had diminished in no., that mental diseases had become less common & especially those attended by deposition of gravel (Quoted by Simon p. 27). Dr. Pront used to enjoin on his patients use of distilled H_2O. Veterinary surgeons say that under continued use of hard H_2O, horses coats become rough & staring

Well known that grooms object to give hard H_2O to horses, because it produces a staring coat, indicative of impaired digestive

Water rich in dolomite at Sunderland, but no goitre

Comparison of over-excretion w. goitre

Suspended mineral matters in unfiltered water occasionally produce diarrhœa. The hill diarrhœa of some parts of India has been traced to water containing fine mica particles in suspension.

Hard water is said by some to be hurtful, though the general impression is that the salts causing hardness are innocuous when not amounting to more than 12 or 16 grains per gallon. Persons in the habit of drinking hard water find soft water unpalatable. Hard water is commonly thought to produce calculus. In Norwich and Norfolk the water is hard, and there is an excess of calculous disease in these districts, but according to Dr. Richardson, it is not attributable to the water. Professor Gamgee says that sheep are particularly affected by calculus in limestone districts. Calculus is common at Canton among the Chinese, but they always boil their water. The salts producing permanent hardness are much more injurious than calcium carbonate, dyspeptic symptoms having arisen when there were only 8 grains per gallon of calcium sulphate and chloride, and magnesium salts. A bitter taste in water indicates the probable presence of excess of magnesium sulphate, and this may cause griping pains in the abdomen.

Goitre, a swelling of the thyroid gland in the neck, is often associated with the use of drinking water from magnesian limestone formations. In some parts of Yorkshire, Derbyshire (hence the name "Derbyshire neck"), Hampshire, and Sussex, it still prevails, though much less commonly than formerly. In Switzerland, cretinism, a congenital form of idiocy, frequently occurs in the same districts as goitre, and is apparently due to similar conditions. The exact origin of goitre is yet uncertain. In many magnesian limestone districts it is unknown, while in some districts where this formation is absent, cases of goitre have occasionally occurred. The latest view is that sulphide of iron is the cause of goitre, and it is said that this is always present in magnesian limestone districts. Others hold that a miasmatic poison in the water is necessary for the causation of goitre, in addition to the metallic salts.

Lead dissolved in water may produce serious and lasting ailments, and they are often present for a long time before their cause is detected. The amount of lead capable of producing poisonous symptoms has been as little as $\frac{1}{100}$ grain per gallon of water (Dr. Angus Smith). According to Dr. de Chaumont, $\frac{1}{10}$ grain per gallon, that is 1 part in 700,000 is usually required to produce such symptoms. In the well-known case of the poisoning of Louis Phillippe's family, at Claremount, there was $\frac{7}{10}$ grain of lead in a gallon of water; and this affected 34 per cent. of those who drank it. The symptoms produced by lead poisoning are those of indigestion, accompanied by colic; a blue line at the junction of the gums with the teeth; "wrist drop,"—a paralysis of the muscles of the forearm, or some other paralysis; and if the poisoning is continued, attacks of gout, followed by its usual consequence, chronic kidney disease. The latter affections only occur when the poisoning is continued for a long time, as in the case of painters or type-setters: poisoning from water is generally discovered before any other than dyspeptic symptoms are produced.

The presence of traces of **iron** in water may give it a slightly astringent taste: and such water is liable to cause headache and constipation.

2. **Effects of Vegetable Impurities.**—Living plants are unobjectionable, but decomposing vegetable matter is apt to produce diarrhœa and other severe symptoms. Assuming that the specific fevers are due to the development in the organism of minute bacilli, we ought to consider these under the present heading; but inasmuch as they always accompany animal matter, in sewage, etc., they will be more conveniently studied in the next section.

3. **Effects of Animal Impurities.**—Animal impurities of water are by far the most important from a sanitary point of view. Their most common source is from cesspool and sewer contamination; but they may arise from other accidental causes. The quality of the contamination is more important than its quantity; and this will explain why water containing a large amount of sewage may

$\frac{1}{100}$ gr (A Smith $\frac{1}{10}$ gr per gal Dr Ch.)

Zinc in compar^{s} sm. qty prod^{s} a disag. astring^{t} taste.
Solv^{d} Fe is simply Fe w. a thin coat^{g} of Zn by solv^{n} sm impure H
esp^{l} attacks Zn.

Dry scurf : temp. persist. above 60°.

Acc. to B. Latham ~~Scurf~~ Diar.ª a guide of temp. of drink.ª H2O – Diar.ª as a dis.e in this country never spid.ª until pipe-system of H2O supply introd. In London Diar.ª began 16th Century in dists supplied by river water.

be drunk for a prolonged period with impunity, while at another time the least trace, if it contain the active germs of disease, will lead to serious mischief.

Suspended animal impurities are apparently much more dangerous than those completely dissolved. Hence the examination of the colour and turbidity of drinking water is very important. Fœcal contamination is by far the most dangerous of all, and chiefly so when it is derived from a patient suffering from some communicable disease, belonging to the same class as typhoid fever.

Certain Parasites occasionally are swallowed with water in the form of embryo or egg. The liver fluke, round worm, and less frequently other kinds of entozoa have been introduced in this way. The occasional swallowing of small leeches has been already noticed, giving rise to hœmorrhage.

Diarrhœa is often due to animal contamination of water. It most commonly occurs in summer, when all the circumstances are favourable to active fermentative changes, and proves very fatal to young children. There is some reason for believing that the summer diarrhœa of children has a specific bacterial origin. The presence of fœtid gases in water may lead to diarrhœa, as when the absorption of sewer gas is allowed by the overflow pipe of a cistern opening into the soil pipe.

Dysentery, like cholera and typhoid fever, may be propagated by water contaminated with the stools of a patient suffering from the same disease. In some cases it seems to have arisen where the water contained organic filth of a non-specific origin.

Ague is usually propagated by the air of malarious districts, but occasionally the water of marshes has produced it. In such cases the attack has developed rapidly, and been very severe.

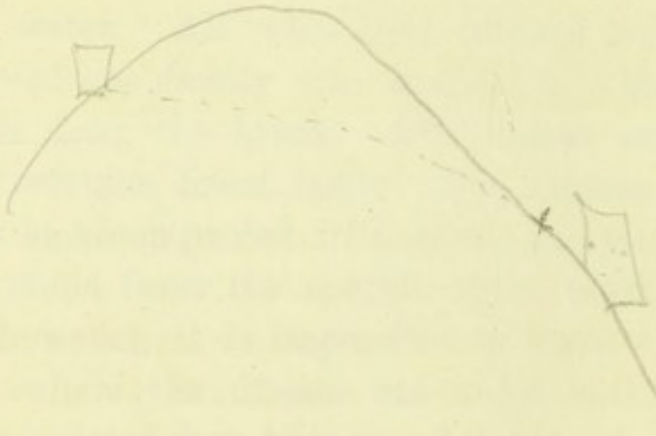
Typhoid fever may originate in the inhalation of the sewer-gas from a drain, or the drinking of water contaminated with sewage. Probably infection is much more certain in the latter case than in the former, as well as much more frequent. In a report of the

Local Government Board it is stated that of 142 epidemics of typhoid fever observed in various localities, in 125 the epidemic had no other determining cause than the use of water containing organic impurities.

There is a difference of opinion as to whether ordinary decomposing sewage will produce typhoid fever, or whether it must contain the stools of a typhoid patient. There can be no doubt that contaminated water may be drunk for a long time without producing typhoid fever. A report given by Dr. Ballard to the Local Government Board (1872) strongly supports this view. Water containing a large amount of animal pollution had been drunk by the inhabitants of the village of Nunney for years without causing fever; but a person suffering from typhoid fever came in May, 1872, to the village from a distance, and his excreta were washed into the stream supplying the village with drinking water. Between June and October 1872, 76 cases of typhoid occurred out of a population of 832 persons. All those attacked were in the habit of drinking the stream water. All who used filtered rain or well water escaped, except one family who drank the water of a well only 4 or 5 yards from the brook. Dr. Parkes concludes from this case, that "common fœcal matter may produce diarrhœa, which may perhaps be accompanied with fever, but for the production of enteric or typhoid fever the specific agent must be present." In some cases, however, it is impossible to trace a previous case of typhoid, as where the disease has originated under unsanitary conditions in isolated farm-houses. It must, therefore, be acknowledged that exceptionally filth contaminations of drinking water are competent alone to produce symptoms indistinguishable from those of typhoid fever. We may explain this by assuming that Bacteria are constantly present in the atmosphere, capable of assuming a violent and infective character, when a suitable soil is found; but that this only occurs under certain exceptional conditions of putrefaction of sewage matters.

The contamination of water with sewage products may occur in

It wd appear that specif. poisonous virul. properties when add^d to a pollut^d than to a pure H_2O.



The dist. thro. the Mts. at Lausen was nearly 1 mile. That the travers? of Zy. germs for such a dist., was not due to fiss. shewn by fact that sev. cuts of flow., inserted at one side, did not appear at the other, not a vestige

various ways. In country places surface wells and small streams commonly supply the drinking water, and these are frequently contaminated by putrefied sewage, if not by actual typhoid stools. The accompanying illustration shews the percolation of liquid excretory matters from an out-door closet through the porous gravel,

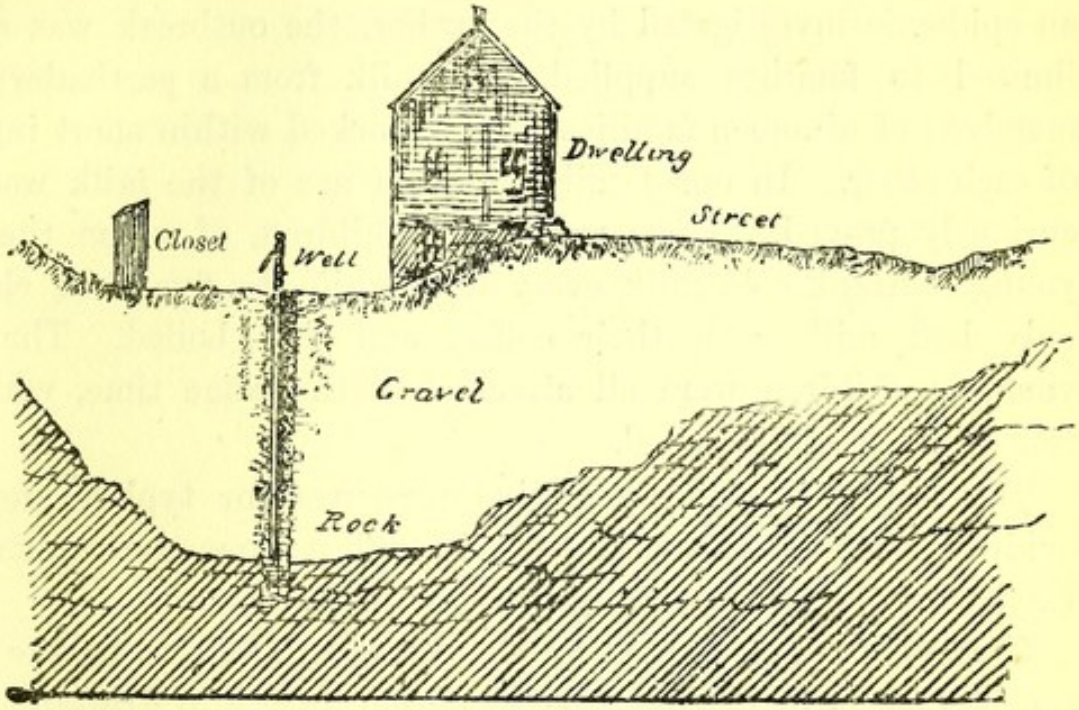


FIG. 4.

into a neighbouring well; the result being an epidemic of typhoid fever among those who drank the water of the well. Alterations in the level of the subsoil water are sometimes followed by an outbreak of typhoid; this is also true of scarlet fever, according to Baldwin Latham. A sudden fall of rain occurs, and the excess of water in the soil absorbs the soakings from country privies or cesspools, and carries them into the nearest well. Several severe epidemics have been traced to this source. The percolation and filtration of tainted water through a considerable tract of porous land is in many cases insufficient to purify it, as proved by a remarkable epidemic in the small village of Lausen, in Switzerland.

In other cases sewage matter gains access into leaky water-pipes, or from the drains into the cistern by means of the overflow pipe

of the latter, or from the water-closet when a separate cistern is not provided for it.

Milk may, by the admixture of water, become contaminated with typhoid matter. Such milk has occasionally produced epidemics. Where the water is very impure, even the small amount used in washing cans may suffice to produce poisoning. In an epidemic investigated by the author, the outbreak was strictly limited to families supplied with milk from a particular dairy, members of nineteen families being attacked within short intervals of each other. In one family the influence of the milk was very curiously proved. There were eight children, of whom the three youngest drank cold milk every day, while the five older children only had milk with their coffee, and that boiled. The three youngest children were all attacked at the same time, while the rest of the family escaped.

The importance of preventive measures for typhoid fever is evident when it is stated that 15,000 persons die annually in England and Wales from this disease alone.

Cholera was first proved by Dr. Snow, in 1849, to be due to the specific poison of cholera gaining an entrance into drinking water. Whether it can be produced by animal matter, not of a specific character, is still an open question ; but if this ever occurs, it must be exceptional.

The vomit and intestinal evacuations of cholera patients are practically the sole means of infection ; and these are not dangerous in the fresh condition, but only after three or four days, when fermentative changes have been set up.

The close connection of the spread of cholera with an impure water supply has been repeatedly shown in this country. The cholera epidemic of 1854 was very severe in the southern districts of London. At that period these districts were supplied with water by the Southwark and Vauxhall Company, deriving its water from the Thames at Battersea; and by the Lambeth Company, having its intake at Thames Ditton, where the water was infinitely

Even in India prov.ly pure Hydrop.s alw. fol.s by
Dim.d Chol.a mortal?

There is a complete absence of any proof that Sc. fev. & Diph.ª have been conveyed by Drink & H_2O (S. Murphy)

purer. The two companies were acting in rivalry, so that in many streets their mains ran side by side, and houses in the same street, similar in all other respects, received a different water supply. An investigation of the distribution of cholera in these districts gave the following results :—

	Population in 1851.	Cholera deaths in 14 weeks.	Cholera deaths per 10,000.
Houses supplied by Southwark Co....	266,516	4,093	153
„ „ „ Lambeth Co. ...	173,748	461	26

The facts, when examined in detail, brought out still more strikingly the exemption of the houses supplied by the Lambeth Company ; next-door neighbours being attacked, when their supply of water was from the Southwark Company.

A low temperature of the air prevents the development of the cholera germs. The prevalence of cholera in Russia is quoted as proving the contrary ; but in that country the indoor temperature is commonly maintained at a high point ; ejecta are often cast out around the dwelling-houses ; and in cold weather, snow derived from the same vicinity is melted and drunk, thus providing a ready entry into the system for cholera or any other germs which may be present.

Diphtheria, in some cases at least, probably originates in polluted water ; but the evidence as yet is not very conclusive. In a recent outbreak of diphtheria (1883) an investigation of the sanitary inspector revealed the fact that there were upwards of sixty polluted wells in the district, in which the cases of disease occurred ; in every instance the water being contaminated with sewage, and swarming with living organisms.

Scarlet Fever, again, is probably due to the same cause in a few cases, though it is much more commonly carried from person to person. According to one good authority, epidemics of scarlet fever are occasionally due to a sudden alteration in the level of the subsoil water (Baldwin Latham).

Sore Throat not uncommonly is caused by bad drains, whether the poison from these is inhaled or drunk in the water.

Erysipelas has occasionally a similar origin.

A curiously localised epidemic of boils occurred near Frankfort, in 1848, and was traced to the drinking of water containing sulphuretted hydrogen.

Effects of an Insufficient Supply of Water.—The influence on personal health is most baneful. Water is used sparingly for purposes of cleanliness, with the necessary results that cutaneous diseases become more common, and the whole body suffers; the linen is imperfectly and infrequently washed; the house becomes dirty; drains are imperfectly flushed; the streets are not cleaned; and the whole atmosphere becomes loaded with impurities. According to Dr. Parkes, it is probable that the remarkable cessation of spotted typhus among civilized and cleanly nations, is not merely owing to better ventilation, but also to more frequent and thorough washing of clothes.

Insufficient cleansing of sewers, owing to a deficient supply of water, has a very important influence on the spread of typhoid fever and epidemic diarrhœa. A heavy fall of rain often causes a rapid diminution in their prevalence.

CHAPTER XIII.

THE PURIFICATION OF WATER.

Distillation.—Boiling.—Chemical Measures.—Filtration on a Large Scale.—Domestic Filtration.—The Varieties of Filters.

When a public water-supply is provided, it is natural to suppose that the water is furnished pure and fit for use; but this, unfortunately, is often not the case. The reports, for instance, of the condition of the London Water Supply, not infrequently shew that it is turbid and impure; and this is especially the case

Coal will distil f. 7 to 9 times its wt of H2O. Obvious
advantg of conveyg it on boards ship instd of H2O.

when, during heavy rain-falls, mud and refuse are washed into the streams or reservoirs. Rain-water and well-water nearly always require to be purified before use.

METHODS OF PURIFICATION.—The only absolutely certain way of obtaining pure water is by **Distillation**; but this plan is quite inapplicable to water on a large scale, and distilled water is not so palatable as ordinary water. The distillation of water is more especially required on board ship, during long voyages, and should be followed by the use of some measure to secure efficient aëration.

2. **Boiling the water** serves to get rid of the temporary hardness, and the chalk carries down with it a considerable amount of any organic matter that may be present. Boiling deprives the water of its dissolved gases, and renders it flat; it is desirable, therefore, to filter it after boiling. These two measures form a great protection against infectious diseases; and if the water is at all suspicious, it ought, in all cases, to be boiled and filtered. It is very improbable that the germs of disease would resist the temperature of boiling water. According to Prof. Sanderson, the common Septic Bacteria die at the temperature of 110° Cent., or 230° Fahr. It is possible, however, that the spores of these organisms may resist a higher temperature than the adult forms. Rev. W. H. Dallinger, F.R.S., has obtained some very valuable results, by employing object glasses of $\frac{1}{25}$ to $\frac{1}{50}$ inch, with very powerful eye-pieces. He found that although a temperature of 150° Fahr. killed all the adult monads, young monads continued to appear and develop in an infusion which had been raised to 260° Fahr.

3. **The Exposure of Water in Divided Currents to the Air.**—The water is passed through a fine sieve, so as to cause a minute division of it. It is said that organic matter is oxidised by this process, and certainly sulphuretted hydrogen and offensive organic vapours are removed by it.

4. **The Immersion of Charcoal or Iron Wire** in the water decomposes organic matter. Charring the interior of casks in which

water is kept is a very effective process, but the charring requires to be repeated.

5. **The Influence of Plants and Fishes.**—In reservoirs the presence of a moderate quantity of living plants is beneficial, by aiding oxidation of any organic matter present. The destruction of fish has led to a rapid increase in the number of small crustaceans on which the fish had lived, rendering the water impure and nauseous (Rankine.) The remedy is to re-stock the reservoir with fishes.

6. **The Addition of Chemical Substances.**—(1) *Clarke's process* consists in adding milk of lime to the water in the reservoir on a large scale. By this means calcium carbonate is precipitated, but no effect is produced on calcium and magnesium sulphates and chlorides. The calcium carbonate carries down with it suspended and possibly dissolved organic matter; consequently this process is valuable sanitarily as well as commercially.

(2) *Carbonate of Soda* added to boiling water throws down calcium carbonate, and possibly lead if present. Much less is required when added to boiling than to cold water.

(3) *Aluminous salts* are very effectual in removing suspended organic matter, if the water contains calcium carbonate. On the addition of alum, calcium sulphate and aluminium hydrate are formed, both of which fall to the bottom, carrying with them other impurities. The amount of alum required is about 6 grains per gallon of water. It is doubtful however whether dissolved organic matter is precipitated. If the water is not hard, a little calcium chloride and carbonate of soda should be put in before the alum is added, in order that a precipitable substance may be formed.

(4) *Potassium permanganate* readily removes the offensive smell of stagnant water, but as it commonly gives a yellow tint to the water, its use is objected to. The addition of a little alum will sometimes carry down the decomposed permanganate. According to experiments of Dr. Parkes, it is doubtful if all organic matters are oxidised by the permanganate; some organic substances, and

in Clark's process

To detect uncomb^{d} CaO, add $AgNO_3$ sol^{n} – brownish colour prod^{d}

CaO also used in Porter-Clark process; but susp^{d} $CaCO_3$ is removed, not by filter settle^{n} but by filter thro' a series of linen cloths in a filter press under high press^{e}.

Howatson's process – sol^{n} $NaOH$ mix^{d} wth the H_2O as well as CaO_2H_2

Maignen's process simil^{r} professes to remove permanent hard^{s}

By Clark's process Thames Water 16° red^{d} to 3° or 4° hard^{s} (L.P)

Qty of H_2O in sa. storage reserv^{r} shd not be less than 1 wk's supply.

Filter^{g} bed — sand 2' deep.
gravel ½' " size of shot.
" ½ " " " peas.
" ½ " " " beans
" ½ " " " walnuts

Upper layers req^{e} v. freq^{y} renewing. Vast extn of surf^{s} in sand, estim^{d} at 2500 sq. yds in sa. yard cube.
A process of multiple subsid^{n} occurs.

Dr P. T. Frankland fd by expert that the aver^{e} red^{n} in no. of microbes in London water effect^{d} by London H_2O Comp^{s} in yr '76, amount^{d} to 96 % of no. orig^{y} present. Experts quoted by him of amount^{g} Dr Plagge shew that most domestic filters are worthless & worse fr encour^{g} microbes fr. water: earthenware & asbestos being the only reliable forms for impr^{g} biolog^{l} qual^{y} of water.

especially those in solution, appearing to be untouched by it. We may regard the addition of Condy's fluid as a valuable preliminary to the alum process. It is also very serviceable in cleansing filters.

(5) *Perchloride of Iron*, in the proportion of 2½ grains to a gallon of water, has been found to completely purify water from finely suspended organic matters and clay.

7. **Filtration.** Where filtration is required, it should be done on a large scale, by the company supplying the water. If the water supply is pure, as in Liverpool, Glasgow, and Manchester, domestic filtration is not only useless, but likely to do more harm than good.

Filtration **on a large scale** is generally carried on as follows:— A preliminary step consists in collecting the water into settling reservoirs, wherein the more bulky substances subside. The water is then filtered through beds of gravel and sand, containing perforated tubular drains below, into which the filtered water flows. The drains are covered by a bed of gravel about 3 feet deep, over which is spread a layer of sand about 1½ to 2 feet deep. Sharp angular particles of sand are the best; and the gravel should gradually increase in coarseness as it descends. The depth of the water should never be above 2 feet; about 70 to 75 gallons is the usual quantity passing through each square foot of the filtering bed in 24 hours. It is essential that the filtration should be downward and intermittent; and that, in the intervals of filtration, the filtering bed should be freely exposed to the atmosphere, and occasionally changed.

The effect of this filtration is chiefly *mechanical;* it separates any coarse suspended matter, whether organic or inorganic. Whether it is competent to stop the minute organisms to which in all probability specific diseases are due, is very doubtful.

Some *chemical* action may also occur during filtration. It is possible that the air contained in the interstices of the sand may act on the organic matter contained in the finely divided current of water, and oxidise a certain amount of it. But such

oxidation is incomplete, and does not suffice to render the germs of disease inert.

Other materials have been used in filtration in addition to sand. *Sponge* has considerable power in arresting suspended particles, but its use is not to be recommended. *Animal charcoal* (deprived, by means of hydrochloric acid, of the salts it originally contains) is one of the best filtering materials; and its use, on a large scale, is advised by Dr. Frankland, spite of its expense, and the fact that it requires renewing at intervals. A weak solution of Condy's fluid is decolorised by passing through animal charcoal; and there is a general concensus of opinion, that both suspended and dissolved inorganic and organic matters are, to a large extent, removed by charcoal. According to Mr. Byrne, the purifying action of animal charcoal on water containing organic matter, ceases after a time, though it can be restored by passing a little Condy's fluid through the filter. This is confirmed by Mr. Chapman, who obtained from a charcoal filter as much organic matter as the water passing through the filter had previously contained. On the other hand, Dr. Letheby obtained some charcoal which had been used for filtration two years, and found that it was still capable of depriving water of colour and organic matter, and that the organic matter had not accumulated. One is compelled, therefore, to infer that it had been oxidised; and this agrees with the well-known power of charcoal to condense gases in its interior, and oxidise noxious vapours. The conclusion seems to be that when the amount of organic matter in water is small, the purifying action of animal charcoal is almost permanent. Dr. Frankland has suggested that there are two kinds of organic matter, one of which is not acted on by charcoal. The condition of the organic matter is important; it has been shewn that fresh albumin passes through unchanged, while about 95 per cent. of decomposing albumin is arrested.

In addition, the constancy with which a filter is used has great influence; if long unused, the charcoal is liable to get dirty; and,

Even spongy iron allows Bact^a to pass thro. as shewn by
Dr Koch's cultures. Carbon blocks from hot beds for their
growth - The only filters answering for this purpose are constructed
on Pasteur's principle of unglazed porcelain, or (2) on Dr Hesse's, the
mat^l of wh is asbestos - (as Pasteur Chamberland filter) W.

? accumulg matria c.
a acidum gt

Purificn of H_2O by

1. Distillⁿ
2. boiling
3. exposure in divd cond. to air
4. immersn. of charc. or Fe wire in H_2O
5. Influ. of plants & fishes.
6. addn. of chem. subst.
   1. Clarke's process
   2. Sod. carb.
   3. Alum & salts (Glauber Salt)
   4. K. Permang.
   5. Fe_2Cl_6.
7. Filtration - sand
   spong
   animal C.
   spongy Fe (hæmatite Fe)
   magnetic Fe carbide (hæmatite + sawdust)
   silicated carbon
   carferal (char. Fe & clay)

if always wet, the oxygen held in its substance—which enables it to oxidise organic matter—becomes exhausted.

Vegetable charcoal is decidedly inferior to animal in purifying water. A mixture of *animal charcoal* and *spongy iron* forms a very good purifier of water.

Domestic Filters are in common use in households, and if regularly superintended, are of considerable value. Where an ordinary filter is too expensive, an efficient one may be made as follows at a very trifling expense:—Take an ordinary earthenware garden flower-

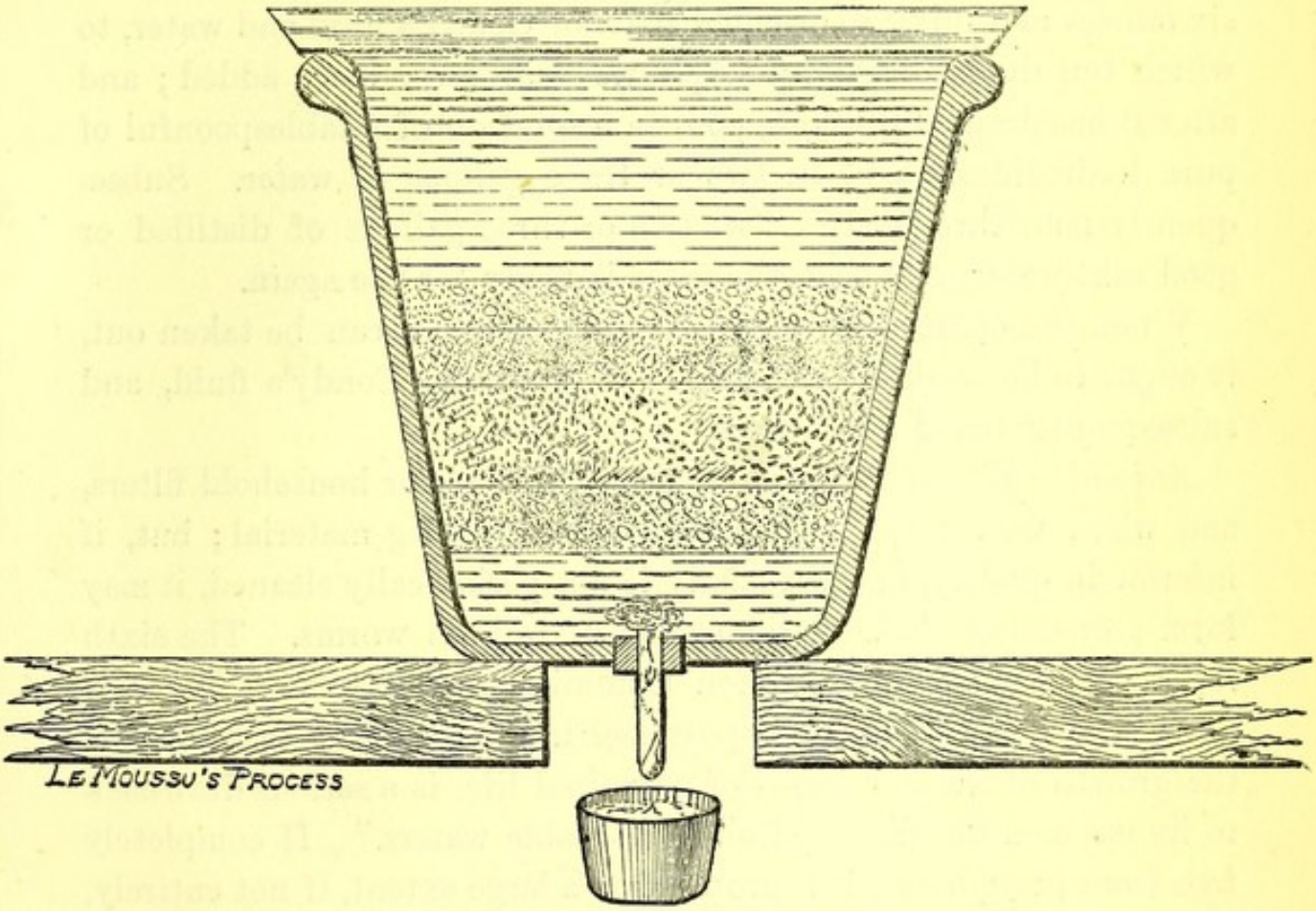


FIG. 5.—A HOME-MADE FILTER.

pot; cover the hole with zinc gauze, or fit it with a piece of glass tube and a sponge, as in *Fig. 5;* then get some rather small gravel, wash it thoroughly, and put it in the pot to the height of about three inches; next buy two pounds of animal charcoal, and after well washing it by pouring boiling water on it several times, and allowing it to settle, put it on the gravel, and press it well down,

making about four inches deep of charcoal; next take some white sand, and after washing it well, put it on the charcoal; and finally, some more gravel may be placed on this. The filter is now ready for use.

All filters tend to become clogged by the deposit of suspended organic matter and calcium salts. Animal charcoal ought to be renewed or cleaned every three or four months; spongy iron remains good a year at least. To purify a charcoal filter, brush its surface, if the charcoal is in the block form. Then pour into the filter four or six ounces of a mixture of equal parts of Condy's fluid and water, to which ten drops of strong sulphuric acid have been added; and after it has drained through, pour in a solution of a tablespoonful of pure hydrochloric acid in two or three gallons of water. Subsequently pour through the filter two or three gallons of distilled or good rain water, and then the filter is ready for use again.

When the charcoal or other filtering material can be taken out, it ought to be washed, then boiled with a little Condy's fluid, and subsequently dried in an oven.

Animal charcoal is the chief material used for household filters, and when well prepared, forms a good filtering material; but, if inferior in quality, and especially if not periodically cleaned, it may form a breeding place for thousands of minute worms. The sixth report of the Rivers Pollution Commissioners states: "The property which animal charcoal possesses in a high degree of favouring the growth of the low forms of organised life, is a serious drawback to its use as a filtering medium for potable waters." If completely free from phosphates, it is probably to a large extent, if not entirely, deprived of this drawback. At the same time, they state that "*fresh* animal charcoal removes not only a large proportion of the organic matter present in water, but also a not inconsiderable amount of mineral saline matters." According to Dr. Parkes, "on an average there is no charcoal or magnetic carbide filter now in the English market which cannot be relied upon to remove 40 per cent. of dissolved organic matter, and in some cases more;" while

Festh. anim C. removes org. mat. also much of salts

the amount of hardness (especially that due to calcium carbonate), and of nitrites and ammonia is also lessened, and common salt is arrested by some filters to a certain extent.

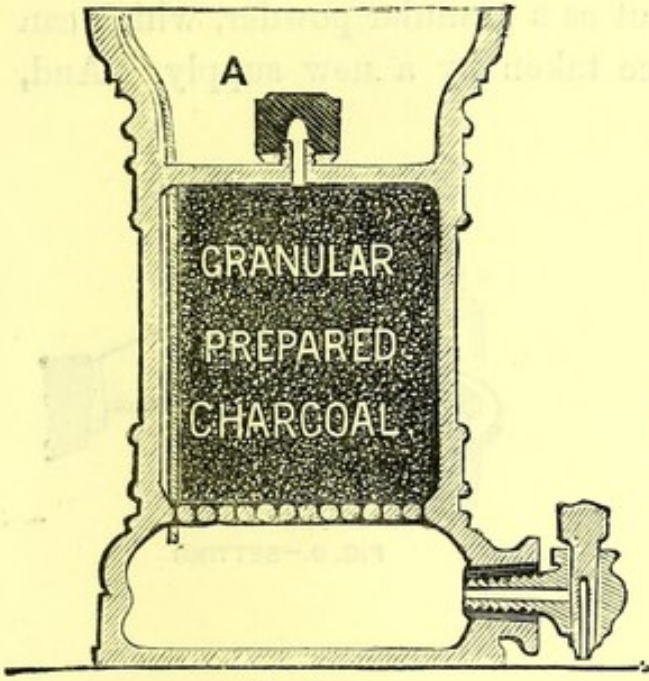


FIG. 6.
GRANULAR CHARCOAL FILTER.

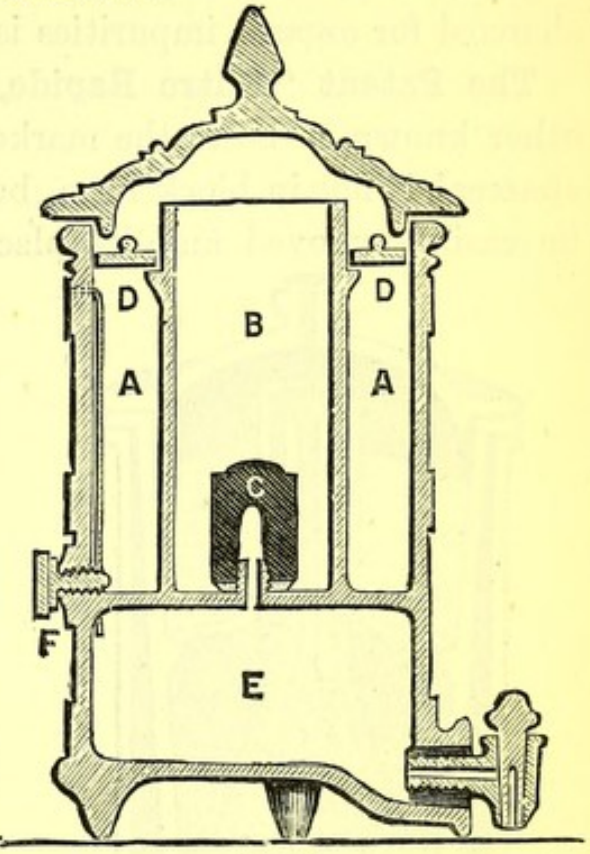


FIG. 7.
MANGANOUS CARBON REFRIGERATOR FILTER.

The Patent Granular Carbon Filter, manufactured by Messrs. Doulton & Co., contains a block of manganous carbon (A *Fig. 6*), which is screwed on to the plate covering the block of granular carbon and thus ensures a double filtration of the water.

The Manganous Carbon Refrigerator Filter, of the same firm, is similar to the last in principle, but contains a compartment in which ice or a freezing mixture can be placed to keep the water cool in hot weather.

In *Fig. 7*, A A is the ice-compartment. B is the space for unfiltered water. C the filtering block of patent manganous carbon. D D the cover to the ice-compartment. E the space for filtered water. F the outlet for freezing mixture.

In both these filters, manganous carbon is used. This is

prepared by mixing animal charcoal and black oxide of manganese together, and then heating strongly out of contact with the air. In this way, according to Dr. Bernays, the oxidising power of charcoal for organic impurities is greatly increased.

The Patent "Filtre Rapide," of M. Maignen, differs from any other known to be in the market, in two important respects. The charcoal is not in block form, but as a granular powder, which can be easily removed and its place taken by a new supply. And,

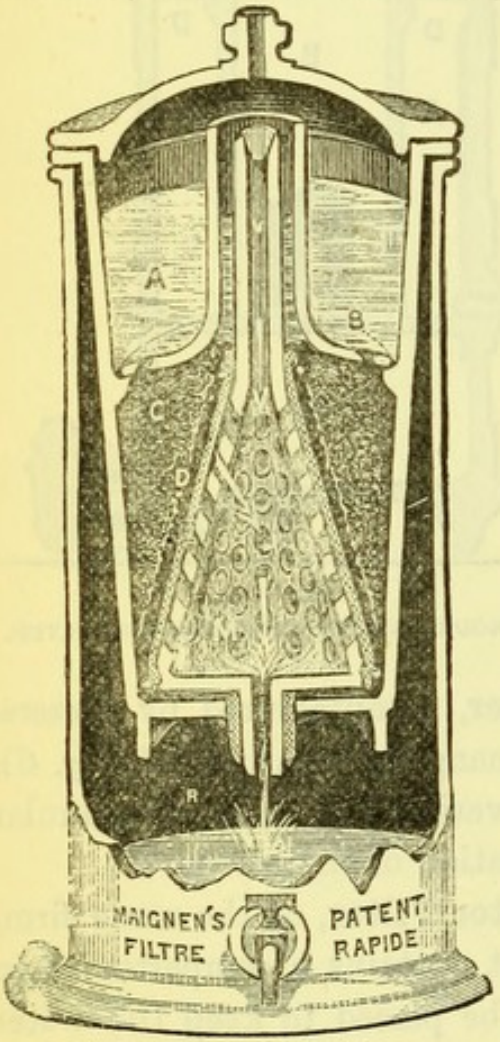


FIG. 8.—MAIGNEN'S PATENT FILTER.

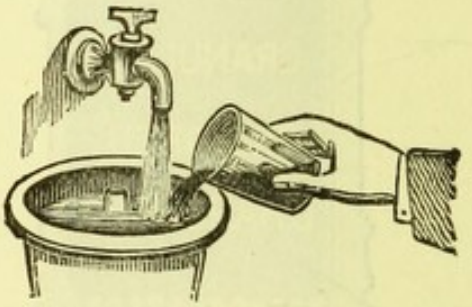


FIG. 9.—SETTING.

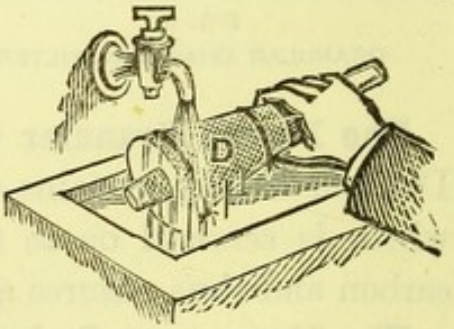


FIG. 10.—CLEANSING.

in the next place, the charcoal is mixed with lime ("carbo-calcis"), and in this way serves actually to soften the water which is passed through it, for a time at least. In *Fig. 8* is shewn a vertical section of this filter. R is the reservoir containing the filtered water. As the filtering apparatus simply rests loosely in the filter

Plain removes not only org. matter but dissd salts of Fe. Ca &c (W)

Power of remov.g spongy Fe to remove diss.d inorg.c & org.c matt.rs is wonderful. In Experts at Netley contin.d for 8 mos, it was the only one the effluent fr. wh. never devel.d Bact.a or any form of org.sms

Bischoff's spongy iron removes diss.d mat.rs org.c during the time it is effic.t for a long time (W) the water filt.d thro. Fe is deprived of Fe & pass.d thro. sand a fine powder & grad.te, a crude oxide of Fe. (L P) See illust.n spongy Fe removes separ.d Fe fr. water; yields nothing to water &c. a little water wh. can be removed by filt.n thro. sand (L P)

Mag. carbide of Fe used for purifn of pollut.d water of Calder at Wakef.d. When in situ need never be disturb.d or renewed. If filt.n intermit.t sand beds on thro Fe are foul.d renewed.

case, R is easily accessible for cleansing. M, the filtering frame, is covered with asbestos cloth, E, which is tied with cords of asbestos. D is a layer of powdered "carbo-calcis," which has been deposited on the asbestos by mixing the carbo-calcis in a tumbler with water, and then pouring it into the filter, as shewn in *Fig. 9.* C is granular carbo-calcis put in loosely, to fill up the space between D and the screen B. Water put into the upper part of the filter, goes first through the granular carbo-calcis, then through the layer of powdered carbo-calcis and the asbestos cloth. It becomes partially oxygenated by the air contained in the funnel-shaped part of the apparatus (as shewn by the single arrow). The great advantage possessed by this filter, is the fact that it can be easily cleansed and new filtering material inserted.

Besides animal charcoal, the chief filtering materials are spongy iron, the magnetic carbide of iron, and silicated carbon.

Spongy iron is prepared by the reduction of hœmatite ore with fusion, so that the iron is obtained in a porous and finely-divided condition. The Rivers Pollution Commissioners found spongy iron to be "a very active agent, not only in removing organic matter from water, but also in materially reducing its hardness, and otherwise altering its character."

Various forms of spongy iron filter are to be obtained.

Fig. 11 represents a vertical section of one of the more complex of them, in which U is the unfiltered water, B the ball-cock, V a screw-valve, I spongy iron, S S′ S″ prepared sand, F filtered water, T stop-cock, A regulator.

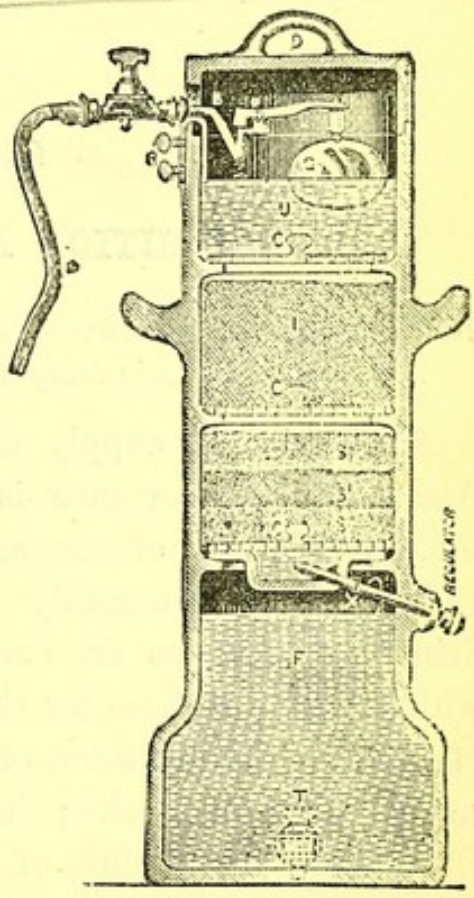


FIG. 11.—SECTION OF SPONGY IRON FILTER.

The so-called *magnetic carbide of*

iron is obtained by heating hœmatite ore with sawdust, and forms an admirable purifier of water.

Silicated carbon consists of 75 per cent. of charcoal and 22 per cent. of silica with a little oxide of iron and alumina. Mr. Wanklyn has shown that repeated filtration of river water by this material makes it as free from organic matter as deep spring water.

Carferal, a filtering medium recently introduced, consists of a mixture of charcoal, iron, and clay, and is highly spoken of.

All filters require cleansing and renewing at intervals. They should be allowed to run dry occasionally, in order that the filtering material may become aërated. It is not advisable to allow water to remain stagnant in a filter.

The use of sponges in domestic filters is pernicious. They soon become dirty, and are apt to be infested with microscopic growths.

CHAPTER XIV.

COMPOSITION AND PROPERTIES OF AIR.

The Constituents of Air.—Nitrogen, Oxygen, Ozone, Ammonia, Carbonic Acid.—The Changes in the Air produced by Respiration.

An abundant supply of fresh air is necessary at all times. And yet its importance is being constantly ignored in practical life. Strenuous efforts are made to ensure a supply of food, and water is commonly filtered or otherwise purified before drinking; but we are content to live in an impure atmosphere, which hardly suffices for the preservation of life, and certainly not of health. Deprivation of food, or even of water, only kills after several days or weeks; deprivation of air kills in a few minutes. Only about three pints of water are required daily, while at least 1,500 gallons of air are necessary for carrying on the vital

Formed of a hard graphitic mat.l (W)

It also removes Pb by redn. to its sol. salts insol. Does not need aerat.n

Pasteur-Chamberland filter, water pass.d under press.e thro. 5 or 6 solid porous & unglazed cylin.rs. Water thus steril.d but actuis mechanl & no alter.n in chem. compos.n of water (L P)

Hopeless.s of filtr.n shown by Lausen epid.c of Typ. f.

Put a bottle inside a Ger bottle & pump air out of latter, atm. press in former will burst it or force out the cork

Boil? H_2O at low temp. w. less atm. pressure.

Prof. Liebig's method of determ. amt O in air. Air is measd in graduated tubes over Hg - ca. cont. 20 c.c. divd into 5 pts; next $\frac{1}{30}$ or $\frac{1}{40}$ of its vol. of sol. KOH of 1.4 s.g. (1 KOH to 2 H_2O) introd by pipette w. curved point - by movg tubes KOH spread over whole inner surf. - now read off decr. of vol. If air has been previously dried by $CaCl_2$ decr. represents amt CO_2. Next abt half the amt of sol. of KOH is add'd of sol. of pyrogallic acid 1 gm in 5.6 c.c water - shake up & then read off vol. of N rem. Error f. sol. of pyrog. A. & KOH avoid by introd. piece of stick KOH corresp. to amt H_2O in sol. of pyrog. A. (Chem. p. 91)

functions; and yet, through ignorance or carelessness, the provision of pure air is almost universally neglected.

Composition of Air.—The air is a material substance; it constitutes a gaseous ocean in which we live, as fishes live in water. In virtue of its weight, it exerts a pressure of about 15 lbs. on every square inch. This pressure is usually measured by the *barometer*, and is equivalent on an average to that of a column of 30 inches of quicksilver. Being possessed of weight, the density of air varies with its height, diminishing as the height above the sea-level is increased. If the air were of the same density throughout, its limit would be reached at a height of about five miles.

Chemically, air consists of a mixture of various gases and vapours. These are chiefly **Oxygen** and **Nitrogen**; but in addition, there are minute quantities of carbonic acid, water vapour, ammonia, ozone, and suspended matters.

The oxygen and nitrogen exist in the proportion by volume of 20·9 of oxygen to 79·1 of nitrogen, or of 23·16 grains of oxygen to 76·84 of nitrogen, by weight.

These two gases do not exist in chemical combination, but mechanically mixed. This is proved by the fact, that they do not exist in air in the proportion of their combining weights, or any multiple of these; that the proportion varies slightly at different parts; and that the air which is dissolved in water does not contain the nitrogen and oxygen in the proportion 4 to 1 (as in the atmosphere), but in the proportion 1·87 to 1. This means that oxygen, being more soluble in water than nitrogen, has dissolved in a larger proportion; as it certainly would not have done, had the oxygen and nitrogen been chemically combined. The oxygen dissolved in water supplies fishes with the necessary oxygen for their respiratory processes. Similarly the oxygen in the atmosphere is its most essential constituent, being required in all processes of oxidation (*i.e.*, combustion), whether in living organisms or in the inanimate world. Nitrogen serves as an innocuous diluting agent, and has no active properties of its own.

Ozone is a remarkable condensed form of oxygen, which is present in minute quantities in pure air, and especially during a thunder-storm or after a fall of snow, and in the air near the sea. In it three volumes of oxygen are condensed so as to occupy two volumes. In this condensed condition it has powerful chemical affinities; often oxidising substances which oxygen cannot attack. It is generally absent from the close air of towns and dwelling houses, having been used up to oxidise the organic matter present in these places. Air without it is said to be "devitalised." The advisability of building public institutions, and especially hospitals, in central and crowded situations, is somewhat questionable; the diminished purity of the atmosphere interfering with recovery. It is doubtful, however, whether more remote and therefore less convenient sites would always be practicable.

Ozone can be produced by hanging a piece of moist phosphorus in a room; and it is stated by Dr. Daubeny, that part of the oxygen given out by plants is in the condition of ozone. A small quantity is produced when an electrical machine is worked; its presence is evidenced by a peculiar smell (the name ozone is derived from the Greek word for smell).

Aqueous Vapour is always present in air, though the amount varies greatly. It is invisible in the ordinary condition, but by condensation becomes cloud or fog, rain, snow, or hail. The quantity of moisture present varies with the temperature of the air; the higher the temperature, the more water can be vaporised, without the point of saturation being reached. The amount of moisture is estimated by the *hygrometer*. It is by far the most variable constituent of the atmosphere, but forms on an average from 1 to 1½ per cent. of its volume, that is from 50 to 75 per cent. of the amount requisite for complete saturation.

Ammonia in normal air does not exceed one part in a million of air; but it is always present—either as free ammonia or as sulphate, chloride, carbonate, or sulphide of ammonia. From this source, plants derive a large proportion of the nitrogen they require as food.

Ozone prod^{d} by evap^{n} f. saline liq^{ds} ; dash^{g} waves on coast : oxid^{n} of metals More ozone at high levels (M. Tidy)
Ozone the scavenger of the air (De Chaum^{t}).

Resp^{n} for a short time of 0 cont^{g} $\frac{1}{240}$ Ozone is fatal to all anim^{s} but sim^{r} anim^{s} live well for mths after health^{y} O_2 alone for 37 hrs, the CO_2 being removed dur^{g} the exper^{t}

In some crowd^{d} offices of New York an appar^{s} for prod^{g} O_3 by slow combust^{n} of P is in use.

No comm^{n} traced betw amt O_3 & prevail^{g} epid^{cs}

and yet scent^{d} flowering plants do this to a remarkable extent

A vol. i.e. 11.2 litres of air weighs 14.4 grms, 10 of water vap 9 grms.
Cold dry air is heaviest, warm moist air lightest, so barom^{r} rises during E & sinks dur^{g} W. wind in Europe (W)

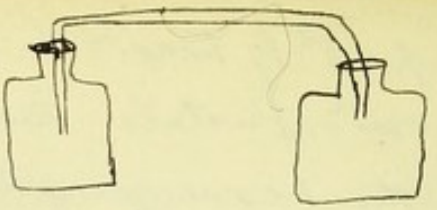
Incr of 27° F in temp of air doubles its capac for moisture.

Capac^{y} of air for moist^{e} incr^{s} enorm^{ly} w. temp^{e}. What wd satur^{e} air at 30° F wd give only 71 % at 60° F.

Air absol^{y} humid at 32° F holds vapn eq to $\frac{1}{160}$ its wt ; at 59° $\frac{1}{80}$, at 86° $\frac{1}{40}$; at 113° $\frac{1}{20}$ at 140° $\frac{1}{10}$. Thus temp. adv^{s} in A.P., retent^{e} power for moist^{g} s. P. w. a ratio of 2.

Poss. maxim. of aq. vapor in air ranges from 2.13 grains per cubic foot at 32° F to 104 grains at 80° F

Expert- proper CO_2.



Acc. to Mr. Armstrong's expts CO_2 in normal air only .35 pts per 1000. In Mid-Atlantic excess of CO_2 in day over nt (Lewes)

Liebig 1st assert. that the whole of the carbon of vegtn is not derived from humus or decayd vegl matter, but f. CO_2 of air. The complete agricult. proof of this by Lawes & Gilbert's agricl. expts over 44 yrs. at Rothamsted Plots of land set apart to grow wheat, & no carbonl manure add. for 44 yrs, so that the only C obtd was f. air. Nowan aver. amt of 1000 lbs C was removed yearly; while f. another plot from wh. a nitrog. manure was used 1500 lbs C annually removed. Thus 2500 lbs C removed by the wheat crop annually with- the addn of any carbonaceous manure.

Liebig also assert. that whole of N. reqd by plant was derived f. NH_3 of air. Lawes & Gilbt have shown that this source is insuffic- to account for the N. removed in the crop, & that N. must be obtd f. the soil or free N of air. Berthelot has shown that under certn conds the soil has power of absorbg N. of air, formg compds wh. can subseq be assimd by the plant

Ground air much richer CO_2 even 25% - as at bottom of wells. In severe winters of Germ. where excess much greater of nit- over ext. temp., coal gas sometr f. broken mains let into use. Cases mistaken for 7yd fev. Odour of coal gas due to any substs prest to CO. In many cases in Fr. & Germ. nat gas laid on to use (W).

Traces of nitrous and nitric acid are also present in air, produced by the direct combination of nitrogen and oxygen occurring as the result of the electric spark during lightning.

Carbonic Acid or carbon dioxide is always present in air, in the proportion of 3·36 to 4 parts in 10,000; but in impure air may be present in much larger amount. It is a heavy gas, incapable of supporting combustion, and therefore of supporting animal life. Being a heavy gas, it tends to accumulate where it is produced, as about lime-kilns, and at the bottom of wells; and the great problem in the purification of air is to disperse it as rapidly as possible.

It is produced by the oxidation of carbonaceous matters, hence in all ordinary combustion, in many cases of putrefaction and fermentation, and in the respiratory processes of all animals.

Plants on the whole diminish the amount of carbonic acid in the atmosphere. It is a mistake, however, to suppose that they do not exhale carbonic acid. As a matter of fact two processes occur in most plants: a process of respiration, as in animals; and a process of assimilation, by which the leaves and all other green parts of a plant under the influence of sunlight decompose the carbonic acid of the atmosphere, fixing its carbon and liberating its oxygen. Plants such as fungi, which are destitute of green colouring matter, cannot decompose carbonic acid; nor can any plants during the night. It follows that during the day green plants are air purifiers; during the night all plants vitiate the air, and consequently it is inadvisable to keep them in bedrooms.

The Air in Relation to Respiration.—The oxygen of air is absolutely essential for the continuance of life. In every organised animal, *lungs* or analogous organs are provided, in order to supply the necessary oxygen to the system, and to remove the impure air from it.

The act of breathing occurs in man about seventeen times per minute. *Inspiration* is performed by the contraction of the chest muscles, which raise and evert the ribs, and so increase the horizontal space in the thoracic cavity; and by the contraction of the

diaphragm or midriff, which in contracting become less concave and flatter, and so increases the vertical extent of the chest. Air rushes into the trachea, and down to each lung to fill the comparative vacuum thus produced, and to maintain the lungs in contact with the expanded chest walls. *Expiration* is chiefly a passive act; the muscles concerned in inspiration relax; consequently the diaphragm rises, and the chest walls fall in, with the result that the air now become impure is forced out of the lungs, and through the trachea.

During the time in which the inspired air is in contact with the lungs, it undergoes important alterations. To understand these, it is necessary to enter briefly into the structure of the lungs. The trachea or windpipe, entering the chest, divides into two branches—one for each lung. These divide in a forked manner in every direction, and the ultimate branches end in minute cavities, called air-cells or air-vesicles. It has been estimated that there are at least five or six millions of these air-vesicles, having an aggregate area of ten to twenty square feet; some place the figures higher than these. Each of the air-vesicles has extremely thin walls, so delicate that their existence has even been doubted; and outside these delicate walls lie capillary blood-vessels, full of impure blood. An active interchange now occurs between the air and the gases dissolved in the blood. Oxygen passes through the intervening membrane into the blood, while carbonic acid and other impurities of the blood pass into the air-vesicle. The consequence of this is that the impure dark-coloured blood becomes bright scarlet and pure. This purification is not confined to any

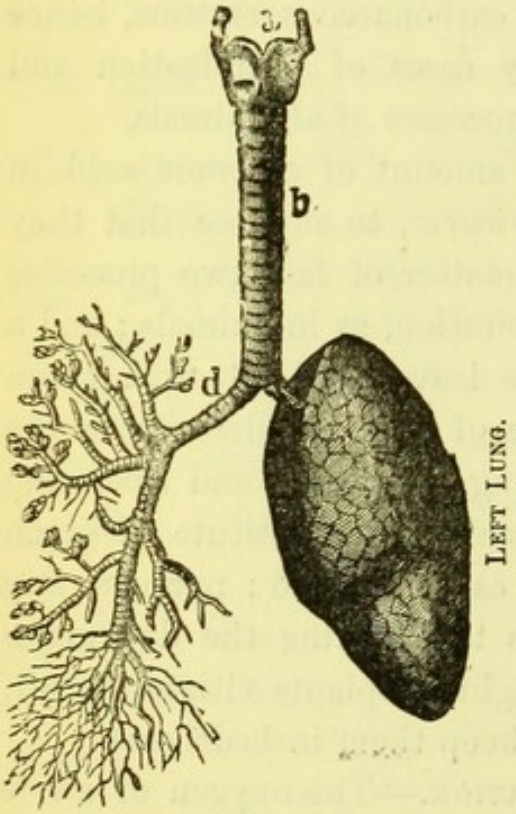


FIG. 12.
DIAGRAM OF THE RESPIRATORY TRACT.
a—Larynx; *b*—Trachea; *d*—Right Bronchus, dividing into numerous branches; Left Lung left intact.

5-6 mils air vesicles
Area of 10-20 sq. ft.

30 c. in per inhale $= \frac{30 \times 17 \times 60}{1728} = 17.7$ c. ft per hr

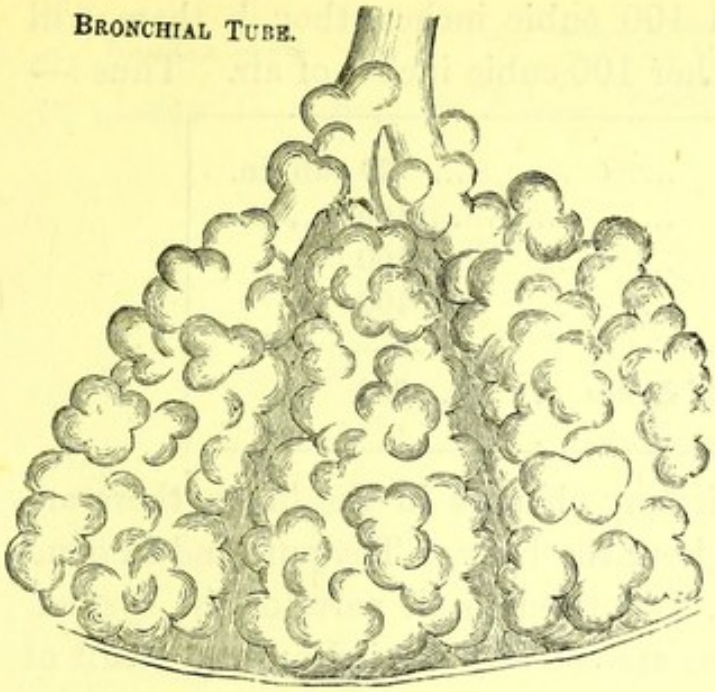


FIG. 13.
Shewing the dilated extremities (infundibula) at the ends of three minute bronchial tubes, with the air-vesicles bulging out on their walls.

one portion of the blood; for the heart contracting 60 or 70 times per minute, pours successive portions of blood into the capillaries surrounding the air-vesicles; while at the same time, pure air is brought into the air-vesicles seventeen times per minute, and so the interchange is constantly kept up.

It will be evident, from the incessant character of respiration and circulation, that all the blood will be purified if the external air is pure, and that if there is any poison or detrimental matter in the air, there is little or no chance of its not coming in contact with the blood in the lungs.

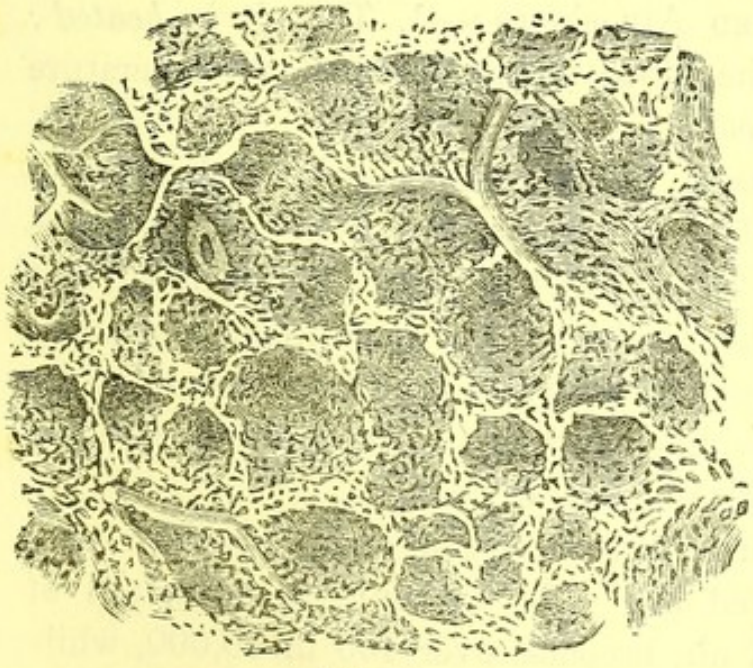


FIG. 14
Shewing the network of minute capillaries spread on the air-vesicles of the lungs.

The amount of air taken in with each inspiration is about thirty cubic inches. This is called the *tidal air*, as it is constantly ebbing and flowing from and to the lungs. By means of a very forced inspiration, about 100 cubic inches of additional air can be inspired; and similarly after an ordinary inspiration, one can

expire forcibly an additional 100 cubic inches, though there will still be left in the lungs another 100 cubic inches of air. Thus :—

Tidal Air	30 cub. in.
Complemental Air	100 ,,
Supplemental Air	100 ,,
Residual Air	100 ,,
Total capacity of Lungs	330 ,,

Corresponding to the respiratory changes in the lungs, there are changes in the tissues throughout the body. The pure and oxygenated blood leaving the lungs, is carried to all parts of the system. Oxidation and allied processes are actively carried on, the result of which is the formation of urea, carbonic acid, and smaller quantities of other effete matters. These are then carried by the blood to the excretory organs, urea being chiefly eliminated by the kidneys, and carbonic acid by the lungs.

Examination of Expired Air shews :—1. That it is *heated ;* in its passage through the blood it has acquired a temperature approaching that of the blood.

2. Its *moisture* is increased. By the skin and lungs from 25 to 40 ounces of water pass off in the twenty-four hours ; the relative amount varies somewhat. Dr. de Chaumont has estimated that 2,000 people, during two hours, the time of an ordinary concert or service, would give off 17 gallons of water from their lungs and by perspiration, and nearly as much carbon (in the form of carbonic acid) as would be contained in 1 cwt. of coal.

3. It contains 4 to 5 per cent. less oxygen, and *4 per cent. more carbonic acid* than inspired air. The carbonic acid, instead of being 4 parts in 10,000 of air, becomes over 400 in 10,000, while the oxygen is diminished in a somewhat larger proportion. Thus :—

	Oxygen.	Nitrogen.	Carbonic Acid.
Inspired air contains	20·81	79·15	·04
Expired ,, ,, ...	16·033	79·557	4·38

Boy's Essay on "Breathing" - Breath is made of air. We breathe in our lungs. Lungs like. Our breath keeps the life going thro. the nose when we sleep. Boys who stay in doors all day shd not breathe. They shd wait till they get out of doors. Girls kill the breath w. corsets that squeeze the diaphram. Girls cant run or holler like boys, bec. their diaph. is squeez'd too much. If I was a girl I'd rather be a boy, so I can holler than have a big diaphram.

9 ozs H_2O daily fr. lungs (Huxley)

Obsns at Dundee shewd. that boys made air more impure than girls thro'. more effict ventn because 1/. more restless & more dust & CO_2 2/. not so clean. 3/. more exercise thro' school 4/. diffce in constitn

Amt of air inspired reckd 30 c. in per inspirn & 17 inspirns per min = 17·7 c. ft per hr.

Dr. A Smith fd only ·4 c. ft CO_2 eliminated per hr.
Pettenkofer says ·7 ft.

A Smith ·4 c ft CO_2 per hr
·6
Pettenkofer ·7
Liebig ·79

Acc. to Dr. Ransome a healthy adult excretes by health
·2 gramme per diem of org. matr.

The *amount* of carbonic acid expired varies under different circumstances. It is increased by active work, by an increase of food, by a diminution of the external temperature; it is greater when the surrounding air is pure, and when it is moist; and it varies with the season, being greatest in spring, and least in autumn.

Children require more oxygen, and expire more carbonic acid than adults, weight for weight. A child six or seven years old requires nearly as much oxygen as one twice that age.

The average amount of carbonic acid eliminated by a healthy adult is at least 0·6 cubic foot per hour, or 14·4 cubic feet per day. This reckoned as carbon is equivalent to 160 grains per hour, or half a pound of carbon in the twenty-four hours. Liebig gives the amount of carbonic acid expired as 0·79 cubic foot per hour, or 19 cubic feet per day.

4. It contains *organic impurities.* These are probably partly gaseous, and partly suspended, the latter being particles of epithelium, fat, and putrescible nitrogenous substances. It has been estimated that about 30 grains of organic matter are eliminated from the lungs in twenty-four hours.

CHAPTER XV.

SUSPENDED IMPURITIES OF AIR.

Nature of Suspended Impurities, Organic and Inorganic.—The Impurities Inhaled in Various Occupations.—Hay Asthma.—Contagious and Septic Diseases.

Pure air being essential to life and health, it is important to ascertain the character and origin of the impurities of air. Innumerable substances—in the condition of gases, vapours, or solid particles—constantly pass into it, and tend to deteriorate its quality. To counteract this tendency, certain purifying agencies are at work, the mechanism of which will be considered hereafter.

Impurities are much commoner and more abundant in the air of enclosed spaces than in the external air, as the natural processes of

purification cannot be brought to bear so efficiently in the former case. In sick rooms, hospitals, etc., impurities arise, which are not present where only healthy people are collected. The most important impurities are derived from the respiration of animals, and the combustion of gases, candles, or lamps in rooms, from sewage emanations, from various occupations, and the air of marshes, mines, church-yards, etc. These may be classed under two heads—*solid* and *gaseous;* the solid being simply suspended in the air in a finely divided condition, or floated about in a coarser condition by currents of air. They are revealed in an atmosphere in which one did not previously suspect their existence, by the passage of a beam of sunlight. Light itself is invisible, but its course is rendered visible by the particles from which its rays are reflected. Professor Tyndall has applied this fact to the discovery of the presence of disease germs in the atmosphere.

Suspended Matters are *mineral* or *organic*, the two being commonly associated together. The **mineral matters** consist largely of fine particles of common salt, silica, clay, iron rust, dried mud, chalk, coal, soot, and similar substances. Not uncommonly the mineral particles are coated by, or mixed with, organic matter, and it would seem as though the comparative lightness of the organic matter enables the mineral matter to float about more easily. The objection to dust is thus intensified, for not only is it irritating to the respiratory passages and generally disagreeable, but it carries with it putrescent and morbific particles, often in a most active and virulent condition.

Organic Suspended Matters in the **open air** are, most commonly, minute fragments of wood and straw, dried horse litter, fragments of insects, the spores and pollen of plants, and microscopic plants and animals. In addition, there is the putrescent organic matter resulting from respiration.

Dr. A. Smith took a bottle holding five litres of air, and containing a little distilled water, and after drawing through it, by means of an aspirator, a quantity of Manchester air equal to 500

Smoke Nuisance. – C charged to SO_2 to other acid mat[ls]

(1) Dirt prod[n] – bdgs, stats, lace curtains walls &c. Metal ornam[ts] & insides destroyed by it. Skin dirty. Time means expense.

(2) Certain of smoke shuts off sun rays important part in prod[n] fever. Intense light has power of even destroying spores of bac[i]. Insignif[t] compensating drawings act[n] of SO_2, C &c.

(3) Prod[n] gloomy dismal fog – brks & tends to Phthis. prod[n]. – Prest[y] people opened their windows. (4) Depressed effect of dull gloomy atmosph.

Soot + SO_2 much more destruct[e] to respir[y] plts than of animals.

Ev[y] reason to believe that the greatest of mischief done by SO_2 is while attached to soot. Mr Estcourt estim[d] amt of S turned into SO_2 as f. 1 to 1½ % of wt of coal used. SO_2 disappears rapidly like CO_2.

Mr J. E. Davis late Asst Insp[r] Alkali Works says "in coal gas we have a fuel cont[g] far less S than ord[y] coal (abt ½) With coal gas 3/- per 1000 c ft heat[g] rooms by its means is ×5 dearer than coal-heat[g]; but cooking by gas cheaper than by coal.

Co keep autom[c] moveable bar machines, the best smoke preventers

Prof. Vivian Lewes (Jan. Rec. Jan. 91) shows fog depends on atmos[c] circumstances to dew. Must be consid[e] layer of air above earth's surf[e] charged w. moist[e] before there can be fog. In London abt 5 mill[n] tons coal burnt per ann. Lasting prop[y] of Lond. fog due to particles of moist[e] getting laden w. a tar-like subst[ce] fr. imperf[y] burnt coal wh. weights them. Usually not higher than top of St Paul's; at that height is able to get away into space. In London 1889-90, that in 4 mos Dec[r]–Feb. only

Na_2SO_4 in air where coal burnt. KNO_3 in air of mines from gunpowd[r] blasting. Fe particles fr. railway trains.

62 hrs sunshine at Greenwich 15·7 hrs, Kew 222, Eastbourne 300, I. Wight 316 hrs. Particles often prest[e] the rapid evap[n] wh occurs in country fogs. Fog prest[y] CO_2 &c escaping. During recent fog at Charing X 14 parts CO_2 in 10000 air fd – at one time in town 16 pts.

Suspend. Matters

1. mineral – NaCl, Silica, clay, Fe &c.
2. organic – wood, straw, litter, pollen, spores, insects, fungoid matts, starch, linen, silk &c products of oxide

Gaseous Impurities

CO_2
CO
SH_2
SO_2
CS_2
NH_3
HCl, HNO_3
KCy, Impent Resin
Paraffin
Hg
Respir. products
Coal gas
Prodts of Combustn
Exhalns of sick
" of sewers, cesspls &c
Decomp. org. matr from
marshes
graveyds
decomp. carcases
Manure &c
tallow makg &c
brick burng &c

times the size of the bottle, he examined the water by microscopic powers, varying from 120 to 1,600 diameters.

The bodies seen were particles of vegetable tissues; fragments of vegetation, such as hay, straw, and hay-seeds; the hairs of plants, and fibres resembling flax; cotton fibres; starch granules; wool, white and coloured; and, most abundant of all, fungoid and lichenous matter, spores and sporidia, varying from $\frac{1}{10000}$ to $\frac{1}{30000}$ of an inch in diameter. Under each field of the microscope, over 100 spores were visible. In each drop of liquid there were over 250,000; the whole quantity consisted of 150 drops; so that there were in this water not fewer than $37\frac{1}{2}$ million spores visible to a magnifying power of 1,600 diameters. The amount of air which was drawn through the bottle, was equal to that respired by an average active man in ten hours; the dangers from such spores, if any capable of producing disease are present, are very great.

Indoors, the air commonly contains, in addition, fragments of cotton, linen, silk, or other fibres, fragments of vegetables, starch cells, soot, charred wood, splinters from floors, etc.

In Sick Rooms, products of the morbid conditions may be evolved; thus, pus-cells, particles from the expectoration, blood cells, fat particles, epithelium, etc. Often the poisons of specific diseases are diffused in the air, probably as minute suspended matter. It is possible also, that the bacteria of consumption and various septic diseases, may be carried from one individual to another by the atmosphere.

Flies and other winged insects are important auxiliaries in the diffusion of such disease-carrying particles. Receiving some morbid secretions on their limbs, or other parts of their bodies, they have occasionally been the means of spreading erysipelas in hospitals, and glanders in veterinary stables. Moreover, their excreta which are not uncommonly deposited on food, or on articles of furniture, have occasionally been found to contain the minute ova of intestinal worms; and it is possible that, in this way, parasitic disease is occasionally acquired.

Effects of Suspended Matters.—The inhalation of dust from whatever source is followed by deleterious effects. We may divide the solid substances inhaled as dust into three kinds:—dead substances, living substances, and the contagia of various diseases.

1. **Dead Substances** inhaled for a prolonged period in various occupations are a common cause of premature death. The *potter* draws into his lungs a fine silicious dust, which irritates his lungs, and finally produces a very fatal disease, known as **potter's asthma.**

Mill-stone Cutters and **Stone Masons** inhale the fine particles of stone given off from the material which is being chiselled. Ultimate destruction of the lungs results.

Pearl Cutters inhale fine particles of pearl-dust, and as they generally work in close rooms, and the dust is light and tasteless, serious disease of the lungs results. The organic part of the pearl conchyline also gets into the circulation, and, being carried to the ends of bones, produces inflammation and symptoms resembling acute rheumatism.

Sand-paper Makers inhale minute portions of glass and sand; and **needle and knife grinders** are exposed to similar dangers, and at one time the mortality among them was frightful. It has greatly diminished since the introduction of wet grinding, the use of steam fans, and wearing of respirators.

Hemp and Flax Dressers inhale a dust which is peculiarly irritating; and so fatal is the result, that if a girl of eighteen commences with this work, and is regularly employed, she nearly always dies of consumption before reaching the age of 30 years. **Workers in rags and in wool** suffer in like manner from dust. The dust from fleeces of wool, and especially from the alpaca fleece, has produced in many cases (in the neighbourhood of Bradford and elsewhere) an acute disease proving fatal in a few days. There is strong reason for regarding this as identical with malignant pustule (or the splenic fever of animals); the specific germs of this disease being inhaled as dust from diseased hides.

Manufe of white lead – Prob.ly impos.e to divest the Dutch or stack process of its fatal char.s. Many attempts to prod.e the desired mist.e of $PbCO_3$ & Pb Hydrate by ppt.n processes, as by add.n of commercial soda to Pb Acet.e, prod.s a crystal.e product. Grinding of white Pb done by wet method. Most unhealthy processes are the tak.g down stacks & detach.g films of white Pb fr. plates of metal.

In Prof. Gardner's patent process electrolysis takes place of chem.l act.n & process is cond.ct.d in closed chambers – This process more rapid than the ord.y one.

The **miller** commonly suffers from a form of asthma, not so severe as potter's asthma, as the particles in this case are not equally irritating. The **hairdresser** is liable to inhale the short fragments of hair cut by the scissors, and the mortality of this class of workers is decidedly above the average. **Miners** are frightfully subject to lung diseases, and, as a rule, die prematurely from bronchitis and pneumonia, due to the dust they inhale. The lungs are made dark and hard in texture by the particles of coal, which also excite a large overgrowth of fibrous tissue, as in many other cases of inhalation of foreign particles. The only exception to the rule is among the colliers of Durham and Northumberland, where the mines are well ventilated.

The Fur-dyer is very prone to suffer from the dust of the dyed furs, great irritation and disease resulting in many cases.

Artificial Flower-makers, and those engaged in colouring arsenical wall-papers, suffer from the inhalation of arsenical vapours, as well as from its absorption by the skin. Sooner or later the arsenic is absorbed into the circulation, and produces weakness, diarrhœa and vomiting, thirst, and occasionally nervous symptoms; in addition to smarting of gums, eyes, and nose, from local absorption, and small ulcers on exposed parts of the body.

Cigar-makers are liable to have their lungs irritated by inhalation of the dust of the tobacco-leaf; and in addition, the nicotine of the tobacco, becoming absorbed into the system, commonly produces muscular weakness, irregular and intermittent action of the heart, and general failure of health. Some persons are much more tolerant of the poison than others.

Workers in Lead are very liable to be poisoned by the metal; thus, house painters, potters engaged in the glazing process, in which the ware is dipped into a solution containing lead, manufacturers of white lead, and others, are commonly affected. The lead is partly absorbed by the skin; in some cases it is inhaled, either as dust or along with the fumes of turpentine; and frequently it is swallowed, from the workman eating his meals

with unwashed hands. The symptoms have been already named; "painter's colic" and "drop-wrist" are the two most important, though, in some cases, lead shews its effects more insidiously, leading to gout and chronic renal disease.

Brass-founders occasionally inhale the fumes of oxide of zinc, and diarrhœa, cramp, waterbrash, and other troubles are the result. Those engaged in the manufacture of **bichromate of potass**, are liable to partial destruction of the mucous membrane of the nose, and to irritation of the skin, with the formation, in some cases, of small ulcers.

Workers with Phosphorus, as those engaged in the making of phosphorus matches, not uncommonly suffer from a gradual necrosis (death) of the jaw-bone, which produces great deformity. Those having carious teeth are especially attacked by this disease, which is due to the fumes of oxide of phosphorus, evolved in the process, attacking the jaw. Improved ventilation of workshops, careful attention to the teeth, and other measures, have greatly diminished this disease; and it has almost disappeared since the introduction of red non-volatile phosphorus, in place of the yellow variety.

Chimney Sweeps occasionally suffer from irritative skin diseases, as well as bronchitis. In some cases the chronic irritation of the soot has produced a cancer of the skin.

Since the investigation of the above dust diseases, means have been taken to diminish their prevalence, in several cases with remarkable success. In the case of steel-grinding, for instance, it has been found that the mortality varies according to the amount of water used on the stone—being greatest with dry grinding, and least with **wet grinding.** Wet processes have been applied to others of the industries named, with a like success. Where the dust cannot be avoided, the use of **steam-fans**, to deflect the dust away from the workman, has been found successful; and in many cases, **free ventilation** of the workshops has greatly diminished the mortality. Where none of the above measures

Menin^{s}. & Epileptif. Convulsions in bad cases.

Wet grinding
steam fans
ventil^{n}
respirators { avoid^{g} of conversat^{n} breath^{g} thro. nostrils
Cleanliness

suffice, the use of **respirators** ought to be insisted on. These are made of various materials; Mr. Baker, an inspector of factories, has invented a crape mask, which answers well. Breathing through the nostrils ought to be carefully maintained, as thus the dust is to a large extent stopped before reaching the lungs; and unnecessary conversation, involving breathing through the mouth, ought to be discouraged.

The dangers of lead poisoning may be avoided by absolute **cleanliness.** The hands ought always to be washed before taking meals, and the mouth rinsed out with water containing a trace of sulphuric acid. It is a useful practice, among the workmen in some lead factories, to make a beverage by dipping a straw into strong oil of vitriol, and then soaking it in a gallon of water. The weak acid liquid forms an insoluble and harmless sulphate of lead, which passes through the alimentary canal without being absorbed.

The dangers from the fumes of quicksilver and phosphorus are much more difficult to avoid. In the case of phosphorus, the substitution of the red for the yellow variety has removed the difficulty. But no means have yet been discovered for preventing the noxious effects of mercurial fumes.

2. **Living Substances.**—The pollen of plants in some persons produces a distressing form of disease, called **hay-asthma**, which is apt to recur each year, and is sometimes only curable by living in a town or removing to the sea-coast. The amount of pollen floating about in the atmosphere is considerable; 95 per cent. of it is grass-pollen, and this form and the pollen from pine-trees appear to be the most powerful in inducing hay-asthma. According to some authorities, hay-asthma is rather due to the minute particles constituting the scent of various flowers, than to the pollen; but this is probably not the usual mode of origin of the disease, though it may be in some cases. In some cases, true asthma results from smelling particular plants. Here as in the case of hay-asthma a peculiar idiosyncrasy is involved, only a very small

proportion of those exposed to the minute particles being affected by the morbid condition.

The spores of many fungi and of other living organisms are constantly being floated about in the air, until they find a suitable resting place, when they settle and proceed to grow and multiply. The souring of milk, the fermentation of a saccharine solution, the moulding of bread, the presence of mildew, the blighting of corn, and numerous other phenomena are due to the growth of organisms carried by the atmosphere from one part to another.

3. **The Contagia** of the specific diseases, are probably living organisms, but it is convenient to class them under a separate head. Nearly all the specific fevers may be propagated through the air, though some much more easily than others. The exact condition in which these contagia exist in the atmosphere is doubtful, but there are strong reasons for regarding them as microscopic organisms, which float about alone or along with particles of epithelium or pus cells or putrescent organic matter, until they find a suitable "soil" in which to develop. Some of these contagia have a persistent vitality, resisting oxidation for a considerable time, as is the case with the poisons of scarlet fever and small-pox. They may infect the air of a room for weeks, and in this respect they resemble other low forms of animal and vegetable life, which may be dried for years and yet recover their vitality when moistened. The poisons of typhus fever and of the Oriental plague, on the other hand, are easily destroyed by free ventilation. Malarious poison may be carried by winds for a considerable distance, unless a surface of water or a belt of trees intervenes; and in some cases a similar carriage of cholera seems to have occurred, though this is uncommon.

Besides the contagia of the specific fevers, *septic organisms* may be carried by the atmosphere. Formerly, blood-poisoning from operation and other wounds was frightfully common; but Professor Lister introduced the antiseptic system of dressings, by means of which the air having access to the wound was filtered through layers of

carbolised gauze and deprived of its septic germs; with the result that wounds can now be kept perfectly "sweet," the suppuration in them is reduced to a minimum, and the danger of blood-poisoning is almost annihilated. It had often been noticed that recovery from even very severe injuries was common, if only the skin remained unbroken; while the same injuries, with the addition of a rupture of the skin, and consequent access of air, were rapidly fatal. But to Lister is due the great honour of proving that it was not the air which produced the mischief, but the germs it contained, and that filtered air might be admitted with impunity.

Erysipelas and *hospital gangrene* are occasionally carried about in hospital wards by dirty sponges and dressings; and if the ventilation is not perfect, particles of epithelium and pus from the diseased persons may be carried to other patients at a distance. Some forms of *purulent disease of the eyes* are transferable from patient to patient, and in children some forms of *eczema* are also contagious. In these, however, it is probable that actual contact is necessary.

CHAPTER XVI.

GASEOUS IMPURITIES OF AIR.

Effects of Inhalation of Carbonic Acid, Carbonic Oxide, and other Gases and Vapours.—Air rendered Impure by Respiration.—Coal-Gas and its products.—Emanations from the Sick.—The Air of Sewers, etc.—Effluvia from Decomposing Organic Matter.—Extremes of Moisture or Temperature.

Gaseous impurities of the air are very commonly associated with suspended matters, and it is in many cases difficult or impossible to separate the effects of the two.

Different gases are also often associated, and so produce modified results. It will be convenient to consider, first of all, certain well-marked gaseous impurities, and then others in which there is a mixture of several gases, or of these with suspended solid particles.

Under the first head the most important impurity is—

(1) **Carbonic Acid.**—This is reckoned an impurity if amounting to more than 5 parts in 10,000 of air. Owing to the large amount produced in the respiration of animals, in the combustion of fires, gas, lamps, etc., and in other natural processes, it would be much greater in populous parts, were it not for the rapid diffusion occurring in the air, and the purifying action of plants. The following analyses from Dr. Angus Smith's work on "Air and Rain," illustrate the facts that in towns the amount rises, and is greatest in the most populous parts, while during fogs it is greatly increased.

	VOLUMES OF CARBONIC ACID IN 10,000 VOLUMES OF AIR.
On the mountains and moors of Scotland—mean of 57 analyses	3·36
In the streets of Glasgow—mean of 42 analyses	5·02
London, N., N.E., and N.W. postal districts—mean of 30 analyses	4·384
London, E. and E.C.—mean of 12 analyses ...	4·745
Manchester streets, ordinary weather	4·03
During fogs in Manchester	6·79

The effects of carbonic acid gas alone must be carefully distinguished from those of the same gas *plus* the organic impurities from respiration, with which it is commonly associated. Dr. Angus Smith found that air containing 3 per cent. of carbonic acid produced difficulty of breathing, but he was able to breathe comfortably an atmosphere containing 0·2 per cent. carbonic acid. Other observers have found they could breathe without discomfort air containing 1 per cent. carbonic acid. When the carbonic acid is derived from respiration, headache and giddiness are produced in many persons when the carbonic acid amounts to 0·15 per cent. A fatal result has occasionally occurred from the inhalation of the carbonic acid at the bottom of wells, or of brewing vats, or about limekilns.

A CO. indicator (San. News Vol. 15. no. 328) — perfected by H. Rasine.

Actn depds on presp. of spongy Pt to absorb CO w. evoln of sensible heat. Two metc plates placed vertly over ea. other, wh. when touchg cause an elc circt. Upr plate is susp. fr. a hook by means of an easily combustle thread. This thread is wrapd in muslin, contg a little coty powder dustd over wh spongy Pt. If this arrangt is exposed in an atmosph. of cont. CO, the spongy Pt wl absorb it, & set fire to the cotton, wh. wl burn the thread & so cause elc contacts to trip a bell.

17 c fatal

CO causes asphyxia & paralt nervs centres of ht & respirn.
Bld scarlet after dth & charactc spectr. bands.
Poisg by water gas.

Estimd that coal consumed in Glasgow weighbd in 1 yr gives off enough SO_2 to prodc 300,000 tons oil of vitriol

The presence of an excess of carbonic acid probably retards the elimination of carbonic acid from the lungs; the consequence is that general nutrition is impaired, and muscular energy fails. This is seen in workshops where the air is confined and gaslight is commonly employed; though the air here also contains carbonic oxide, sulphurous acid, and organic impurities, and these probably have a large share in producing the evil results.

(2) **Carbonic Oxide** in the proportion of more than 1 per cent. is rapidly fatal, and has poisoned when under ½ per cent. Poisoning by its means occurs chiefly where charcoal stoves are used, and especially when the charcoal is burnt in rooms with no chimney flue. This is an occasional mode of suicide on the continent. Carbonic oxide is a much more deadly poison than the dioxide (carbonic acid); it forms a stable compound with the hœmoglobin of the red blood-corpuscles, which displaces oxygen from them, and is got rid of with great difficulty. Lace-frame makers place a coke stove under their work, and thus inhale the invisible gas. Headache, giddiness, irregular action of the heart, and depression of the general health result.

(3) **Sulphuretted Hydrogen** occasionally seems to produce troublesome symptoms, such as headache, nausea, and diarrhœa; but many persons engaged in manufactures involving the evolution of this gas seem to escape.

(4) **Sulphurous Acid** is always present in small quantities in the air of towns, derived from the combustion of coal and gas. Straw-bleachers and the bleachers in cotton and worsted manufactories, often suffer from severe cough and bronchitis from inhaling its irritating vapours.

(5) **Carbon Disulphide** when vaporised and inhaled produces headache, general muscular pains, nervous depression, and even worse symptoms. It is used in the manufacture of vulcanised india-rubber, toy-balloons, etc.

(6) **Ammonia** produces irritation of the eyes and bronchial irritation. Hat-makers commonly suffer from its effects, being

generally pale and feeble. It is difficult to say how much is due to the ammonia, and how much to the necessarily high temperature at which they work.

(7) **Acid Fumes** are very irritating to the lungs, and in the case of alkali manufactures, they destroy all vegetation for considerable distances. *Hydrochloric acid* produces great irritation, and chlorine even more so. The fur-dyer is not only subject to the dangers of dust, but also of the fumes of *nitric acid*, used to remove fat and give certain shades of colour to the fur.

(8) **Other Vapours** evolved in various processes produce special symptoms. Photographers suffer from depression, giddiness, etc., due to the fumes evolved by *cyanide of potassium*. This is now largely abandoned, and hyposulphites have taken its place. House-painters suffer from the inhalation of *turpentine vapour*, headache and loss of appetite commonly resulting. The symptoms from the commonly coexistent lead-poisoning are distinct. Brush-makers have a persistent suffocative cough, the result of the inhalation of *resinous fumes*, evolved in making brushes.

Workers in paraffin are liable to an irritative disease of the hair-follicles of the body, followed by the formation of scars, almost like smallpox marks.

Workers in quicksilver, as those engaged in making mirrors or thermometers, are prone to suffer from mercurial poisoning. The gums become spongy, and there is profuse salivation, also generally alimentary disturbance; and in some cases nervous affections, resulting in persistent muscular tremblings, etc.

Under the second head—cases of inhalation of mixed gases, often of a doubtful constitution—we must consider

(1) **The Effects of Air Rendered Impure by Respiration.**—It has been already stated that an amount of carbonic acid which could easily be borne alone, is intolerable when other products of respiration are mixed with it. These are chiefly organic gases and solids, which (unless removed quickly) render the atmosphere close and "stuffy"—an effect which is readily perceptible by the sense

of smell of those entering an occupied room immediately from the outer air. When such a room is inhabited for a few hours, headache, languor, drowsiness, and yawning (which is really a cry for purer air) result. The soporific effects so commonly produced in churches, etc., are commonly due to the vitiated atmosphere, rather than as is supposed to the soothing effects of the sermon. After leaving a room of the above description and retiring to the bedroom, the previous drowsiness is succeeded by a wide-awake condition, due to the colder and fresher air inhaled.

When the exposure to foul air is *more chronic*, and occurs day after day, there results a general lowering of strength and vigour—both bodily and mental—even where no actual disease is set up. Oxidation processes are retarded; the consequence is an anœmic sallow complexion, which compares badly with the ruddy complexion of those spending a great part of the day out of doors.

The prolonged breathing of air, foul from the products of respiration, is perhaps more common in workshops and schools than in private houses; but in both, a faint smell is commonly perceptible on entering from the open air, speaking of imperfect ventilation and accumulation of organic putrescible matter.

The **tendency to catarrhs** is greatly increased by living in a vitiated atmosphere. A "cold" most commonly results on leaving a vitiated atmosphere, which has disordered the nervous system, and rendered its control over the circulation in the skin and internal organs incomplete. It seldom or never arises from cold weather *per se*. This was abundantly proved by the experience of the British army in the Crimea. When the soldiers lived in tents in the most severe weather, colds were unknown; but when some of the men were put in huts, in which the air was warmer and not so freely renewed, the sick rate increased, and colds and coughs became common.

The close connection of **phthisis** (consumption) with overcrowding and the breathing of a vitiated atmosphere, will be

discussed hereafter. The polluted air in producing consumption probably acts by depressing the vital functions, and by inducing a tendency to degenerative changes and the development of lowly organised growths, as well as by favouring the propagation of the disease from individual to individual.

The germs of contagious diseases are propagated very rapidly in an impure atmosphere; and typhus fever seems under some conditions to be produced by overcrowding.

In the cattle-plague of 1866, it was found that nearly all the cows died when crowded together in unventilated sheds, while only a third died when there was free ventilation.

The effects of air containing the products of respiration in a *concentrated condition*, has been shewn only too well in the oft-quoted case of the Black Hole of Calcutta. In this case, 146 persons were confined in a space eighteen feet every way, with two small windows on one side. Next morning 123 were found dead, and the remaining 23 were very ill.

Speaking generally, it is found that the average death-rate in this country increases in the same ratio as the density of the population. The death-rate from phthisis, child-birth, and typhus fever, for instance, is far higher in cities than country places. This may be explained in various ways. Density of population commonly implies insufficient or unwholesome food, unhealthy work, and poverty; but especially impurity of the air, uncleanliness, and imperfect removal of excreta. Of these factors, the vitiated air is probably the most powerful for evil. It has been observed that children's diseases are twice as fatal in towns as in rural districts. According to Sir T. Watson, town children get as much exercise as their time of life would allow anywhere, and one is bound to infer that the vitiated atmosphere is the main cause of the difference.

(2) **Coal-gas** consists of a mixture of various gases, as shewn in the following analysis from Parkes :—

Dr Farr 1st point out the apparent constancy of relative density & mort. Doubtful if this is a "law". Note incr. dens. & dim. mort. of Engl. towns in recent yrs. Effect of density varies under diff. conds. Popl. of a town div. by the arbitrary area of its municipal gives but a clumsy measure of density. Density of populous towns only becomes really dang. to health under conds. of defect. sanit. conds & agens. With equal defect. correct. for varying prop. of social classes may be viewed as there is no law impos. diff. rates of mort. on the various classes of the pop. Correct. for diffs of age distrib. are a fundam. necessity (3 Mc Jan 87)

Dr Buda-Pesth in yrs 1879-82, fol. table shows p.c. incr. of mort. fr. var. dis. in lowest classes of rooms ("cellars") compared w. the d.r. in rest of town:
p.c. incr. a decrease in d.r.

Measles	+ 154.
Wh. Cough	+ 100
Sc. fever	− 8
Croup & Diphtheria	+ 11
General D.R.	+ 35

The best candles are the hardest, of stearin, wax, paraffin &
as these do not melt so quickly as tallow - which rises in wick quicker
than it can be completely burnt.
Mineral oils dangerous to use unless rectified as volatile hydrocarbons
are given off in vapour.

Coal gas dangerous: 1). explosive mixtures with air - 2) very poisonous due to CO.

Coal gas also contains CS_2 - SO_2 produced acts injuriously on picture hangings & books, exercises of fabrics as well as on vegetable life. Often escape of unburnt gas from excessive pressure. Then very prone to heavy hydrocarbons burnt first, poisonous flame: CH_4 & CO escaping into room.
Sometimes a regulator act by adapted throttle orifice to pressure save 20-30 o/o - Stott's patent test - (W)
Welsbach burner has a wick & "mantel" steeped in a mineral sol: - incombustible skeleton w. a Bunsen burner.

1 c.ft coal gas produces 2 c.ft CO_2 and .2 to .5 grains SO_2.
Medium gas burner burns 3 c.ft gas per hr.

No S. compounds from use of candles & oil.

(1 c.ft per hr of gas = as much vitiation as by 1 individual in same time - Galton)

Hydrogen	40 to 45·58
Marsh gas (CH_4)	35 to 40
Carbonic oxide	3 to 6·6
Olefiant gas (C_2H_4)	3 to 4
Acetylene (C_2H_2)	2 to 3
Sulphuretted hydrogen	0·29 to 1
Nitrogen	2 to 2·5
Carbonic acid	3 to 3·75
Sulphurous acid	·5 to 1
Ammonia or ammonic sulphide ...	
Carbon disulphide	

The inhalation of coal-gas, even in small quantities, is liable to produce headache, and may lead to chronic poisoning if allowed to continue. Where the escape of gas is more extensive, as when a tap is left turned on accidentally during the night, two dangers may arise. If a light is struck in the room, an explosion occurs; or persons may be poisoned in their sleep by inhalation of the gas.

The products of the combustion of coal-gas are likewise deleterious. It is found that one cubic foot of coal-gas consumes the oxygen of eight to ten cubic feet of air, and produces about two cubic feet of carbonic acid. A medium gas-burner therefore, which burns about three cubic feet of gas per hour, destroys twenty-four cubic feet of oxygen, and produces six cubic feet of carbonic acid. These six cubic feet of carbonic acid ought to be contained in more than 10,000 cubic feet of air, instead of in an ordinary sized room. The necessity of a frequent change for air will consequently be evident.

Two hard candles or one good oil lamp produce the same amount of carbonic acid as a man; while a medium gas-burner produces as much carbonic acid as four or five men. These data will help in estimating what amount of fresh air is necessary in an enclosed space per hour, in addition to that required for removing the impurities produced by respiration.

For equal illuminating power, candles give more impurity to the air than gas; but one is commonly content with a smaller and more localised light from candles or lamps than from gas. Besides carbonic acid, minute quantities of carbonic oxide, sulphurous acid, sulphuretted hydrogen, ammonia, &c., are produced by the combustion of coal-gas, and all these produce injurious effects. The ill effects of living in an atmosphere polluted with the products of combustion have been abundantly proved. A condition of general ill health, mental and physical inaptitude for work, with loss of appetite, anæmia, and other symptoms, are produced.

(3) **Air Rendered Impure by Exhalations from the Sick.**—In the case of the specific fevers, infection almost certainly results from breathing the polluted atmosphere, and the aggregation of numerous cases of the same fever always increases the danger. Erysipelas and septicæmia (blood poisoning) have until recent years been frequently spread in hospital wards; and there can be no doubt that the aggregation of cases of suppurating wounds with decomposition has been the chief cause of this. The adoption of greater cleanliness both in the wards themselves and in the dressing of wounds, and the application of antiseptic principles (whether according to Lister's method or otherwise) have led to a wonderful improvement in these respects; and now the mortality of hospital patients does not compare very unfavourably with that of patients treated in private houses. Hospital gangrene, formerly very common, now rarely occurs. It can be avoided by free ventilation; and is hardly ever seen when wounded soldiers are treated in tents.

The air which consumptive patients breathe, ought to be avoided as far as possible, and free ventilation insisted on. The cases of actual carriage of consumption by the breath from one person to another, must however be very rare, and probably only occur when the healthy and diseased have slept together. (See also under solid impurities, *page 154*; emanations from the sick are both gaseous and suspended).

(4) **The Air of Sewers, Cesspools, etc.,** usually contains the

Proved by experts that combustion of colza oil produces ½ the heat of flame of cannel gas of same standard of luminosity that compared with standard 13-sperm-candle gas the proportions of heat are 78 : 68.

Why not use reflectors for gas as well as day-lights?

Air of hospitals because or that smell of organic matter perceptible when CO_2 over .566 p 1000 (De Ch.), while in barracks not perceptible till amounts to .608 p 1000.

Sten contamination of hospital air due to

1. more organic effluvia from bodies & excretions of sick persons
2. recent effusions of excreta, dressings, soiled clothes &c.
3. absorption of organic matters by walls & floors, bedding & furniture
4. continuous occupation.

Free supply fresh air lessens duration of S. Pox & Typhus, hastens convalescence in time of war.

NH_3, H_2S, Am. S., CO_2 &c

Lower? of barom: aids expulsion of gases fr. sewage

products of decomposition of sewage, such as volatile fœtid organic matter, carbo-ammoniacal substances, sulphuretted hydrogen, carbonic acid, etc. The amount of these various products varies greatly under different circumstances, such as dilution of the sewage, ventilation of sewers, temperature, etc. The chief danger of sewer-gas appears to lie in the organic matters it contains. These probably do not become scattered in the atmosphere until gas is developed in the sewers; then the slow effervescence throws particles of liquid into the air which may be transmitted through considerable distances by gentle currents. (Frankland) Dr. Parkes, reporting on an epidemic of cholera at Southampton, shewed similarly that sewage in passing through untrapped drains may froth, and that the bubbles may throw spray a long way into the air, rendering it infectious. These observations serve to impress the practical lesson that the danger of sewage is in proportion to its stagnation. If it is hurried away before time is allowed for putrefaction, the danger is reduced to a minimum.

The exhalations from cesspools or privies on cleaning them out, may produce severe disorders, which are sometimes fatal. When a drain is newly opened or sewer gas gets into a house, a less marked form of poisoning commonly results, chiefly characterised by languor, headache, vomiting, and diarrhœa. In some cases there may be febrile attacks lasting a few days. Children are especially sensitive to such conditions and quickly fall into ill health.

The emanations from *obstructed* drains are especially to be feared. It is doubtful whether the air of unobstructed sewers is dangerous; statistics concerning sewer-men seems to prove the opposite; but the enquiry has not been very thoroughly carried out. Probably much depends on the ventilation of the sewers.

The presence of healthy fæcal matters undergoing fermentative changes is competent to produce the non-specific disorders already mentioned; but under some conditions specific diseases are produced by sewer-gases.

Erysipelas and puerperal (childbirth) fever have been proved to

be due to sewer emanations, and many lives have been lost from these causes.

Diphtheria is in many cases due to emanations from sewers, either directly inhaled, or perhaps more commonly received after having been absorbed by water or milk. Ulcerated sore-throat has in some cases been distinctly traced to sewer-gases. Summer diarrhœa is due to sewer-emanations directly inhaled, or taken in drinking water. It is worst in badly drained districts, and when there is a dry season, with the thermometer persistently above 60°.

Typhoid fever is due to the effluvia from drains, but whether these must be of a specific character (derived from a previous case), or whether putrefactive changes alone, under certain conditions of temperature, etc., will produce it, is still an open question. Dr. Murchison, one of the greatest authorities on the subject, has adopted the latter view, and has proposed for typhoid fever the name "pythogenic fever" (*i.e.*, filth-produced). Isolated cases of typhoid, occurring where there is no system of drainage, support the same view, as does also the fact that, with the adoption of drainage, the typhoid mortality has steadily diminished. In twenty-one English towns, the average reduction of typhoid mortality after drainage was 45·4 per cent. But if typhoid fever is due to emanations from putrefied excreta, one would expect it to be very common. On the other hand, numerous cases can be quoted to shew that such emanations have been breathed, and sewage-contaminated water drunk, for years, without the production of a single case of typhoid—until a case is accidentally imported. On the whole, the somewhat conflicting evidence supports the view that typhoid fever is most commonly due to a specific cause—*i.e.*, arises from a previous case; though the possibility of its origin without any such specific cause cannot in the present state of our knowledge be denied.

In addition to the diseases already named, the poisons of cholera and yellow fever may exist in sewer air; possibly also

Heck. Pettenkofer Rotters have sought in vain for comp.n of Am. S &c in air of churchyds. Must have been neglig.t burial if impurs in air

Brick burng in open clamps shd be prohibd. Kiln-burng substd. Also prev.n screening of dust to be enforced. Often what can't be burnt in the brick is burnt separ.s in the brick-yard

those of small-pox, scarlet fever, etc., as well as of dysentery and diarrhœa.

(5) **Effluvia from Decomposing Organic Matter.**—(*a*) **The air of marshes** contains an excess of carbonic acid, marsh gas, etc., in addition to other organic matters. Intermittent and remittent fevers are due to the inhalation of the marsh effluvia under certain conditions. Some forms of diarrhœa and dysentery have been ascribed, with a less degree of certainty, to the same cause. In this case, as in that of emanations from other organic sources, the impurities received by the air are both gaseous and particular.

(*b*) **The Air of Graveyards** has occasionally produced disease. In other instances where no actual disease has resulted, it has been found that in the neighbourhood of thickly crowded graveyards, the sick-rate and death-rate have been increased.

(*c*) **The Effluvia from Decomposing Carcases,** especially of horses on the battle-field, have led to outbreaks of diarrhœa and dysentery among the soldiers.

(*d*) **The Effluvia from Manure and Similar Manufactories** do not seem to injure the workmen as a rule, but attacks of diarrhœa have been produced in the neighbourhood when the wind has wafted the effluvia towards any particular part.

(6) **The Effluvia from Certain Manufacturing Processes** seem to be rather nuisances than actually productive of ill health. The vapours given off by *tallow-making* and *bone-burning* processes are most disagreeable, but there is little or no positive evidence of their insalubrity.

The air of *brickfields* and cement works is peculiarly disagreeable, but nothing more than a nuisance has been established in the numerous trials regarding these.

The Degree of Moisture and the Temperature of air are of great importance in relation to health. Air which is unduly moist or dry, hot or cold, may be injurious apart from any foreign matters it contains.

The *relative amount of moisture* is of greater importance than its

actual amount. An atmosphere which contains aqueous vapour up to the point of saturation is very oppressive ; the normal evaporation of insensible perspiration (and with it of the organic impurities removed from the skin) is interfered with ; and consequently the "oppressiveness of the day" is complained of.

It is a common fallacy to suppose that the windows of a room must be kept closed on a wet day, "to prevent the damp getting in." If the temperature of the room is moderately high, there is no fear of making the air damp. Damp air is only dangerous when the point of saturation is nearly reached; and it is in such conditions that rheumatism commonly develops. Washing and drying linen in bed-rooms, which is common among poorer people, is very objectionable because of the damp induced; and for a similar reason the frequent washing of floors, unless there is free ventilation, is not desirable. If the floors are of wood, they may sometimes be stained and varnished ; and in other cases damp may be avoided by choosing a dry day for cleaning, and having free ventilation afterwards.

It is stated that the prevalence of catarrhs in the United States of America (as well as, possibly to some extent, the nasal manner of speech) is largely due to the exceeding *dryness* of the atmosphere. The nasal articulation is, however, chiefly hereditary.

An unduly hot air is generally productive of pallor and ill health, though it is difficult to know how much to ascribe to the high temperature, and how much to the commonly co-existent vitiated atmosphere. The temperature of living-rooms ought not to be over 60° to 65° Fahr., and of bed-rooms not over 60° Fahr.

A hot air is commonly also a dry one ; and the combination is very distressing. This is seen where closed stoves are employed for heating rooms. The discomfort may be removed by having a pail of water standing near the stove.

The devitalising influence of extreme *cold* is well known. Its effects are more particularly seen in young children and the very old. The obituary column of the "Times" is generally crowded

Pettenkofer gives for ? comparn of loss of heat by respiry dry & saturd air : We lose

at 32° & dry .... 1172 cal. units
" 68° " " .... 1096 " "

diff. only 76

at 32° & saturd 1060
" 86° " " 420

diff. 640 cal. units

Thus diffl degs of dry & appard of ten moment than diffce of temp., & consequ our sensns do not alwa coincide w. thermr.
In hot clims & oppressn wd be dird if cd devise some plan of dry? intl air. Thick stone walls help.

Accd to Lehmann's experts, more CO_2 elimd in rabts in v. moist than in a dry atmosph. Malard: dirn req[s] & humidt of air appd. Plague & S. Pox both check[d] by a v. dry air. In the dry Harmattan wind on W. coast Africa, S. Pox cant be inoc?

1 c. ft of air at 70° does not contn as much O as same vol. at 50°; therefr more air reqd to be inhaled at the higher temp[e]

with notices of the deaths of old people, after a few days' severe frost. Dry, cold weather, with the temperature near the freezing point of water, and a cutting east wind prevailing, is not uncommonly described as "bracing." This is so far from being the case, that it requires all the vital powers of the strong and healthy to resist its depressing influence, and the feeble of both extremes of age succumb.

CHAPTER XVII.

THE EXAMINATION OF AIR.

Examination of Impurity by the Senses.—Chemical Examination.—Estimation of Carbonic Acid, etc.—Organic Matter.—Microscopical Examination.—Examination of Moisture and Temperature.

It is important to be able to ascertain the quality of the air in enclosed spaces. There are various methods of doing this, of which not the least useful is the information furnished by the *sense of smell*, on entering a room from the external air. Besides the evidence given by the senses, *chemical* and *microscopical* examination of the air give important information, while the *thermometer* and *hygrometer* ascertain the temperature and degree of moisture.

Examination by the Senses.—One often sees a dull grey haze hanging over a town, when it is viewed from a distance, indicating comparative impurity of its atmosphere, and the presence of a considerable amount of suspended matter.

But the *smell* of a stagnant atmosphere is one of the best guides to its condition. The presence of even a small amount of respiratory products can be thus detected on entering a room from the external air. The sense of smell is extremely delicate; it has been estimated that the $\frac{3}{100,000,000}$ part of a grain of musk can be apprehended by it. But nothing is so soon dulled as the sense of smell. An atmosphere which did not appear to be unpleasant while remaining in a room, is intolerable when one returns to it

after a few minutes in the open air. It is important not to confound the "closeness" perceived by the sense of smell, with the oppression due to the high temperature of a room. The two are easily distinguished by a reference to the thermometer, which ought always to be placed in rooms inhabited during the evening. The remedy for a close room is to allow free entry of fresh air, and *not* allow the fire to go down, as is so commonly done, under the impression that the closeness is due to heat.

Dr. de Chaumont has made many experiments, shewing how accurate is the information given by an acute sense of smell. Carbonic acid is destitute of odour, but as its amount is usually proportionate to that of the organic matter producing closeness, it may be taken as an index of the amount of impurity present in living rooms. Dr. de Chaumont has found that the limit of smell is reached when carbonic acid amounts to 6 parts in 10,000 of air, or half as much again as in the external air. In the following extracts from his experiments, there was a close accordance between the evidence of his sense of smell and the per-centage of carbonic acid :—

At ·1408 *per cent.*	*Extremely close and unpleasant.*	*At* ·0843 *per cent...*	*Not very foul.*
,, ·1090 ,, ...	*Extremely close.*	,, ·0804 ,, ...	*Close.*
,, ·0962 ,, ...	*Very close.*	,, ·0658 ,, ...	*Not very close.*
,, ·0921 ,, ...	*Close.*	,, ·0568 ,, ...	*Not close.*

He also found that humidity of the air had a marked influence in rendering the smell of organic matter perceptible, even more than a rise of temperature. The sense of smell is doubtless aided in detecting impurities in the air, by the *besoin de respirer*, a feeling of oppression caused by the deficiency of interchange between the blood and air.

Chemical Examination.—The estimation of nitrogen and oxygen in air is unnecessary, as these vary little, if at all. The ill effects of an often-breathed atmosphere are not due so much to deficiency

Combust^{n} of gas in room wl prod^{s} a high CO_2 & feel^{g} of closeness but little effect on org^{c} matt^{r}

In case of sick-men, found that more air req^{d} to keep air-space pure to senses than in case of men in health.

State of cleanlin^{s} of pers^{s} in a room influences smell, not p. amt of CO_2. Smell not a reliable guide esp^{y} in hosp^{ls}

x. Oppressn of town air theref. Due to other causes, - as SO_2.

Acc.to Dundee Obsers no constt rel: betw. org: matr & CO_2, unless we take averge of lge no. of Obsers, in wh. case a high CO_2 is usly accomp: by a high org: matr & vice versâ.

of oxygen, as to the addition of carbonic acid and organic matters, rendering difficult the interchange between oxygen and the blood. The amount of oxygen in the streets of large towns is as great as on the hill-tops in country places. Dr. Angus Smith has shewn that the lowering of oxygen in badly-ventilated places only amounts to 0·3 per cent. At the bottom of mines there is a greater diminution of oxygen than in the worst ventilated places, sometimes falling even to 18·27 per cent. (A. Smith).

The Estimation of Carbonic Acid is of great importance, as it is found that, under ordinary circumstances, its amount is an exact indication of the amount of contamination in the air. When the temperature of the air is excessive, however, the carbonic acid increases disproportionately. It has been proved, both by estimation of the organic matter in air and of that dissolved from the air by rain-water, that the amount is proportional to that of the carbonic acid, and that both carbonic acid and organic matter (separated in the form of ammonia) increase with the density of the population of a district.

In estimating the carbonic acid in air, the amount in 1,000 volumes has to be determined. A carefully dried glass vessel capable of holding a gallon, is filled with the air to be examined, which is pumped in by a bellows. 60 cubic centimetres of clear lime-water are then added, and the vessel is closed with an india-rubber cap. It is then well shaken, and afterwards allowed to stand for six or eight hours. The carbonic acid combines with part of the lime to form calcium carbonate; and the lime-water remaining is consequently diminished in alkalinity or causticity. Given the causticity of the lime-water before and after the experiment, and the difference will give the amount of lime which has combined with carbonic acid.

The causticity of the lime is estimated by a standard solution of oxalic acid, the addition of a known amount of which forms a discoverable amount of oxalate of calcium; specimens of lime-water being taken and estimated before and after shaking up with

the given air. The difference between these two shows the number of milligrammes of lime precipitated by the carbonic acid. Multiply the difference by 0·795, and the result is the cubic centimetres of carbonic acid in the quantity of air examined. The factor 0.795 is obtained from the ratio of the equivalents of quick-lime ($CaO = 56$) and carbonic acid ($CO_2 = 44$).

A certain correction must be made for temperature, the standard being 32° Fahr.; also if the place of observation is much above the sea-level, a correction must be made for difference of atmospheric pressure.

Dr. Angus Smith's plan for the estimation of carbonic acid in air is very useful, as not involving skilled manipulations or difficult calculations. It is based on the fact that the amount of carbonic acid in a given volume of air will not render turbid a given amount of lime-water, unless the carbonic acid is in excess.

EASIEST PROPOSED HOUSEHOLD METHOD.

TABLE.—*To be used when the point of observation is "No precipitate."* Half an ounce of lime water containing ·0195 gramme lime.

Air at 0° C. and 760 M. M. Barometric pressure.

CARBONIC ACID IN THE AIR. PER CENT.	VOLUME OF AIR IN CUBIC CENTIMETRES.	SIZE OF BOTTLE IN CUBIC CENTIMETRES.	SIZE OF BOTTLE IN OUNCES AVOIRDUPOIS.
·03	571	584	20·63
·04	428	443	15·60
·05	342	356	12·58
·06	285	299	10·57
·07	245	259	9·13
·08	214	228	8·05
·09	190	204	7·21
·10	171	185	6·54
·11	156	170	6·00
·12	143	157	5·53
·13	132	146	5·15
·14	123	137	4·82
·15	114	128	4·53
·20	86	100	3·52
·25	69	83	2·92
·30	57	71	2·51

1. Pettenkofer's method of estimat^{g} CO_2.
2. D^{r} A Smith's household method.
3. De Saussure's method - weigh^{g} result^{g} $CaCO_3$ or $BaCO_3$.
4. Wanklyn's method - compare turbid^{y} prod^{d} by standd sol^{n} of Na_2CO_3 w. BaH_2O_2, w. that prod^{d} by agiven vol. of air.

See process descr^{d} by Prof. Carnelley & W. Mackie (Proc. Roy. Soc. V. 41 p. 238)
By "org^{c} mat^{r}" is really meant the bleach^{g} act^{n} of the air on a dil. sol^{n} K. Permang acidif^{d} w. H_2SO_4. It therefore includes SH_2, SO_2 &c.
Obsern^{s} at Schools in Dundee shew^{d} that bef. boys stamp^{d}. 10 Bact^{a} & 1 Moulds were found: after stamp^{g} 150 Bact^{a} & 0 moulds.

The foregoing table arranged by Dr. A. Smith, shews how to apply this method. The first and second columns state the ratio of carbonic acid in a quantity of air which will give no turbidity or precipitate in half an ounce of lime water; the third column gives the corresponding size of the bottle in cubic centimetres; and the fourth column gives the same in ounces. Thus different sized bottles, each containing half an ounce of lime water, will indicate with a fair degree of accuracy the ratio of carbonic acid in the air containing them, by giving no precipitate when the bottle is well shaken. For instance, if a pint bottle is used and there is no precipitate with half an ounce of lime water, it indicates that the ratio of carbonic acid does not exceed ·03 per cent.; if an eight ounce bottle be used, and there is no precipitate, it indicates that the ratio does not exceed ·08 per cent., and so on. The air of a room ought never to contain more than six parts of carbonic acid in 10,000 of air, or ·06 per cent., *i.e.*, a $10\frac{1}{2}$ ounce bottle full of the air shaken up with half an ounce of clear lime-water ought to give no precipitate.

The Estimation of Organic Impurities may be accomplished approximately by drawing a definite amount of air by means of an aspirator, through a dilute solution of permanganate of potassium of known strength. The result is stated by giving the number of cubic feet of air required to decolourise ·001 gramme of the permanganate in solution. Sulphuretted hydrogen, sulphurous acid, and other substances in air likewise decolourise the permanganate; these ought to be separately tested for, and allowance made.

The Estimation of Ammonia, whether free or derived from albuminoid impurities, is a matter requiring very delicate processes. It is accomplished in the same way as the estimation of ammonia in water, the air being drawn through perfectly pure distilled water, and then the analysis proceeded with as a water analysis. The mere presence of free ammonia may be determined by exposing to the air strips of filtering paper dipped in Nessler's solution, which become brown if there is any ammonia in the air.

Microscopical Examination is only of use in the detection of suspended matters, but as these are probably the most potent for harm, containing sometimes the germs of dangerous diseases, this method may in the future lead to valuable results. The suspended matters scattered throughout the air may be collected by Pouchet's aeroscope. This consists of a small funnel drawn out to a fine point, under which a slip of glass is placed moistened with glycerine. Both funnel and glass are enclosed in an air-tight chamber, connected by tubing with an aspirator, by means of which when water is allowed to escape from it, air is drawn through the funnel and its particles impinging on the glycerine are there arrested. Glycerine may be objectionable from the foreign particles previously contained in it. Various other plans have been devised, one of which is to draw the air through a small quantity of pure distilled water and then examine a drop of it. The drop of water may have a small quantity of gelatine added to it, and in this condition solidified. The organisms found in water may be grown in this medium and examined at leisure (Koch's gelatine process).

Examination of Temperature and Moisture.—The temperature should be observed at the point most remote from an open fire-place, and compared with the external temperature. If there is a great difference between the two, the probability of draughts is greatly increased.

The moisture may be estimated by various forms of hygrometer; wet and dry bulb thermometers are convenient and reliable. The hair hygrometer gives fairly accurate results.

It may be useful to recapitulate at this point the desiderata in an inhabited room. The temperature should be 60 – 62° Fahr., the amount of carbonic acid should not exceed ·06 per cent., and the humidity should range between 73 and 75 per cent. of the amount required to produce saturation.

For descr^{n}. of Hesse's method of detect^{n} of micro-org^{ms} see Cornil[illegible]'s paper. Phil. Trans^{ns}. Results at Dundee shew^{d} that org^{c} matt^{r} at night was red^{d} to less than $\frac{1}{3}$, micro-org^{ms} to nearly $\frac{1}{10}$ of what they were during day. CO_2 pract^{y} the same. In all respects determ^{ns} for night lower than for day.

Microsc. Exam. 1. in glycerine
2. in H_2O
3. in gelatine

Dry bulb therm^{r} shd read 63–65°F., wet bulb 58–61°F.
Diff^{ce} betw the two shd not be less than 4° or more than 8°F.

CHAPTER XVIII.

THE PURIFICATION OF AIR.

Influence of Plants and of Rain.—Diffusion of Gases.—Thermo-Diffusion.—Interchange owing to Differences of Temperature.—The Two-fold Action of Winds.—Chemical Measures for Purifying Air.

In previous chapters we have discussed the various impurities to which air is subject. It is necessary that these should be removed. In addition to the artificial measures which will be discussed in the next chapter, various natural agencies are constantly at work for this purpose. Of these, the most important are the action of plants, the fall of rain, natural methods of ventilation, and certain natural constituents of the atmosphere.

1. **Plants,** by virtue of the chlorophyl contained in their green parts, absorb carbonic acid from the atmosphere, liberating oxygen in an active condition. In addition, ammonia and nitrous and nitric acids are dissolved from the air by rain-water, and assimilated by plants. During the night plants only give off carbonic acid.

2. **The Fall of Rain** clears the atmosphere of any solid particles contained in it, the impurities being transferred to rain-water, which generally contains an appreciable amount of ammonia as well as other impurities. It is found, however, that when the atmosphere is excessively moist, and especially when its temperature is somewhat high, the amount of organic matter contained in it is increased; while a dry atmosphere, as a rule, contains little organic matter.

3. **Ventilation**—that is, the interchange of pure and impure air, is constantly being effected. Before entering on the details of ventilation, we must consider the *physical causes* at work which tend to purify the air, apart from all artificial contrivances. These are three in number—namely, diffusion, winds, and differences of temperature of masses of air.

(1) **Diffusion** causes the rapid mixture of gases placed together. Every gas diffuses at a certain rate—namely, inversely as the square root of its density. In any room which is not air-tight, diffusion is constantly occurring, air passing in and out at every possible point. Through chinks and openings in the carpentry-work of a room, the air diffuses rapidly. Bricks and stone commonly allow air to pass through them; diffusion occurs to a slight extent even if the wall is plastered, but very little through paper. Yet diffusion alone hardly purifies a room sufficiently under ordinary circumstances; and the organic molecular matter evolved from the skin and lungs, not being gaseous, is unaffected by it. To remove the latter, the room must be periodically flushed with air.

A peculiar form of diffusion has been described by Fedderson of Leipzig, to which it is proposed to give the name of **thermo-diffusion.** It was shewn as the result of careful experiments that when a porous partition separates two columns of air, one warm and the other cold, a passage of air from the cold to the warm side occurs. This form of diffusion is not dependent like the ordinary diffusion on the presence of gases of different density, but occurs when there is the same gas with the same pressure on both sides of the porous partition.

Diffusion sometimes produces evil results, when the sanitary arrangements of a house are bad. If there is a leakage of sewage under the kitchen-floor, the foul gases from it diffuse upwards; occasionally foul air diffuses from the dust-bin through the wall into the rooms of a house. Both these unfortunate results are helped by the fact that the internal temperature of a house is commonly higher than the external.

(2) **Differences of Temperature** cause active movements of air. In fact winds are caused by movements between large masses of air of unequal temperature and consequently of unequal density. Light gases ascend, as familiarly illustrated by the smell of dinner perceived in bedrooms, or the smell of a cigar lit in the hall perceived in the attic. In rooms differences of temperature of the

He who supplies a poor man w. fuel does an unthought of good, in helping vent^{n}. We do not feel the cut^{s} of air when less than 19^{M} per sec^{d} i.e. a little over 1 m. per hr.

air are caused by the heat of fire, gas, and our own bodies. Currents of air result; the warmer and lighter air ascends up the chimney or towards the ceiling, while colder and denser air rushes in under the door or through the floor, etc. The lighter gases carry with them solid particles in suspension and thus tend to remove the most important respiratory and other impurities. As a rule in this country the external temperature is lower than the internal, but occasionally in summer the opposite condition occurs. Assuming that the external air is colder, if admitted into the lower part of a room, it produces a draught; if admitted at the top of a room, being heavier, it falls by its own weight on the heads of those in the room. The problem of ventilation is to secure a sufficient interchange of air without the production of perceptible currents.

Movements of air are constantly occurring, so long as the temperature of the air is subject to changes. This cause alone will suffice to ventilate all rooms in which the air is hotter than the external air. It may thus happen that a room with windows and doors closed in winter, may possess purer air than the same room in summer with these thrown widely open. The value of diffusion of air through the walls, and the influence of temperature on this diffusion are well illustrated by some experiments of Pettenkofer. When the difference between the outside and inside temperatures was 34° Fahr. (66° inside and 32° outside), and the doors and windows were shut, an ordinary room in his house, of the capacity of 2,650 cubic feet, which was built of brick, and furnished with a German stove instead of an open fire-place, had its entire atmosphere changed once in an hour. With the same difference of temperature, but with the addition of a good fire in the stove, the change of air rose to 3,320 cubic feet per hour. On lessening the difference between the external and internal temperature to 7° Fahr. (64° and 71°), the change of air was reduced to only 780 cubic feet per hour. In these experiments, all crevices and openings in doors and windows

were pasted up. It is instructive to note the proportionate amount of ventilation effected through the walls and by the draught of the stove. In the first experiment, the ventilation due to diffusion and difference of temperature equalled 2,650 cubic feet of air; that due to the draught of the stove 670 cubic feet of air.

The amount of ventilation through walls varies with the material of which they are built. Mortar is exceedingly porous when dry; sandstones and bricks are easily permeated by both water and air. Limestone is almost impervious to air, but requires much mortar in building, which effects a partial compensation.

The rise of temperature caused by the bodily heat and by the combustion of illuminating agents, is well shown by some figures of Dr. Angus Smith. He found that the rise of temperature of 170 cubic feet of air in one hour, by the bodily heat of one man was 5°·6 Fahr.; by the combustion of a candle 3°·8 Fahr. Thus, in a room 8 feet high, 4 feet broad, and 6 feet long, a man burning a candle would in an hour raise the temperature from 60° to 70° Fahr. This rise in temperature would not only cause currents of hot air towards the upper part of the room, but would probably make the room uncomfortable, and so lead to the opening of a door, etc.

(3) **Winds** are of great value in flushing rooms with fresh air. This ought to be done as often as possible, by throwing windows widely open; without, however, taking the place of constant ventilation in the intervals. It is especially valuable in getting rid of organic matters which are unaffected by diffusion.

The chief objections to winds as ventilating agents are that—first, the air may be stagnant, a condition which is rare in this country; and second, the movement of winds is uncertain and difficult to regulate. Thus, when the velocity is five or six feet per second, unless the air is warm, it becomes uncomfortable, and is consequently excluded.

The wind will pass through wood, and even brick and stone walls. When it is allowed to pass directly through a room, as

Air of room can't be changed more than 3 or 4 times an hr. with[t] prod.[s] draught.

Suppos^{g}. mean meas^{t}. $6\frac{1}{2}$' by $1\frac{1}{2}$' or 9 sq. ft. × this by aver. vel^{y} of air, say 10 ft per sec. (abt 7 mrs an hr); then 90 c. ft in 1 sec, & in 1 hr 324 000 c. ft of air flow over one person in the open. Assum^{g}. 3000 c. ft as am^{t} allow^{d} of space in room, this req^{s} abt $\frac{1}{100}$ of open allow^{e}

× Any vel^{y} betw. 40 & 70 miles is called a gale, over this a storm or hurricane. Casella's & Robinson's anem^{rs} most used.

from window to door, it produces a more powerful effect than can be produced in any other way. Thus, air moving at the rate of two miles an hour, and therefore hardly perceptible, if allowed to pass freely through a space 20 feet wide, changes the air of the space 528 times in one hour (Parkes).

The average rate of movement of winds in this country is seven to eight miles, or about 40,000 feet, per hour; at this rate of movement, the amount and rapidity of purification would be much greater.

Winds act as a ventilating agent in two ways—**directly by perflation,** driving impure air before them, or freely mixing with it; and **indirectly by aspiration,** drawing the impure air along with them. In the last case, the wind causes a partial vacuum on each side of its path, towards which all the air in its vicinity flows. Thus, the wind blowing over the top of a chimney causes a current at right angles to itself up the chimney. In a spray-producing apparatus we have a common instance of the same principle, the current of air or steam along the horizontal tube causing the fluid to rise in the vertical tube till it is scattered in spray. In Sylvester's plan of ventilation, both these forces are used (see *page 192*).

4. **Certain Constituents of the Atmosphere** have an important purifying effect. Of these oxygen is by far the most important. By its means organic impurities become oxidised, and thus rendered harmless. It is probable that much of this oxidation is effected by means of ozone—a peculiarly active and concentrated form of oxygen. A large part of this ozone is probably produced during thunder-storms and similar electrical disturbances of the atmosphere. The ammonia and organic impurities in air become changed into nitrites and nitrates—chiefly of ammonium—and then being washed down by rain, form an important part of the food of plants.

5. **Chemical Measures** are occasionally used for the purification of the atmosphere, and it will be convenient to enumerate them here, although they are chiefly artificial appliances. The chemical

action of ozone has been already mentioned. Many of the disinfectants in common use act by oxidising noxious matters. Thus chlorine attacks and combines with the hydrogen of any water present, and the nascent and active oxygen liberated, oxidises organic matter. Sulphurous acid, on the other hand, acts by deoxidising.

The chief disinfectants and deodorants used for the atmosphere are as follows:—among *solids*, charcoal, quicklime, dried earth, carbolic powders, and a mixture of lime and coal-tar; among *liquids*, Condy's fluid, carbolic acid, solution of chloride of zinc, terebene, sanitas, etc.; among *gaseous* disinfectants, ozone, chlorine, nitrous acid, sulphurous acid, the vapours of vinegar or carbolic acid, etc.

CHAPTER XIX.

GENERAL PRINCIPLES OF VENTILATION.

The Standard of Purity of Air.—Amount of Air Required.—Estimation by Experience, and from Physiological Data.—Cubic Space required.—Relation of this to Ventilation.—Fallacies in connection with Cubic Space.—Rules respecting Ventilation.—Inlet and Outlet.—Result of Division of Current of Air.

The Amount of Air Required.—Ventilation is chiefly concerned with the removal of the products of respiration, just as sewage is chiefly concerned with the removal of the solid and liquid excreta.

In a less degree it is required for removing the impurities produced by the burning of gas, candles, and lamps. The main problem however is the removal of the respiratory products.

The amount of carbonic acid in air is fairly proportional to that of the other respiratory products. It may therefore be taken as a measure of the impurity of the air.

The **Standard of purity** is somewhat difficult to fix. The external air ought only to contain 4 parts of carbonic acid in 10,000 parts; but it is almost impossible to maintain this degree of purity in

Acc. to Prof. Carnelley &c (Dundee) limits of impurity are

	Total	Excess over outside air
CO_2	for dwellings 10 vols. per 10000	6 vols. per 10000
	for schools 13 " " "	9 " " "
Org. matter	. . . . .	2.0 vols. O per 1000,000
Total micro-organisms	. . . . .	20 per litre

(Org. matter is represented by vols of O required to oxidise the oxidisable org. matter in 1000000 vols air. Micro-organisms by the no per litre of air).

× Lond. Sch - Bd req^{s} 130 c. ft per scholar
Priv Council " 80 " " " (15 sq. ft flor).
Com^{rs} Lodg^{g} Houses ~~240~~ 200 c. ft per head.
Poor-law for healthy pers^{s} 300 " " "
" " " sick 850-1200 " "
Barracks 600 " "

Lond. M. Off req^{s} for rooms occup^{d} nt & day 350 " "
By nt or day only 300 " "
Workhouse hosp^{ls} 850 " "
Hospitals 1000-1500 " "
Prisons 800

In the Workhse 300 c ft stat^{d} that must not be more than 2 rows of beds, height above 12' not to be reck^{d}. This gives a minim. flor-space of 25' per occup^{t} or w. dormit^{s} 17' wide. a bed. space of abt 3'

In Hosp^{ls} shd be a bed-space of 7½', thus giv^{g} 90 sq. ft per bed. In St Thos's it is 112 sq. ft. More than 90 sq. ft req^{d} - if a med^{l} school.

× In Canad^{n} schools 240 c ft per scholar suffic^{t} (W)

Flor space per bed - St Georges 70 sq. ft
Herbert (Chatham) 99 " "
Netley 103 "
St Thos Hosp^{l} 112 sq. ft
Guys " 138 " "
New Hotel Dieu 102-110 " "
Fever Hosp^{ls} 150 - 300 sq. ft

inhabited rooms. The experiments made by Drs. Parkes and de Chaumont shew that when the carbonic acid is ·06 per cent., or in the proportion of 6 parts in 10,000 of air, the air begins to be perceptibly stuffy; this may therefore be taken as the limit of impurity. Pettenkofer has adopted the limit of ·07 per cent.

The problem then is to discover the amount of pure external air (containing ·04 per cent. of carbonic acid) that will be required to pass hourly through a room, for every person in that room, in order to keep the carbonic acid at the ratio of ·06 per cent.

This may be ascertained by actual observation of the air of rooms in which a given number of persons are placed; or by calculations from physiological data.

As *the result of numerous experiments* on the atmosphere of prisons, barracks, etc., where the amount of fresh air supplied per hour is exactly known, it is found that in order to keep the carbonic acid at ·06 per cent., 3,000 cubic feet of pure air are required per head per hour; 2,000 cubic feet keep the carbonic acid at ·07 per cent.; 1,500 cubic feet at ·08 per cent., and 1,200 cubic feet at ·09 per cent.

For the removal of the products of combustion of gas, an additional supply of air is required. A common gas-burner consumes nearly 3 cubic feet of gas per hour, and produces 6 cubic feet of carbonic acid. Thus, from 18,000 to 21,600 cubic feet of air must be introduced into a room, during an evening of about four hours, to maintain the carbonic acid from this source at the proper amount.

Where a number of sick persons are collected, as in hospitals and workhouses, a much freer supply of air is required. Much depends, however, on the cleanliness of the wards, and on whether the ventilation is constant in character. In St. Thomas's Hospital, the space allotted to each ordinary patient is 1,800 cubic feet, and to each patient in the fever wards 2,500 cubic feet. Thus, by changing the air of the wards twice in the hour, an abundant supply of fresh air is ensured. The mortality after operations,

and in all fevers, is much diminished by a free supply of air; and, as a rule, fever cases are better treated in temporary buildings, in which every part is freely exposed to air.

Soldiers are allowed 600 cubic feet of space per head in their sleeping rooms, which involves a change of the air five times per hour, in order that the carbonic acid may be maintained at ·06 per cent. The limit of overcrowding for lodging-houses is officially fixed at 300 cubic feet, but this is much too small.

The amount of pure air required in order to keep the carbonic acid in a room at ·06 per cent., may also be ascertained from *physiological data.*

It is found that the smallest amount of food capable of maintaining life for a day, contains 18 to 19 grains of carbon for each pound weight of the body. This, when oxidised, is equivalent to 150 cubic inches of carbonic acid; so that a man of 126 pounds (9 stones) weight produces daily 11 cubic feet of carbonic acid. This is the amount during absolute rest. We must allow one-half more to obtain a fair average, which gives 225 cubic inches per pound weight of body, or a total of 16 to 17 cubic feet for 9-stone weight (De Chaumont). The accuracy of this estimate has been confirmed by Pettenkofer, who found that, with gentle exertion during the day and rest at night, the amount of carbonic acid given off was 232 cubic inches per pound—that is, about 17 cubic feet per day for a weight of 9 stone, or $\frac{7}{10}$ of a cubic foot every hour. Assuming these figures to be correct, as each person expires ·7 cubic foot of carbonic acid per hour—*i.e.*, $3\frac{1}{2} \times \cdot 2$ cubic feet—and the proportion must not be increased beyond ·6 per 1,000 or ·2 per 1,000 more than it is in the external air, it follows that the expired air must be diluted with $3\frac{1}{2} \times 1{,}000$ or 3,500 cubic feet of pure air per hour.

Relation of Air Required to Cubic Space of Room.—If we accept 3,000 cubic feet of air as the amount required per head per hour, it is evident that this may be furnished by having a large room with comparatively little circulation of air, or having a small room with

Amt req^d for pers^l at work. – Men at work give off from .0060 to .0115 c ft CO_2 per lb wt of body per hr, acc. to hard^s of work. Thus a man weighing 150 lbs wt req^s 4500 to 8600 c ft fresh air per hr. Has been noticed that in mines 6000 c ft req^d per hr & that w 3000 to 4000 a serious fall^g off in work done (W)

Chem^l Ex^n respir^n in Horse dur^g rest & work (J. of Phys^l vol 40. Nos 1 & 2)

Mean of 18 exper^ts – 67.5 c ft air exp^d per hr, 1.7 c ft O absorb^d & 1.2 c ft CO_2 exhaled when horses at rest (coldest am^t was .39 c ft & Goat 2.24 c ft per hr – vary^g w. size of horse &c)
Results also given for walking, trotting &c.

$\frac{1}{2}$ g H_2O for ea^h 1 lb wt of body.

14.4 c.ft CO_2 given on p. 147.

Ea^h man gives off per hr enough H_2O to raise moist^e of air f. 70 o/o to satur^n in 500 c ft at 60° F, & to raise it to 82 p.c. at in 1500 c. ft. For ea^h 1% amt to 73 o/o wd take 3000 c ft of air satur^d at 50°. But humid^y also f. lights, vapour of leg^d in room &c.

In req^d to vent^e exp^ce of hosp^ls, "nothing less than too much is enough"

Find rate of movt of air into room 500 c. ft, inlet open^g being 12 sq in.

$$\frac{12}{144} \times x \times 60^{\times 60} = 3000$$

$$x = \frac{3000 \times 144}{60 \times 12 \times 60} = 10$$

Given rate of movt 10' per sec. to find amt of entering air per hr.

$$10 \times \frac{12}{144} \times 60 \times 60 = 3000$$

Practly less than 3000 c. ft per hr necessy, bec. of CO_2 disappg in plastering; open windows act on subsequent cmdn of air; passage of air thro crevices, walls &c.

frequent interchanges. Thus, supposing the cubic space allowed to each individual is 1,000 cubic feet—that is, 10 feet in every direction—the atmosphere will require changing three times per hour.

Now, it is found that when a current of air, at the temperature of 55°–60° Fahr., is moving at the rate of less than one mile per hour, it is not perceptible—that is, produces no draught. The rate of a breeze, which is just perceptible, is 18 inches per second, or one mile per hour. As draughts are objectionable, ventilation, in the best sense of the word, means the supplying of abundant fresh air at a rate of less than one mile per hour. Air moving at the rate of $2\frac{1}{2}$ miles per hour, or $3\frac{1}{2}$ feet per second, is perceived as a slight draught by all, at the average temperature of our climate (about 50° Fahr.)

Where natural ventilation is employed (*see next chapter*), the difficulties of thoroughly ventilating a small space, without draught, are very great. Thus, suppose a room of 500 cubic feet dimensions to be occupied by a man, who would require 3,000 cubic feet of air per hour. If the inlet opening is 12 square inches, the rate of movement would be 10 feet per second, or nearly 7 miles per hour; if twice this size, the rate of movement would be 5 feet per second. In either case, a decided draught would be perceived. But if the room were twice this size, the individual would be further away from the ventilating opening, and the current of air would be less felt and more thoroughly broken up.

In barracks, where 600 cubic feet are allowed per head, a change of air five times is required to supply 3,000 cubic feet of air per hour; but this makes the rooms cold and draughty (Parkes). A change of air three or four times in an hour is all that can be borne under ordinary conditions in this country, and this necessitates a supply of 1,000 or 750 cubic feet of space respectively for each individual. And a change of this frequency is commonly not effected; the ventilating apparatus may fail temporarily, or may be wilfully stopped up, or there may be no means of ventilation; it is essential therefore to have as large a cubic space as possible. However, it

must be distinctly understood that if one had to choose between a room of small dimensions, but well ventilated and without draught, on the one hand, and a large room with no means of ventilation on the other, the former would be preferable.

(1) In relation to the cubic space of a room, it is most important to note that *a lofty ceiling does not compensate for deficiencies in floor-space.* One hears, "lofty" and "airy" rooms spoken of as though the two terms were necessarily synonymous. This is by no means the case. The impurities produced by respiration tend to accumulate about the persons who have evolved them, although it is true that in rooms heated by gas-light, a large amount of hot and impure air collects near the ceiling. The necessity of an abundant floor-space, is shewn by the fact that a space enclosed by four high walls and without a roof, would, if crowded speedily become offensive; and persons in a crowd in the open air have been known to be suffocated. Twelve feet is quite high enough for ordinary rooms, though of course there is no objection to a greater height, if it is remembered that in reckoning the *practical* cubic dimensions of a room, the height should only be reckoned as twelve feet. Supposing 500 cubic feet is the amount allowed per individual, then the floor-space should be forty-two square feet, which would be furnished by a room about $8\frac{1}{2}$ feet long and $5\frac{1}{2}$ feet wide. In barracks, soldiers are allowed fifty square feet of floor-space. In school-rooms the Privy Council require that eighty cubic feet should be allowed for each child in average attendance, and at least fifteen square feet of floor-space.

(2) Another error commonly entertained is that a large room compensates for a deficient circulation of air. *The cubic space of a room is really of less importance than the capacity for frequent interchanges of air.* Even the largest enclosed space can only supply air for a limited period, after which the same amount of fresh air must be supplied, whether the space be small or large. Thus, supposing that as large a space as 10,000 cubic feet per head were allowed, the limit of purity would be reached in three hours, and after that

Lofty room w. spaces above wind^{s} allows emanⁿˢ to become stagnant & cool, & then fall to floor.

Anim. matᵉʳˢ &c do not diffuse to floor where people are

Larger room prest^{s} the advant^{e}. Air changed w. more comf^{t} than in sm room, & more wind^{s} & less wall surf^{e}.

The Lyc room has the advantge in
1. initl time reqd. to pollute the air.
2. less draughts.
3. nisens. ventn fr. Lyc wall surfce than wind.

Entg air may be cooled in summr
1. by passg over ice – v. expensive.
2. by utilg undergr temple.
3. by using compresd. air.

Ill effects of draughts probly often than those due to defict ventn (Camelley)
Feeling of draught v. often due to radiatn fr window: if curtain draws across window it disapps

time an hourly supply of 3,000 cubic feet of air would be just as necessary as if the space were only 200 cubic feet. Or if 2,500 cubic feet of space be allowed per head, this would be rendered impure in less than one hour, and then a constant interchange at the rate of 3,000 cubic feet per hour would be necessary.

(3) A third fact commonly overlooked, is that the *furniture in a room* must be deducted from the breathing space, as the amount of air is diminished by the space occupied by the furniture. About 10 cubic feet ought to be allowed for each bed, and 3 to 5 cubic feet for each individual in a room; projecting surfaces must be allowed for by subtraction, and recesses by addition. The deductions to be made for furniture are not of any great consequence, if there is a free interchange of air; as the cubic space is of much less importance than free ventilation.

General Rules respecting Ventilation.—The two great objects in ventilating being to remove all impurities from the air, and to avoid draughts, it is important that—

1. *The entering air should be, if possible, of a temperature of about 60° Fahr.* Whenever the temperature of a room differs from the external temperature by 10° Fahr., a draught is certain to ensue. It is impossible at all times to ensure the incoming air being of the temperature of 60°, without some artificial means of warming it.

2. *The entering air should be pure.* When a room is hotter than the passages and kitchens, air from the latter, whatever may be its character, is drawn into the room. Similarly the ground-air under the kitchen-floor may be drawn into the house, and the air from dust-bins, when no other means of ventilation are provided; and this is often followed by dire results.

3. *No draught or current should be perceptible* from the in-coming air, except when it is wished to flush the room with air, by opening the windows wide. It is a common complaint that a room is draughty, and to remedy this keyholes are stopped up, and mats are placed at the bottom of the door, etc. The draught can

often be remedied by increasing the size and number of the openings through which air is admitted, so that the current of air is not so concentrated and rapid. Where this does not remedy it, the in-coming air should be warmed.

4. *The entry of air should be constant not intermittent.* The occasional opening of a window or door will not compensate for the lack of a constant interchange of air, although it forms a very valuable adjunct, especially in the removal of certain organic matters which do not follow the law of diffusion.

5. *An exit should be provided for impure air*, as well as an entrance for pure air. The chimney furnishes this in most living-rooms, and diminishes the necessity for some other means of exit.

Dr. de Chaumont has shewn that if the openings in a room for entrance and exit are properly regulated, a rate of 5 feet per second (~~rather over 5 miles~~ about 3½ miles per hour) will provide sufficient air without any unpleasant draught in a room. For instance, if the opening measure 1 square foot, then a rate of 5 feet per second would give 5 cubic feet of air per second, that is, 18,000 cubic feet per hour. But as only 3,000 cubic feet are required, it follows that an opening one-sixth this size, *i.e.*, 24 square inches, is sufficient for each individual. Reckoning the same amount for means of exit, 48 square inches is the size of the ventilating orifices required by each individual.

6. *A number of small divided openings are not collectively equal in ventilating power to one large one having the same area.* Thus, when a ventilating orifice is divided into four parts, which have the same collective area as the original orifice, it is found that only half as much air passes through these as through the original orifice. In order to obtain as much air, therefore, each opening must be equal in size to half the original opening. When the size of the apertures is still further diminished, the diminution in the current through each one is still greater.

7. It will be useful in concluding this chapter, to re-state the most important requirements of perfect ventilation.

The wider a stream the less rapid its flow.

24 sq. in = $\frac{1}{6}$ sq. ft. If rate of 5' per sec., then in 1 sec. $\frac{5}{6}$' air enters, in 1 min. 50 c ft, in 1 hr 3000 c. ft.

Relat^e vent.^g capac.^y of open^gs. is in prop^n to sq. roots of their areas.

Dr. Richardson req^s the staircase as the principal art^t of a house, & a plentiful supply of warm^d air to it, wd solve the quest^n

1st. The maximum impurity of air vitiated by respiration should not exceed 6 parts carbonic acid per 10,000 volumes.

2nd. To ensure the maintenance of this standard, 3,000 cubic feet of pure air must be supplied per head per hour.

3rd. In order to supply this amount of pure air, with ordinary means of ventilation, 1,000 cubic feet at least must be allowed per head in buildings always occupied.

CHAPTER XX.

METHODS OF VENTILATION.

Flushing Rooms.—Lying Fallow.—Inlets and Outlets.—Natural Ventilation by the Window, Chimney, Ceiling, Wall, Door, and Floor.—Artificial Ventilation.—Aspiration and Propulsion.—Relative Value of Natural and Artificial Ventilation.—Obstructions to Ventilation.—Ventilation of Upper Stories.

In most houses no means of ventilation are provided, the supply of fresh air being left to circumstances or never thought of. Fortunately, the wood-work of houses is, as a rule, not well put together, and the walls are somewhat porous; in these ways, a certain amount of air manages to get into the room. In order to ensure perfect ventilation, however, ventilators should be provided for a house at the time it is built, with as much care and forethought as is incurred in the laying on of a water-supply.

Whatever the system of ventilation adopted, it is always wise to *flush rooms frequently with fresh air.* This is best effected by throwing the windows wide open whenever a room is left unoccupied. In this way a much more thorough and complete purification is effected than by any other means. This is especially important in the case of bed-rooms, in which organic impurities are most prone to accumulate.

Not only should rooms be ventilated, but likewise *the furniture* they contain. This, again, is most important for bed-rooms. Beds

should not be "made" till some time after using; and in the interval, should be freely exposed to the air. The same applies to night apparel. It is a good plan also where feasible, to distribute the day apparel on different chairs in a dressing-room, in order that it may be freely exposed to the air during the night.

It is well to allow *rooms to lie fallow* at intervals. Organic matter accumulates about a room, and devitalises any air which enters. If the room is vacated, and flushed with air for a continuous period, it becomes sweeter and purer. The importance of this is now well recognised in the case of hospital wards, and is frequently acted on.

An Inlet and Outlet for air should both be provided. According to some an inlet only is required, while others would only provide an outlet; but a perfect system of ventilation requires both. *The relative size* of inlets and outlets has been the subject of much discussion. As heated air expands, the outlets should theoretically be larger than the inlets; but as the average difference of temperature is only 10—15° Fahr., the expansion is only slight, and may be practically neglected.

Inlets should bring air from a pure source. They should not be large and single, but rather small and numerous, so that the air may be equally distributed. Externally, inlets should be protected from the wind; and the shorter the inlet tubes the better, as thus a current is ensured, and they can be easily cleaned. The position of inlets should not be too near the outlets, otherwise the fresh air may escape immediately. The best position for inlets is at the floor, but this necessitates warming the entering air, as otherwise it would be intolerable, except in summer time. If the air cannot be warmed, it should be admitted from seven to ten feet above the floor, and directed upwards.

According to Parkes, it is desirable that each individual inlet should not be larger than 48 to 60 square inches in area—that is enough for two men or a little more; and that each outlet should not be larger than one square foot, or enough for six men.

Inlets often bec. contact + v. v. - thus lights of fire may upset equilibrium
Even arang^t for carry^g off prod^ts of combust^n of gas often fail f. act^n of fire.
Staircase acts as exh^t exhaust^g shaft conn^g every apart^t into an inlet (W)

Place a short piece of light^d candle in bot^m of a bottle
CO_2 will soon near^g just out the light. If at this point a
partit^n is insert^d in neck of bottle, smoke will be seen
stream^g out on one side, light will soon burn as brightly as
ever - Such an arang^t in hses also fd closed in cold
weather.

Long channels for inlets collect dirt & harbour insects.
If staircase an inlet, shd be shut off f. base^t supplied w.
fresh air. At London fog rarely percept^e higher than 100',
conseq^y purest inlet wd be by a shaft or tower.

The gtr the diffe betwn. temp. of intd ext air, & the more econom: are extract: shafts

Many unaccountable smells in hses account? for. by their being nearly hermet? sealed. Thus smell of cook? f. kitchen not to be removed by provid? elabrate doors, but by provid? free inlet vent?s to kitchen
Kitchen chimney gen? the least in use.
Ow? to chimney draught any other inlet in room will be an inlet
Many complts of bad smells expl? by this. Sinks & discon? syst
bad smells by air enter? thro. the discon? pipes (Soap soon bec? offensive).

Assumed in nat? vent? tht ext air colder than int?

In 1851 window tax was abol?. after hav? deprived millns of their fair share of sunlight & air for over 150 yrs.

Outlets, under ordinary circumstances, are best placed near the ceiling. They should be enclosed as far as possible within walls, so as to prevent the out-going air being cooled; and should have smooth walls, reducing friction to a minimum. Where artificial warmth increases the temperature of the air, the discharge of outlets is much more certain and constant. The chimney with an open fire forms one of the best outlets. Gas, again, may be made to heat an outlet tube, which carries off the products of combustion.

Two forms of ventilation are usually described—natural and artificial. The former term is used to describe any plan not requiring an apparatus which involves trouble or expense in its working, while the latter implies the use of some special and commonly expensive apparatus. It is obvious, however, that there is no sharp line of demarcation between the two. A lighted fire is strictly an artificial plan of ventilation, involving some expense, but inasmuch as no apparatus intended for ventilating purposes is required, it is hardly a means of artificial ventilation.

NATURAL VENTILATION.—All the parts of a room may serve as means of natural ventilation. The most important of these are, however, the window and the chimney.

The Window is perhaps the most important agent in purifying a room—both the light and air it admits being essential for health. Unfortunately, the window can be least used in winter, when the need for it to be open for purifying purposes is perhaps greatest. The window is invaluable (1) **for flushing the room** with fresh air at intervals. Where possible, opposite windows should be opened, or window and door.

(2) **The Upper Segment** of a window may be made to work on a hinge, and turned so that the current of air may be upwards. Where this plan is adopted, it is wise to have triangular pieces of glass at the two sides, preventing the cold air falling immediately.

(3) **A Block of Wood**, two or three inches wide, may be inserted at the bottom of the window sash at A (*Fig. 15*), and then the window pulled down on this. The consequence is that air is admitted

between the two sashes at B, its current being necessarily directed upwards (*Fig. 15*). This plan answers admirably in admitting pure air; but it possesses a disadvantage common to all the plans in which external air much colder than the internal is admitted into a room. The current of cold air passes upwards for some distance, and then falls down with an increasing rapidity on the heads of those occupying the room; thus producing an uncomfortable draught.

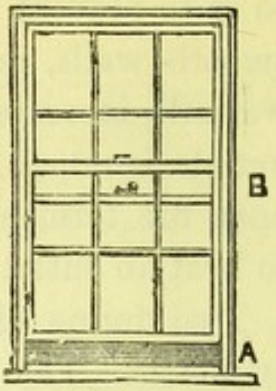


FIG 15.
WINDOW VENTILATION.

(4) The top sash of the window may be opened, and some **zinc gauze** fastened across the open part. This is practically the same as the last arrangement, with the additional advantage of the admission of some air through the zinc. It must be remembered that the admission of air through a number of minute apertures like this is much smaller than through the same area in one continuous piece.

(5) In **Louvre Ventilators,** a number of parallel pieces of glass, each of which is directed upwards, are substituted for a pane of glass. They may be fixed or made movable, as in Moore's ventilator. The incoming current of air may be directed upwards, in the case of an open window, by arranging Venetian blinds with the laths inclined upwards.

(6) In windows that will not open, **Cooper's Ventilators** are useful. Each of these consists of a circular disc of glass, having five oval apertures in it, which works on a pivot through its centre, close in front of one of the panes of a window, which has five similar holes pierced in it. Consequently, when the disc is turned, so that its holes are opposite those of the window, fresh air is admitted.

The Chimney forms the best means of escape of foul air, and no room ought to be built without a chimney. In bedrooms they form a most important means of ventilation, when they are not boarded up. If there is no fire, chimneys may occasionally provide an inlet of air; but as a rule the current in them is upwards, owing to the aspirating action of winds at the

may also cure smoky chimn. by red^{g} its area, thus dim^{h} vol. of air req^{d} to fill it.

Smoky chimn. due to 1). insuff^{t} inlet for air
2). cont^{y} of higher bdgs.
3). too ge area of chimney.

Chimneys shd be built inside the hse, not agst an ext^{l} wall.

If throat of chimn. v. wide, quant^{y} air to smoke pass^{g} up wl be more than the chimn. can accomod^{e} at its narrowest pt, where the vent^{r} is placed, & conseq^{y} smoke wl pass into room thro. valve
The throat of chimn. betw. valve & firepl. shd be contd. so as to leave a val^{e} in ~~of~~ draught to be supplied by air pass^{g} thro. the valve.

No. of c. ft of air capt of pass^{g} thro. a Boyle's vent^{r} is limd, tit is therefr. not adapt^{d} as the only outlet for a room cont^{g} several people (Galton). Also it tends to black the ceil^{g} & wall.

top of the chimney. The downfall of air from a chimney chiefly occurs when there is an insufficient inlet for pure air. This is the explanation of **smoky chimneys** in nine cases out of ten; then the cure is easy by laying on a pipe from the outside of the house to the hearth. When the smoky chimney is due to the contiguity of higher buildings, the chimney must be raised, or a cowl placed over it. Cowls may be either lobster-backed, turning with the wind, or fixed, the latter being preferable, because they are not liable to corrosion & thus cease their action.

(1) The action of the chimney in carrying impure air away from the room may be considerably increased by **narrowing the two ends**, so as to produce a more rapid current at the entrance and exit of air.

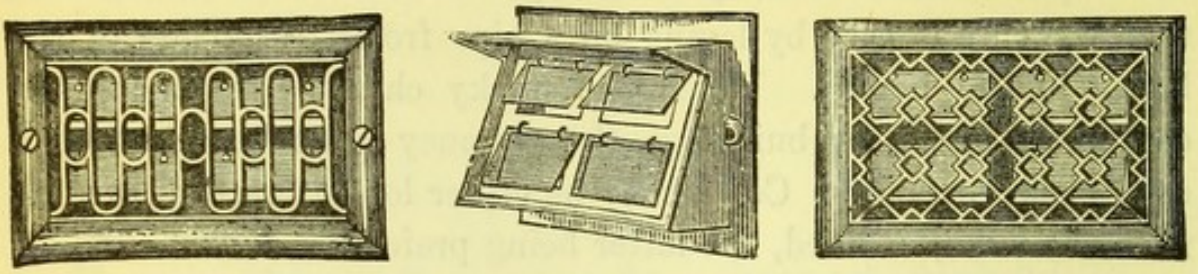
(2) The heat of the chimney may be utilised by having a **separate smaller flue** alongside it, which communicates with the rooms on each floor. The air in this being heated aspirates the air from each room in succession.

Openings may be made into the chimney-flue at a higher point than the fire-place. These are very valuable for carrying off the heated and impure air resulting from the combustion of gas, as well as for carrying off the respiratory products, which, in their warmed condition, tend to rise towards the ceiling.

(3) **Dr. Neil Arnott** first devised a valve for this purpose. An opening being made through the upper part of the wall into the chimney, an iron box was inserted, in which was placed a light metal valve capable of swinging towards the chimney flue, but not towards the room. The objections to this apparatus are that it is apt to make irregular clicking noises, and to admit blacks from the chimney when out of order.

(3) In **Boyle's Valve** these objections are partially obviated. It consists of an iron frame, across which lie iron rods; and from these are suspended thin talc plates, only capable of moving in the direction of the chimney (*Fig. 16*). Even this apparatus is rather noisy when there is a strong wind.

Neither of these plans answers so well as a second flue alongside the chimney flue, communicating with each room near its



VIEW FROM ROOM. VIEW FROM CHIMNEY. VIEW FROM ROOM.

FIG. 16.—BOYLE'S MICA FLAP VENTILATOR.

ceiling; but the latter can only be arranged for when the house is built, while the valves may be inserted at any time.

The Ceiling may be utilised for removing foul air; and thus serve to diminish the draught which is often produced by the currents of air towards the chimney, when this forms the only means of outlet.

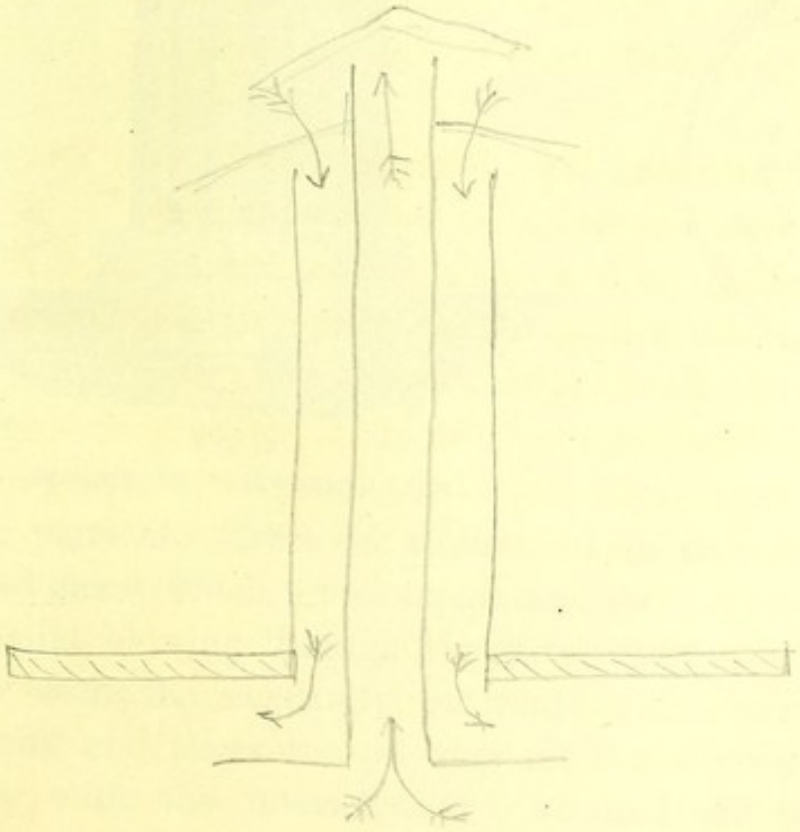
In large rooms, (1) a **sunlight** forms an important means of ventilating. It causes considerable draught, however, from every part of the room.

(2) **Benham's Ventilating Gas Burners**, which carry away the products of combustion, are useful for the same purpose.

(3) A porous ceiling, with a grating or perforated brick in the outer wall between the ceiling of the room and the flooring of the room above, is adopted in some cases.

(4) **McKinnell's Ventilator** consists of two tubes encircling one another, the inner forming an outlet tube, because the casing of the outer tube maintains the temperature of the air in it. It is made higher than the outer tube, and is protected by a hood. The outer tube forms the inlet for fresh air. The entering air is thrown up towards the ceiling and then to the walls by a flange placed at the bottom of the inner tube. The air after traversing the room, and becoming heated, passes upwards to the inner tube. When doors and windows are open, both tubes become outlets;

In lge bdgs tubes may be arang^d to carry prod^ts of combust^n of each gas burner into this shaft & thus incr^s the up-draught



Railway lamps are constructed on this principle

if there is a fire in the room, they may both become inlets; but this may be prevented by closing the outlet tube.

(5) One of the best outlet ventilators is furnished by an aperture in the centre of the ceiling, opening into **an air-tight zinc chamber** between the ceiling and the floor of the room above, from which a zinc pipe runs straight into the chimney, the opening into the latter being guarded by one of the chimney valves already named. This apparatus is difficult to fix in an occupied house; a preferable plan would in that case be to insert one of Boyle's valves in the chimney flue.

(6) **Boyle's Air-pump Ventilator,** shewn in *Fig. 17*, consists of four segments acting independently of each other. In *Fig. 18* these parts are shewn in section. 1 in that figure represents a curved guard which serves to concentrate the current and prevent the wind blowing through the slits opposite. At 2 is a curved plate with the concavity outwards which prevents any down draught, and takes the pressure off the vertical slits communicating with the interior. The external air impinging on the diaphragm 3, is reflected on to the plate 4, thus creating an induced

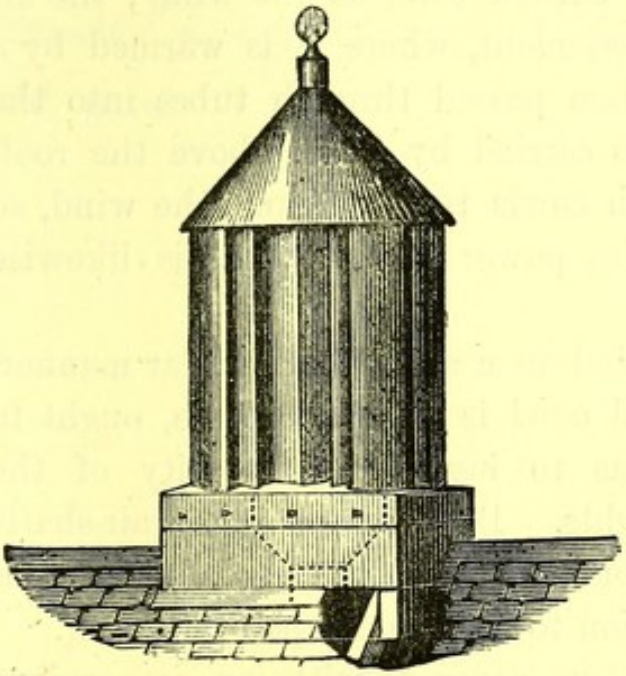


FIG. 17.
BOYLE'S AIR PUMP VENTILATOR.

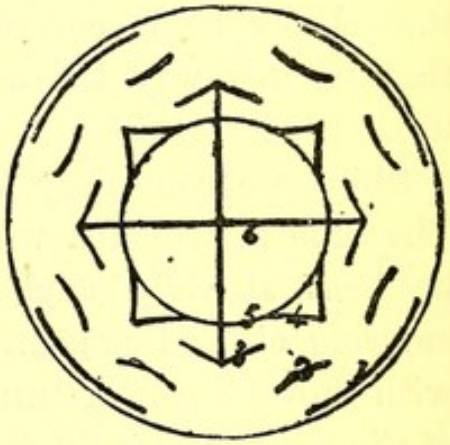


FIG. 18.
SECTION OF THE SAME.

current, and drawing the air from the vertical chamber 5, expelling it at the opposite opening. The ventilator is connected by means of a shaft with the apartment to be ventilated, and the impure air rushes up from the latter to fill the partial vacuum thus produced. At 6 are seen the partitions separating the chambers, which prevent external air being drawn through the slits on which the wind is not directly acting.

In the above plans of ventilation, the ceiling serves almost entirely as an outlet for impure air. In the following plan, it is used as an inlet for pure air.

(7) In **Sylvester's Method of Ventilation**, the perflating force of the wind is employed to produce an abundant entry of fresh air. A cowl is placed, always turned towards the wind; the air received is conducted to the basement, where it is warmed by a stove or hot-water pipes, and then passed through tubes into the upper rooms. From these it is carried by tubes above the roof, these tubes being covered with cowls turning from the wind, so that in this way the aspirating power of the wind is likewise used.

Ships are constantly ventilated in a somewhat similar manner. The tube to which a windward cowl is attached above, ought to be bent at right angles, so as to lessen the velocity of the entering air and prevent draughts. By covering other air-shafts with movable cowls, turned from the wind, the aspirating action of the wind is brought into action to aid the escape of foul air.

The Walls of a room, unless covered with an impervious material, are constantly traversed by gentle currents of air, which play an important part in the ventilation of rooms. Special apertures may be made to furnish a freer supply, and these may be in various forms.

(1) A **Simple Grating**, composed of perforated zinc, is often used, but an iron grating is better. The holes in the zinc get blocked with dirt, and do not allow a large amount of air to enter.

(2) A **Louvred Opening** may be arranged, after the same style

On calm days effect of extract^{n}-shaft limd. to Exch^{n} free
result^{s} fr. Diff^{s}. of temp^{s}. & height of shaft ; wh. much modif^{d}.
by frict^{n}

a considerable area. In order that this may prove an efficient means of ventilation, a considerable number of bricks are required. The same precautions are required as in the case of the inlets and outlets already mentioned.

The **Floor** of a room is always the source of considerable currents of air, even when well carpeted. Air mounts up through the crevices of the wood-work, being aspirated into the room when its temperature is higher than that of the rooms below. In the case of rooms on the ground-floor, air is often drawn from the subjacent soil, or through dust-bins, etc.

Theoretically, in all measures of ventilation, the floor would be the best point for the entry of cold air. This, however, is intolerable when the incoming air is cold, and the floor must therefore be abandoned as a means of ventilation, apart from heating apparatus.

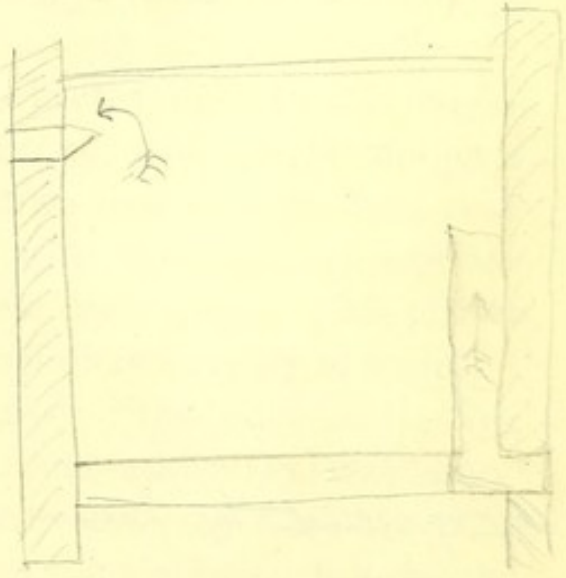
The floor may be used as a means of entry of fresh air in a modified manner, by directing the air entering at the floor-level for some distance up a tube at the side of the wall. This apparatus is known as **Tobin's tube.** It consists of a rectangular or cylindrical tube from 4 to 6 feet high, which communicates at its lowest point with the external air by means of a perforated brick or grating. The air enters the room in an upward direction, and is consequently sent towards the ceiling, where it becomes mixed with warmer air, before diffusing itself throughout the room. But when the incoming air is very cold, it may fall more rapidly, causing cold draughts on the heads of those in the room. For this reason the tube is usually provided with a lid, which may be shut or opened to a varying extent.

As the air enters directly from outside the house, it often carries with it particles of dirt, soot, etc. This may be remedied in various ways. (1) A pan containing *a shallow layer of water* may be placed at the lowest part of the tube. This, for the time, effectually stops the dust, and renders the incoming air moist: but it soon evaporates, and then is commonly not renewed. (2) *Cotton-*

Ow? to the fric^n Tobin's tubes ~~not so good as the more~~ direct inlet fr^m by Sheringham's valve. Also form a recept^e for dust, insects &c. And do not so conven? &c. outlets when occas^y req.^s, as do the valves.

Circ^r form has max. area w. minim. perim^r & therefr. minim. friction.

Dr Chorme's system is a combin^n of Tobin's tubes for inlets w. smi^r set of tubes recessed for outlets - pass^g fr. ceil^g & conn^d to an exhaust^g shaft above (W)



3rd

× Vent.n by Compres.d Air ons applic.e in spec.l inst.s, in wh. compres.d air 1st used to work boring machines, & then allow.d to escape into tunnel for vent.n, as in St Gothard's tunnel &c.

Aspir.e v. val.e when desired to remove partic.e impur.s v. rapidly as manuf.g dust.

System of extract.n by fans v. val.e where desired to rapidly remove partic.e impur.s, as in workshops where dust of cl.s, steel filings or injur.s emanat.ns sh.d be removed at once.

wool may be placed at the point of entry of the tube into the room. This acts very well for its immediate object, but the entry of air, with a plug of cotton-wool inserted, is greatly diminished. It is very useful however in cold weather, or when fogs occur. (3) A better plan is to have a *gauze funnel* inserted in the tube, or a sheet of gauze arranged diagonally across the tube from its highest to its lowest point. These do not diminish the current of air so much as cotton-wool, though still appreciably; but they require to be occasionally cleared from the collected dust.

Artificial Ventilation.—Artificial ventilation may include two important and very different measures. In one of them currents of air and an exchange of pure for impure air are effected by means of various forms of heating apparatus. In the other mechanical measures are used for the same purpose,—the air being either driven out of the room or drawn out of it. In this chapter we shall consider only the **mechanical means of artificial ventilation.** There are two kinds, the first being known as ventilation by aspiration, or the *vacuum* system; and the second as ventilation by propulsion, or the *plenum* system.

In **Ventilation by Aspiration** the foul air is drawn out of the room by machinery, its place being supplied by fresh air, which may be warmed before entry or not. This plan and the next have been employed chiefly in connection with large buildings, such as hospitals, etc., and in mines.

The extraction of foul air may be effected by—(1) *a steam-jet*, which is allowed to pass into a chimney, and sets in motion a body of air more than 200 times its own bulk. Tubes from each room of the building are connected with this chimney, and the strong upward current extracts the air from them. This plan is useful in factories, where there is a superfluous supply of steam.

(2) *A fan or screw* may also be used. The vanes of the fan, when it is caused to revolve by some stationary machinery, produce a powerful current of air, which can be regulated according to requirements. As in the last plan, the aspirating influence of

the fan may be exerted over a system of rooms, by means of connecting tubes. Placing an Archimedean screw in a chimney, to be turned by the wind, has been proposed, but is of little use.

In **Ventilation by Propulsion** a fan is used as in the last plan, the air being propelled along conduits leading from it, into the room to be ventilated. The size of the conduits being known, the amount of air to be discharged can be regulated by timing the rapidity of the revolutions of the fan.

This plan is suitable for crowded places, where a large amount of air is required in a short time. It is also used in the new ironclads, large fans being driven by special machines. The air to be admitted may be warmed by connecting the conduits with some form of heating apparatus.

Besides the fan, various forms of bellows, and a gasometer pump, have been used for the same purpose.

The punkah used in India is a more imperfect apparatus of the same kind. By its means a quantity of air is forced out of the room, and fresh air rushes in from all sides to supply its place. The cooling effect of the punkah is greatly increased by moistening it.

The great advantage of the plan of propulsion, is its certainty. By it the temperature, moisture, and freedom from suspended matters of the incoming air can be exactly regulated and controlled. Its chief disadvantages are that (1) it is a very costly method; (2) the apparatus is liable to break down; and (3) the distribution of the fresh air over different rooms is rather difficult. When combined, as is done in the Houses of Parliament, with the use of a flue for the extraction of foul air, this plan seems to answer admirably.

The Relative Value of Artificial and Natural Ventilation is not very difficult to adjudge. When possible, there can be no doubt that natural ventilation is by far the best plan. But it is impossible to say that in all circumstances, one is better than the other. When the external air is very cold, it cannot be admitted directly without the production of draughts. Then, some means

Gt advantᵉ wherelge amᵗ of air reqᵈ in a com. space, & channels are limᵈ in size.

In Hse of Comᵐᵉ an apparᵗ used, on principle of a gas holder, wᵗ a double-actᵍ piston, by wh. amᵗ of incomᵍ air can be carefᵘˡ regulᵈ

Compresᵒⁿ of air in propulsᵒⁿ raises temp. of inflowᵍ air.
Air freed in tends to seek the leᵗ place of escape, & much of vitiatᵈ air rem. in corners, unless an efficᵗ method of extractᵒⁿ combined.

Results at Dundee in schools shewᵈ that wᵗ mechl ventᵒⁿ & space per person being the same, CO_2 was $\frac{3}{5}$, org. matᵗ $\frac{1}{7}$ & mic. org. less than $\frac{1}{9}$ of what they were wᵗ ordᵉ ventᵒⁿ, & yet that temp. consᵈ higher. The mechl. method in use was flow air by fans over hot pipes & thence into the sev. rooms by shafts (round shafts upright) wh open 5 ft fr. the floor. The vitiated air is carried off by shafts open 5 ft fr. floor & carry the air into a chamber in the roof, whence it is discharged by louvre-boardᵈ ventᵒⁿ fitᵈ inside wᵗ valves wh prevᵗ back draughts (traces of draughts avoidᵈ by mechl introdᵒⁿ of warmᵈ air. Cub. space per chᵈ v. is less. CO_2 in ordⁿ ventᵈ Bd Schl. was 18.6 per 10000 air, & mic. org. 55 per litre.

P. 70.

Descr. of School (Dundee)	No. of rooms exam.	CO_2	Org. matt.	Total micro-orgs.
Vent. mechan. & heat. by hot air blown into the rooms	20	12·3	10·1	16·5
Heat. by fires, vent. in ord. way	18	16·9	15·7	169.
Heat. by hot pipes in room it's elf vent. by windows, vents in room in some cases by a few Tobin's tubes	21	20.0	16·5	92.

Fricn varies 1. directly w. sq. of velt of air-curs
2. " " length of flue or channel
3. inversely w. area of flue.
4. with nature of matl of channel.

With sooty flue velt abt ½ of smooth flue.
Fricn at points of ingress also affects.

of heating the incoming air must be adopted. (Chapter XXI.) When again, the air is warm and comparatively stagnant, as in the hottest part of summer, the ventilation is probably more imperfect with windows widely open, than it is sometimes in mid-winter with curtains drawn and doors shut. In these circumstances some apparatus like the punkah would be useful; or at least, both door and window should be open in order to ensure some slight draught through the room. This applies still more to tropical climates.

In certain large buildings again, where there is a large number of rooms, some artificial means of ventilation is required.

The chief objections against artificial ventilation are those given under the head of ventilation by propulsion. In addition may be named the danger of the long tubes through which air is carried becoming leaky, and so contaminations getting into them. The long tubes also produce great friction, and thereby diminish the current of incoming air.

Obstructions to Ventilation.—1. *Any irregularity in shape or roughness* of the opening will retard the movement of air, by increasing the friction; circular and semicircular orifices cause least friction; a square opening is the next best.

2. The opening may become *clogged with dust and soot.* All ventilators require occasional attention and cleansing. The dust often contains a large proportion of organic matter, and this tends to devitalise the entering air.

3. The insertion of a *grating or of gauze* into the opening, greatly retards the current of air. A number of small openings—the sum of whose area is equal to that of a large opening—do not furnish as much air as the latter. Thus, if an opening, ten square inches in size, is replaced by five openings of two square inches each, the amount of air supplied by each of these is not *one-fifth* of the original amount, but only about *one-sixteenth.* Hence, 32 square inches, so divided, are only equivalent to ten square inches in a single opening.

4. The *ventilating tube* may be *too long* in proportion to its width, or it may be *bent or twisted.* In all these circumstances friction is increased, and the current of fresh air correspondingly diminished. When a ventilating tube is bent at right angles, half the air-current is lost; if there is a second right-angled bend, only one-fourth of the original current is obtainable.

5. Ventilation is much more difficult in *upper rooms of large houses*, and in *single-storied houses*, than in the lower stories of large houses. The cold external air by the attraction of gravity presses downwards to the lowest point, and pushes up the warmer air. The rate at which it presses downwards depends partly on its temperature, and partly on the height through which it has to fall; in the latter respect following the usual law with regard to falling bodies, that the space traversed will equal half the force of gravity (=32) multiplied by the square of the time. Thus it will be 16 feet in the 1st second, 64 in the 2nd, 144 in the 3rd, etc. The height from which the cold air has to descend may be measured from the floor of the room to be ventilated to the point of issue of the foul air, which is commonly the top of the chimney. If calculations are made on this basis, it will be evident that the air entering a room on the ground floor will have a much greater velocity imparted to it than that entering a room on the highest storey; and that, consequently, although 24 inches of ventilating inlet, and an equal amount of outlet, suffice in the former for each individual case, it probably will not keep the air pure in the latter case. A few inches must be added for each storey as we ascend, and a cottage or single-floored dwelling must be treated as a top-storey. (De Chaumont).

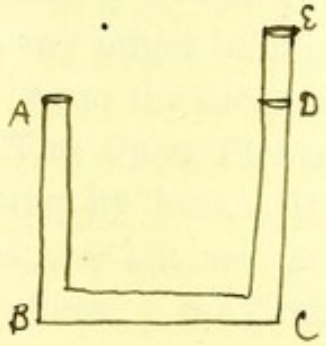
Cold air heavier, so presses up warm air.

Air saturd w. moistr is lighter than dry air, & so ascends more easily.

$$s = \frac{1}{2} g t^2$$

Velr of enterg air & therefr amt of air varr w. sq. root of diffe betwn temp. in & outside shaft.

$$v^2 = 2g.s.$$



AB. is filld w a liqd. eq. in wt to cold air, & CE. w. one eq. in wt to the warm air.

If A covd w. finger & DE. removed, on removg finger, fld wl spout f. D. w velty = that acqd by abovg in fallg f. E to D, if not influenced by frictn or other resistce = 8 × sq. rt of ED.

To ascertn ED, × height of chimney by product of diffe of temp. of air & temp in chimney, & expansn for 1°; result = height of addl colm eqd to balance AB.

Thus if chimn. 20′ high : ext. air 40°. heatd air 100°.

100 − 40 = 60°. 60 × .002036 = .1222 = expans on for 60°.

20 × .1222 = 2.44 ft, the addl height of warm air eqd to balance the cold air.

$8 \times \sqrt{2.44} = 12.49' =$ velty per sec. of air ascendg chimney

CHAPTER XXI.

VENTILATION BY THE INTRODUCTION OF WARMED AIR.

The Chimney as an Outlet and Inlet for Air.—Galton's and other Stoves.—The Ventilation of Mines, Men-of-War, etc.—Ventilation by Hot-Water Pipes.—Ventilation by Gas.—George's Calorigen.—Objections to Ventilation by Warming Apparatus.

Ventilation by the Burning of Coal.—In winter and at any time of the year when the out-door temperature is below 50° Fahr., the warming and ventilation of a room are necessarily combined. If air is admitted unwarmed it is certain to produce draughts, unless it is directed upwards by Tobin's tubes and mixed thoroughly with the hot air near the ceiling. In the comparatively small rooms of dwelling-houses, some such contrivance may suffice; but in any larger building, in order to ensure ventilation, it is necessary to warm the incoming air.

The Open Fire-place forms the most common means of ventilating by heat. It has been already considered in the previous chapter, but we must now consider the mechanism by which it produces a constant circulation of the air in a room. The ascent of warm air up the chimney, causes cold air to rush along the floor to the fire-place from all parts of the room, especially the door. Part of the air thus approaching the fire is carried up the chimney with the smoke, while the remainder, after having been warmed, flows upwards towards the ceiling near the chimney-breast. It passes along the ceiling, and cooling in its progress towards the opposite wall, descends, and is again drawn towards the fire-place. Thus there is a continuous circulation of the air in a room.

In the experiments of the Barrack Commissioners (1861), it was found that the amount of air passing up the chimney while a fire was lit, ranged from 5,300 to 16,000 cubic feet per hour, the

mean of 25 experiments being 9,904 cubic feet. We may conclude, then, that with an ordinary grate, a chimney provides outlet for impure air sufficient for four or five persons. Its lack of economy as a heat-producer will be considered later. Its efficiency as a ventilator within the above limits is evident.

When a fire is burning in the grate, all other openings in the room, except openings into the chimney, serve as inlets. If the room is insufficiently supplied with openings, a double current may be established in the chimney, with the result that occasional down-puffs of smoke occur.

As a rule the chimney serves only as an outlet for impure air. It may by appropriate means be made to serve as an *inlet for pure and warmed air*, the heat which would otherwise escape up the chimney being utilised for this purpose. The **stove** contrived by **Captain D. Galton** is one of the best for this purpose. At the back of this stove is an air-chamber, communicating with the external air, and in which the fresh air is heated before it enters the room. On the back of the stove broad iron flanges are cast, in order to present as large a heating surface as possible. They project backwards into the air chamber; and their heating surface is aided by the iron smoke-flue, which passes through the air-chamber. The warmed fresh air enters the room by a louvred opening above the mantel-piece, or by an opening in each side of the chimney-breast. The grate itself is constructed so to give out as much heat as possible, and the smoke is much more completely burnt than with an ordinary grate.

Boyle's and Shorland's grates are similar in principle to Galton's. In **Boyle's Ventilating Grate** the heated air enters the room through small openings extending along the top of the grate.

In **Shorland's Manchester Grate** the warmed air enters the room through the shelf of the chimney-piece, and can be carried by means of suitable flues to warm the bedrooms, etc.

The Ventilation of Mines is effected by lighting a fire at the bottom of a shaft. The air for the combustion comes down

1 lb coal req^{d} f^{r} combust^{n} at least 160 c ft. air;
8 lbs 1280 c ft. Air at a v. low comput^{n} passes up chim.
at rate of 4-6 ft per sec., v f. 14000 to 20000 c. ft per hr.
A room 20' sq. & 12' high cont^{s} 4800 c. ft air space, & in
it a good fire wd renew the air 4 or 5 times per hr, v
6 to 8 times if a blaz^{g} fire (Galton)

In propn as heat is removed f. the chimney, so is the draught dim^{d}, & combust^{n} of fuel is to some est^{d} dim^{d}.

Genl Morin's exper^{ts} shew^{d} that while propn of heat util^{d} w. ord^{y} fireplace is abt $\frac{1}{9}$, it was $\frac{1}{3}$ w. Galton's stove.
Also draughts f. doors to dim^{d} & vent^{n} effect^{d}

another shaft (the intake shaft), or down another half of the same shaft separated by a partition. The consequence is that a constant up and down current of air is produced. The air from the intake shaft is made to traverse the galleries of the mine, its course being directed by partitions, before it is allowed to reach the fire and so be carried up out of the mine. From 1,000 to 2,000 cubic feet of fresh air are supplied per head per hour in good mines; in fire-damp mines as much as 6,000 cubic feet. As showing how skilfully the air is guided in its course through the galleries of a mine, it may be mentioned that in some mines the air makes a circuit of from thirty to forty miles before reaching the shaft whence it leaves the mine.

The Ventilation of Large Buildings has been effected in a similar way. A chimney has a fire lit at its lowest part, and into this shaft, close to the fire, a number of tubes run from the different rooms. The Houses of Parliament were ventilated for some years by this plan. The workmanship must be very exact, or else air gets into the ventilating shaft otherwise than from the tubes.

Some **men-of-war** have been ventilated in a like manner. The funnel and upper part of the boiler are enclosed in an iron casing, a space of three or four feet being left between the two. When the fires are lit a strong upward current is produced in this space, and to supply the partial vacuum produced, air is drawn through all the hatchways towards the furnace doors. This plan may be applied to ventilate not only the furnace-rooms, but the whole ship. The same principle has also been applied in the ventilation of sewers.

In addition to, or instead of, an ordinary coal-fire, the extractive force for impure air may be obtained from Hot Water or Steam Pipes. There are various plans founded on this principle.

When hot-water pipes are used for baths, etc., they may also be utilised for ventilation, in two ways:—1st. The hot-water pipe may be made to coil round the tube by which fresh air is admitted into a room, thus warming the air as it enters. 2nd. The hot-water pipe

in its course upwards may be enclosed in a shaft, which opens into the external air above. The air in this shaft being heated, the impure air may be collected and removed from the different rooms by tubes connected with it. Thus, a hot-water apparatus, when well arranged and complete, may furnish pure warm air, and carry away impure air. The ventilation by this plan is found in practice to be somewhat irregular.

The plan proposed by Drs. Drysdale and Hayward of Liverpool is similar in principle:—Fresh air is warmed by a coil of hot-water pipes in the basement, and is admitted into the staircase and landings, whence it is supplied to the different rooms by openings provided with valves. From the rooms, special outlets converge to a foul-air chamber under the roof. This is connected with a shaft leading from the kitchen-fire, the latter, therefore, acting as an extraction furnace.

Lighted Gas may be employed to produce a current for ventilating purposes, as well as a fire or hot-water.

Sunlights, and **Benham's Ventilating Gas-burners,** have already been mentioned in this connection. They are unfortunately expensive, but are extremely valuable means of ventilation. Sunlights, unless carefully managed, produce powerful centripetal currents from all quarters of the room, so much so that it is impossible to sit near any point at which air is entering.

In theatres and similar buildings the **Chandeliers** should always be made to extract the vitiated air. Where a number of chandeliers exist, they may be connected by tubes with a main shaft, and all made to contribute to the same object. According to the experiments of General Morin, the discharge of 1,000 cubic feet of air is produced by the combustion of one cubic foot of gas. As a common gas-burner will burn nearly three cubic feet of gas per hour, the value of this means of ventilation is evident.

Dr. A. Carpenter describes a useful form of ventilation and warming by gas, suitable for schools. It consists of a number of Tobin's tubes, at various parts of the room, each enclosing a set of

Draught in tube is dimd by bend, & smallness of tube.
If draught sluggish, fire in chimn. Raw some of fumes
dim? into fire. Only safe plan is to place gas burners in a globe
entirely cut off fr. the room.

Benham's globe light may claim to be to some extent
argand gas-burner, as air for combust? warmed in passage
along tube.

Siemens regen? burner – air for combust? heat? by flame

Clark's & Grimston's regen? burners bet? adapt? for bases.

Schönberger's Swiss? stove combines warm? of room w. a
gas-light – Prod?s of combust? in exit warm incom? air

Illum? intens? of a glowing body increases in a greater
ratio than the temp?. Heat prod? by combust? of gas is out of all
prop? to qty of hydrocarb. cont? in it. A bet? utilis? of heat of
combust? is req?. Clamond lamp is the Drummond lime-light
made useful (air being used for O & retorts of MgO for Ca cylinder)
Heat? air has same effect as O. air enters under press? a tube
of fireclay heat? by the gas. Wick of Mg O lasts 40 hrs is very
cheap.

minute Bunsen's burners, fitted to the bottom of the tube, but capable of receiving the air for their combustion from the room. The products of combustion are conveyed directly out of doors, through a smaller tube lying inside the Tobin's tube, the smaller tube being so arranged that no deleterious gas can possibly enter the room. The Tobin's tube brings fresh air from without, which is warmed by the heat from the Bunsen's burner before it enters the room. About 100 feet of gas per day are said to be ample for a schoolroom containing 100 children.

Various forms of gas-stove are now sold, which act as ventilators as well as sources of heat. Of these, one of the best is **George's Calorigen Stove** *(Fig. 20)*. It can be obtained in various forms suitable for burning coal-gas, or coal, or oil. Within its outer case is contained a special iron tube, which communicates at its lower end with the outer air, and opens at its upper end into the room. The heat generated in the stove warms the air in the spiral tube, which accordingly ascends into the room. The ascent of warm air causes a draught from below, and the consequence is, that so long as the combustion is going on, a current of warm air continues to ascend into the room. The products of combustion are carried out of the room by the pipe F. This stove is free from most of the objections appertaining to gas-stoves; it can be fixed into an ordinary fire-place, and it keeps the temperature of a room at a uniformly warm point.

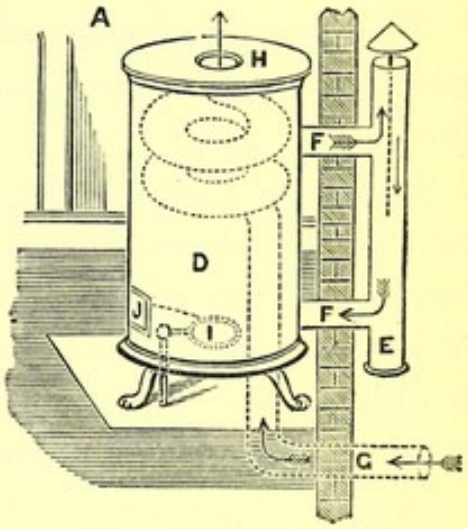


FIG. 20.
GEORGE'S CALORIGEN STOVE.

A—The interior of room.
B—Exterior of building.
C—Wall.
D—The Calorigen.
E—A cylinder.
FF—Pipes communicating with Stove and Cylinder to supply air for combustion, and to carry off the products of combustion.
G—Pipe for passage of fresh cold air to Calorigen. Can be carried above the floor or between the joists, as may be most convenient.
H—Outlet for air into the apartment after being made warm.

Objections to Ventilation by Heating Apparatus.—When

warmed air is admitted into a room, it is very apt to be *dry*, and consequently produces headache and a feeling of oppression. This can be usually avoided by having water standing in the room, so as to allow evaporation.

When the impure air is extracted by fire or hot-air shafts, various objections arise:

1. The *draught is unequal* at different times, owing to the fire not being kept at the same level.

2. Unless the building is a very compact one, the *current of air is very unequal* from the various rooms; being strong from the rooms nearest the shaft, and very slight from remote rooms.

3. When the flue is accidentally blocked, or from other causes, *smoke* or *impure gases* may occasionally re-enter the rooms from the shaft.

4. When the draught is most perfect, it is most difficult to control the places *whence air shall enter the rooms.* It may be forced out from water-closets, or even from sewers, instead of from proper sources. This objection is to a large extent overcome, by combining the extraction of foul air by heat, with some one of the previous plans for an abundant entry of moderately warmed air.

CHAPTER XXII.

THE WARMING OF HOUSES.

The Degree of Temperature Required.—The Modes of Carriage of Heat.—Different Methods of Warming Houses.—The Open Grate.—Objections and Advantages.—Open Gas Fires.—Improvements in Open Grates.—Closed Stoves.—Whole House Systems.—Hot-water Pipes.—Warming by Hot Air.—Boyle's Air Warmer.

Physiological and Physical Considerations.—The warmth of our bodies is naturally kept up by the oxidation changes

constantly going on in the system. We shall discuss in Chapter XXIII. the modes in which heat is lost by the system, and the influence of clothing in controlling the amount of this loss. Artificial warming of houses has a similar action to clothing. It diminishes the demand on the system, and so economises the amount of fuel-food required.

The degree to which this diminution of loss of heat by clothing and artificial warming of houses may be carried varies with circumstances. There can be no doubt that if food be abundant, exposure to external cold, if not too extreme, is on the whole beneficial, for vigorous people. But for old people and young children, the means of artificial warmth require to be more carefully attended to. Severe cold is for them often the harbinger of death.

The **Degree of Temperature** at which living-rooms should be kept will vary somewhat with circumstances.

For *healthy adults* any temperature between 50° and 60° Fahr., will be moderately comfortable ; for *delicate children and old people* it may be 65° with advantage. It must always be remembered however that a temperature lower than this and fairly uniform, is preferable to frequent changes from a high to a low temperature.

For *sick rooms and hospitals* the temperature of 60° is usually adopted, but this is by no means always necessary. In most fevers, with the doubtful exception of scarlet fever, better results are obtained by keeping the temperature of the room as low as 50°. This has been abundantly proved in small-pox for instance ; the proportion of recoveries being larger in tent hospitals than in permanent structures.

Convalescents from any acute illness bear low temperatures badly, and during this period exposure must be avoided.

The Different Kinds of Warmth.—Heat may be communicated by radiation, conduction, and convection. By **radiation of heat** is meant the process by which heat passes from a fire or other source of heat, through a vacuum, dry air or any other medium, without

heating any of the media through which it passes, but only the bodies against which it finally impinges. The solid bodies (including ourselves) which are warmed by radiant heat, by a process of conduction then warm the surrounding air.

Conduction of Heat is the passage of heat from one particle to another, whether it be of a gas or solid. It is an extremely slow process when air is concerned, and may be practically ignored.

Convection of Heat is the process by which a gas or liquid actually carries the heat in itself from one part to another. The heated particles are relatively lighter, and ascend to the higher parts of a room, while colder and heavier particles descend, and are subjected to the same process. Heat can be carried by convection only by gases and liquids. It is quite possible, therefore, to have a room filled with warm air, and yet for a person to be cold in it, if the walls, etc., are cold; while, on the other hand, he might feel comparatively warm in a room filled with cold air, owing to an open fire-place or the warm walls radiating to his body more heat than he radiates to the surrounding structures. The great advantage of radiant heat, then, is that—(1) it heats the body without heating the air; while at the same time (2) there is no possibility of impure gases being added to the air.

It has, however, considerable disadvantages. (1) It is costly, though its expense may be greatly diminished by a well-constructed fire-place. (2) It only acts on bodies near it to any useful extent. Its effect lessens as the square of the distance; thus, its warming effect at five feet distance, is twenty-five times less than at a distance of one foot. It is evident, therefore, that for long rooms, and for large assembly-rooms, a single source of radiant heat is quite inadequate; while, if the fire-places be multiplied, the heat in their vicinity is excessive. The immense loss of heat in our ordinary fire-places, is slowly leading to their modification; and although it is probable that radiant heat will always be the favourite source of warmth, it will doubtless be used as an adjunct to convection and conduction of heat.

Idea of 'draught' f. a wall often due to loss of heat by warm body to surr.g colder objects. Fitting a piece of carpet to suspect.d wall stops most of draught

Perfect.n of ventil.n wd be to have cool air to breathe but be surr.d by warm walls, floors & furnit.e (Galton)

In two rooms, one heat.d by an open fire & one by hot air, & w. air at same temp. in both, the walls in lat.r wd be some degs. colder than the air & therefr. colder than the former room, & wd consequ.y abstract heat by rad.n fr. occup.ts more rapidly than when room heat.d by open fire. In hospl wards heat.g by open fires has alw. been recog.d as preferr.e. Where desired to warm the walls as well as the air, high-press.d steam preferr.e to hot-W.r pipes

Foot warmers - L & N. W. Co? Have them fill them w. Na. Acet^{e}
wh. melts at a temp. of a little over 200°., this process of again
cryst? throws out the heat & contin^{s} to do so in ft warmers for 20 hrs

½ foot warmers
¼ ——— as ft warm air
¼ ——— unconsumed

The different sources of heat are employed, either singly or combined, in the following methods of warming our dwellings and other buildings :—

1. Warming by the open grate.
2. Warming by closed stoves.
3. Warming by hot-water pipes.
4. Warming by steam in pipes.
5. Warming by hot air.

Warming by electricity might have been added to the list, but, although seriously proposed by Edison, its expense renders it at present impracticable.

Warming by the Open Grate.—The old-fashioned English fire-place still retains its popularity, though it has undergone many modifications tending to increase its efficiency. As in it radiation is the source of heat employed, this mode of warming is scientifically the best, though far from being the most economical.

The **position of the fire-place** is important. It should not be on the external wall of the house, as thus a large proportion of heat is lost ; but should be placed where the heat from the flue may be utilised in keeping up the temperature of the house.

The **construction** of an ordinary fire-place is also important. The ordinary construction is faulty in several respects. (1) The fire-place is commonly too far included in the wall, so that the heat at once passes up the chimney. (2) It is composed nearly entirely of iron, which rapidly conducts away the heat, and does not furnish a surface for radiation. (3) The bars and bottom of the grate are so arranged, that coal and cinders fall out in an incompletely burnt condition.

It is estimated that with an ordinary fire-place, seven-eighths of the possible heat is lost, one-half being carried up the chimney with the smoke, one-quarter carried off in the ascending current of warm air, and one-eighth of the combustible matter remaining unconsumed, forming the solid matter of the smoke.

The defects which have been indicated, may be remedied by

bringing the fire-place rather further out into the room; by substituting fire-brick for iron wherever possible; and by having a layer of fire-brick at the bottom of the grate, or the grate fixed to the floor with the intervention of a layer of the same substance.

The **shape of the grate** is important. The width of the back of the grate should be about one-third that of the front, the sides sloping out towards the front of the recess. The depth of the grate from before backwards should be equal to the width of the back. The sides and back of the fire-place must be made of fire-brick. This ensures the heat being retained in the grate; and it often will be given out for hours after the fire has gone out. And finally, the chimney throat must be contracted so as to ensure more complete combustion. The register as a rule is incapable of being fixed at various angles. In some grates, however, this can be done by means of a handle outside the grate, which is a great improvement. The **chief objections to an open fire-place** are (1) the great waste of fuel involved, even after the improvements indicated have been carried out. (2) The unequal heating at different distances from the fire. (3) The smoke and dust always produced to some extent, from accidental smoking of the fire, or from the escape of ashes. (4) The trouble involved in frequently replenishing the fire. (5) The cold draughts produced by the currents of air towards the chimney. These travel chiefly along the floor, when, as is commonly the case, the space between the bottom of the door and the floor forms the chief place for the entry of fresh air. Thus we may suffer from cold feet even when we are enjoying the glow of a warm fire.

The Fuel burnt in an open fire-place may be either coal or coal-gas. Occasionally coke is also employed. Coke and coal-gas have the advantage over coal, that (1) no smoke is produced. Coal-gas presents the additional advantages, that (2) it can be turned on at any moment, without having to go through a tedious process of lighting the fire; and that (3) the amount of heat can be exactly graduated by regulating the supply of gas. For continuous use,

width of back $\frac{1}{3}$ front.

Smoke nuisance – in manufg dists might be minimd by adopting mechanl stokers of "slow-feed" or "coking" class as distg fr. those which throw the fuel in sm. qts on to the red fire – so called "sprinklers"

and a proper up-current

Damp fuel uneconoml., bec. of heat abstrd in evapn of H$_2$O.
Insuffc. supply of air same, bec. CO in prodt gives little heat.

however, in order to have a good cheerful blaze from a gas-fire, the cost involved is three or four times as much as for a coal fire. According to some authorities, the cost is placed as high as ten times that of coal.

Open Gas-stoves are made in various forms. In the common one, small jets of gas are lit under the grate, which is filled with pieces of asbestos. This becomes red hot, and radiates a considerable amount of heat. In *Dr. Siemens' regenerative gas-stove*, there is an air-chamber behind the grate, in which in-coming air may be heated before being used to burn the gas. In this way, more complete combustion is ensured, and the heat is economised.

In another form of gas-stove, coke is burnt, the gas jets under the grate being employed merely to light the fire. This form is economical, but it is found that the ashes of the coke tend after a time to clog up the fire, and cause it to die a natural death.

In all the open gas-stoves we have yet seen, the air in the room becomes after a time unpleasant, and has a peculiar smell. This is probably due to the escape of some of the products of combustion, which owing to the absence of smoke are not readily perceived.

We have already mentioned some improvements in the open grate, in respect of shape and the employment of fire-brick. Other still more important improvements have been effected, such as the introduction of fuel from below, instead of at the highest part of the fire; the utilization of the heat from the fire-place and chimney to warm the air entering the room; and the shutting off of the draught of cold air under the grate.

(1) Many patents have been recently brought out, all agreeing in one respect, viz.: the **introduction of the fuel at the lowest part** of the fire. The uppermost part of the fuel being first burnt, and the remainder attacked from above, the smoke is consumed in passing through the red part of the fire. Thus, a comparatively smokeless fire is produced, and the amount of heat evolved is greatly increased. The production of *a comparatively smokeless fire* is a great boon.

Smoke means so much unburnt fuel, and not only so but the sooty particles float about in the atmosphere, rendering it impure, and changing comparatively harmless mists into town fogs, which are loaded with soot and the products of combustion, and do incalculable mischief to health and property.

(2) **The Utilization of the Heat Produced** in the fire-place, to warm the air on its way into the room, is another important means of improving the open grate. The way in which Galton's stove effects this has been already described. Other stoves are constructed on the same principle.

(3) In order to get the largest possible amount of heat out of a given quantity of fuel, it is advisable to **cut off some of the cold air,** which rushes through the fire, and carries the half-burnt gases and much of the heat up the chimney. This may be effected by having a solid fire-brick bottom to the grate, or as Mr. Pridgin Teale has pointed out, by closing up the front of the open chamber under the grate, by means of a close-fitting shield or door, which can be made by any ironmonger. In both plans, the entry of air into the fire from below is prevented. The "Economisers," as Mr. Teale calls them, appear to answer better than solid fire-brick bottoms, as they do not prevent the ashes falling under the grate.

Closed Stoves form the most economical and efficient warmers for rooms of moderate size. Coal, coke, and coal-gas are the fuels most commonly burnt in them. We shall first consider the closed stoves in which solid fuel is consumed.

The advantages rightly claimed for these are that (1) the amount of fuel consumed is small; (2) by adjusting the damper, combustion may be rendered as slow as desired, so that but little heat is lost by the flue or chimney; and (3) heat radiates from all parts of the stove into the room, and not simply from a small area of fire-front.

The chief objections to closed stoves are, that (1) they *dry* the air excessively, rendering it somewhat unpleasant. (2) They produce a peculiar *close smell*, which has been ascribed to the charring of minute particles of organic matter in the air, coming

Fog appan.ce due to condens.n of H_2O in air on any solid nuclei at hand. If no dust no fog, but aq. wd be condens.d on trees or hses or clothes. NH_3 & SO_2 also seem to have a lge affin.y for aq. Thus all fires are fog producers.

D.r Aitken's conclus.ns 1). In satur.d air all kinds of dust form nuclei determ.g condens.n; in unsat.d air only the dusts hav.g affin.y for H_2O.

2). Dry fogs prod.d by the affin.y of hygrosc.c subst.s for H_2O, esp.y NaCl.

3). SO_2 esp.y mixed wd. NH_3 has power of determ.g condens.n in unsat.d air, prod.g a fine dry fog.

Aver.e amt. of S in Engl. coal is over 1.2 %.

CO in air may be due to 1/. highly heat^{d}. Fe tak^{g} O f. CO_2 of air
2/. CO permeat^{g} thro. cast Fe.
3/. O of air act^{s} on carbon in cast Fe heat^{d}. to red heat

Sem^{l}. Morin says Deleture expects 3 times as gt^{d}. cast as w. wrought Fe stoves

All Fe stoves shd have a lin^{g} of fire-brick

May utilize nearly the whole heat by hav^{g} a long horiz^{l} flue pipe

in contact with the stove. If the air of the room is not heated above 75° Fahr., no smell is produced, and the relative humidity is not lessened to any appreciable extent (Parkes). But when the heat produced by the stove is excessive, these results do follow. The unpleasantness may be modified though not entirely removed, by placing shallow pans of water near the stove.

(3) Portions of the *products of combustion* may pass through cracks or fissures in the stove, or even through the joints of the stove. Independently of such accidental cracks, cast-iron stoves, when red hot, appear to allow gases to pass through them with comparative ease. Thus carbonic oxide and other gases may find their way into the room, and it is probable that this rather than the dryness of the air, is the cause of the unpleasant symptoms sometimes complained of in rooms where closed stoves are in use. Dr. Bond has proposed a coating of silicate to prevent the deleterious gases finding their way through the stove.

Many modifications of the older closed stoves are now in common use. One of them is shewn in *Fig. 21.* In general construction it resembles George's Calorigen, and is manufactured by the same firm (J. F. Farwig & Co., Queen street, E.C.) Excessive heating of the air is prevented by the presence of two air chambers, only the outer one, which brings external air to be warmed, having its air emptied into the room.

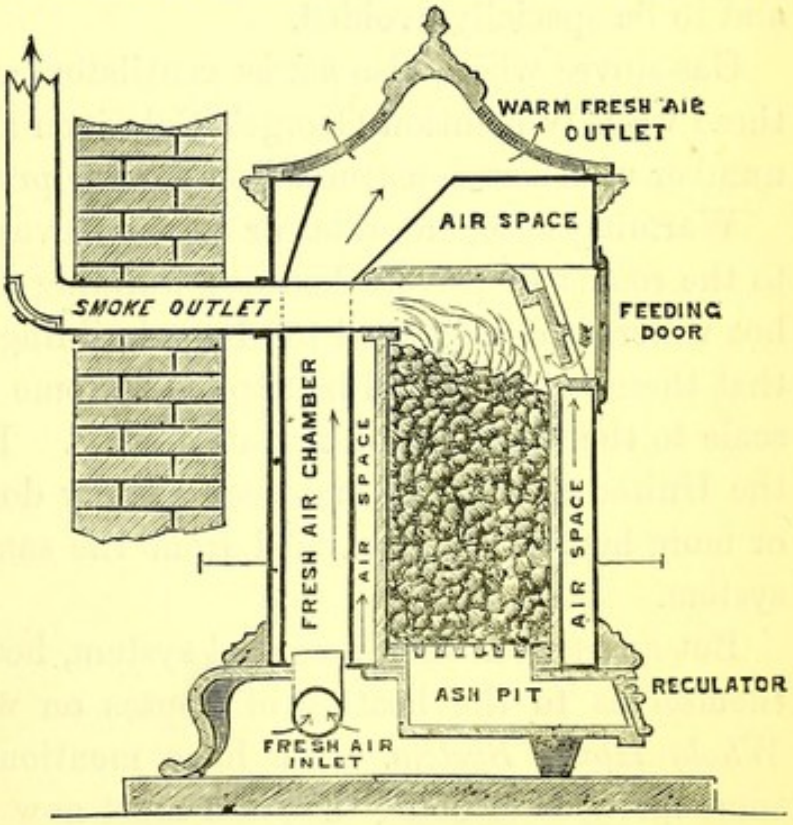


FIG. 21.
SLOW COMBUSTION CALORIGEN

Messrs. Doulton also make a number of slow combustion stoves, which like the last, seem to be quite free from the objections urged against many closed stoves, besides being ornamental.

Gas may be burnt in a closed stove instead of coal or coke. These may be very pernicious, or if properly constructed may actually help in ventilating a room.

The gas-stoves to be specially avoided are those *without a flue*, for the escape of the products of combustion. One occasionally sees misleading advertisements to the effect that "no flue is necessary;" "the products of combustion are turned into water;" "entirely free from smell and smoke;" which last is a pity, as otherwise unwary people would be less likely to be poisoned without knowing the source of their troubles. No gas-stove without a flue is safe, unless some special measures are used to absorb the poisonous gases by lime-water, or some other substance. The light copper-fronted stove, and the platinum and asbestos stove employed to hang on the front of the grate, are perhaps the most injurious, and to be specially avoided.

Gas-stoves which also act as ventilators are by far the best. Of these we may mention George's Calorigen already described, and a number of others constructed on similar principles.

Warming by open grates or closed stoves is specially applicable to the rooms of private houses; warming by hot air or steam, or hot water, is chiefly used for large buildings. It is quite possible that these methods will be applied at some future time on a large scale to the warming of private houses. In some large towns of the United States, this has been already done, blocks of a hundred or more houses being warmed from the same centre, by the same system.

But apart from such a central system, hot air and hot water lend themselves to the heating of houses on what may be called the *Whole House System.* We have mentioned in the last chapter some methods of doing this, and must now describe others.

Hot-water Pipes are probably the best means of carrying heat

From experts at Smoke Abatement Exhibn, it would appear that to maintain 1°. rise of temp. per hr, coal costs about $\frac{1}{3}$ the price of gas.

Effic^{y} of hot H$_2$O system depⁿ on heat^{d} H$_2$O reach^{g} coils of pipe in wh. heat has to be util^{d}: w. as little diff^{ce} f. temp. of boiler H$_2$O as poss. Vel^{y} of flow in pipes wl depⁿ on diff^{ce} of temp. betw H$_2$O leav^{g} boiler & that pass^{g} down return pipe to boiler; & partly on height to wh. H$_2$O has to rise. Therefᵉ upwd flow of H$_2$O shd be as direct as possˢ, & protect^{d} f. loss of heat. Return pipe need not be protect^{d}, but shd pass into bottᵐ of boiler as directly as possˢ, & in as uniform a line f. place where heat has been rais^{d}, as possˢ.

Steam heat^{g} appar^{s} 1/. req^{s} const^{t} attentⁿ to keep up supply of heat, as rad^{g} surfˢ cool rapidly. 2/. Radˢ at a higher temp. than hot-H$_2$O pipes, so more diffic^{t} to regul^{e} supply of heat acc^{g} to vary^{g} reqᵗˢ. This can be remed^{d} by (a) arrang^{g} ra. set of radˢ in sev^{l} distinct sectⁿˢ, in ra. of wh. flow of steam can be indepᵗˡʸ controlled; or by (b) arrang^{g} air ducts that by movᵗ of a valve can be made to pass wholly or in part over a separᵗᵉ f. rad^{g} surfˢ.
3/. Gtr danger of hot heat^{g} appar^{s}. 4/. Heat can be got up very rapidly in a room ow^{g} to gt radiatⁿ.

In Hses Parl^{t} heat^{g} surfˢ of pipes are incr^{d} by numerˢ flanges at rt ∠s to run of pipe.

to various parts of a large house, and hot water is more thoroughly under control and less dangerous than either hot air or steam. There are *two systems* of heating by hot water.

In the first, which we may call the *low pressure system*, there is a boiler from which water circulates through pipes to every part of the building, and as it cools down returns again to the boiler. At the highest points of the pipes, outlets are provided for air. In this system the water is not heated above 200° Fahr., and there is consequently no great pressure on the pipes.

In the *high pressure system* (Perkin's patent), the pipes have an internal diameter of about ½ an inch, and have thick walls made of two pieces of welded iron. There is no boiler, but one portion of the tube passes through the fire, and the water is heated to 300—350° Fahr., thus subjecting the pipes to great pressure. In dwelling-houses with the low pressure system, for every 1,000 cubic feet of space to be warmed to 50°, 12 feet of 4-inch pipe should be given; with Perkin's pipes, probably about two-thirds of this will suffice.

The means by which hot-water pipes, without any elaborate apparatus, can be made to subserve the interests of ventilation, have been already described.

Steam Distributed by Pipes may be employed instead of hot water. The Houses of Parliament are warmed by steam-pipes in a chamber under the floor. This method is chiefly applicable, however, to factories where there is a surplus supply of steam. It is not so safe nor so equable in temperature as hot water.

Warming by Hot Air is only applicable on a large scale, and even here one cannot help doubting its healthiness. It necessitates the carrying on of an artificial system of ventilation conjointly with it, and practically forbids the opening of windows. The entering air is heated by passing it over the flue of a furnace. It is then carried by various flues to different parts of the building, opening at the floor by means of a grating. The air at the gratings is generally intolerably hot, and often presents a degree of

humidity much too small for purposes of health. In addition, the flues are out of sight, and it not uncommonly happens that the ventilating flues communicate through some crack with the furnace flue, and that consequently, carbonic oxide, sulphurous acid, etc., are discharged into the building. The trust in artificial means of ventilation is also productive of evil in another way; for with a high internal temperature, air tends to be sucked from water-closets or drains, instead of from more legitimate sources.

Boyle's Patent Air Warmer is a simple means of warming the fresh air entering into a room, where there is no open fire-place, and when steam or hot air or water pipes are not available. It consists of a copper or iron pipe, about $1\frac{1}{2}$ inches in diameter, which is placed within an inlet ventilating tube, preferably of the form of a bracket. This tube is turned upon itself, as shewn in *Fig. 22*, thus obliging the incoming air to impinge upon it repeatedly in its passage from below upwards. At the lowest part of the tube is a small chamber C, which contains a small Bunsen's burner, the flame of which plays up into the lower end of the tube. The heat produced by the com-

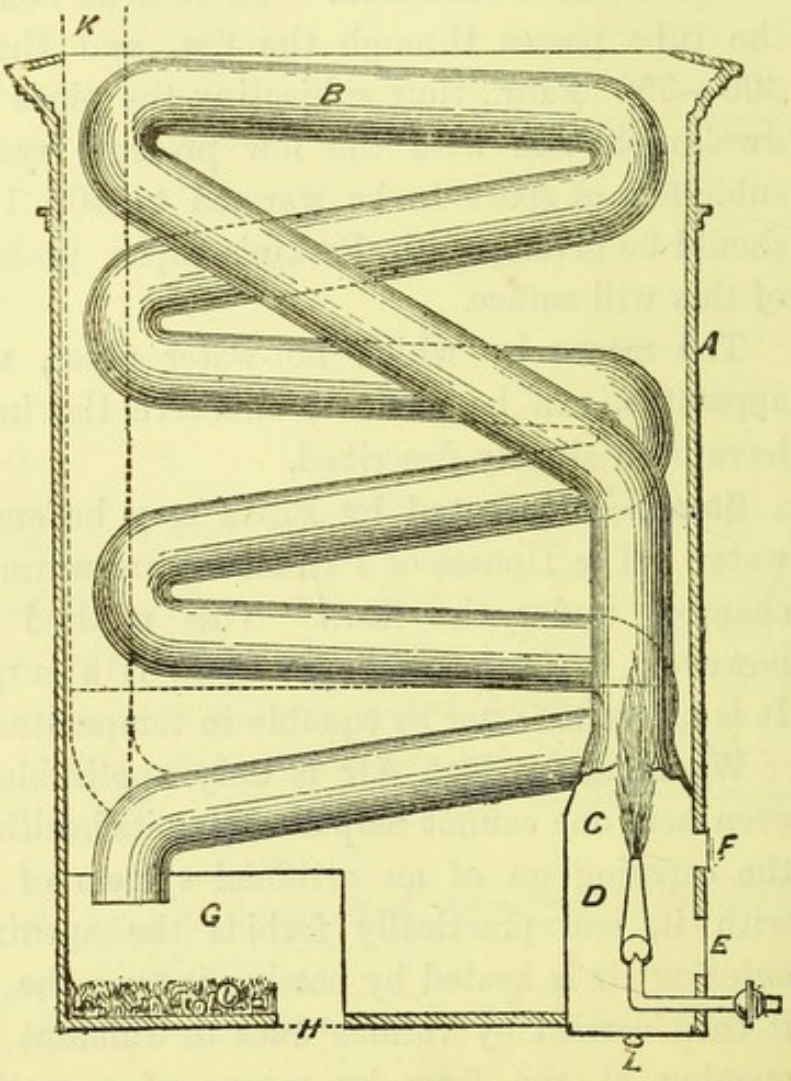


FIG. 22.
BOYLE'S PATENT AIR WARMER.

bustion travels throughout the length of the pipe, which at its further end dips into a condensation box G, containing a quantity of loose charcoal intended to absorb the products of combustion. The charcoal should be frequently renewed, as its absorptive power soon disappears. A much better arrangement is to carry the pipe, as shewn by the dotted line, to K, which leads into a flue or extraction shaft. At E is an opening covered with perforated zinc, for the purpose of supplying air to the burner. At F is a sliding door, through which the gas is lit.

When the tubes are placed against wood-work, they ought, in order to avoid any danger of fire, to be fitted with a double casing, the space between being filled in with asbestos or some other non-conducting material.

CHAPTER XXIII.

CLOTHING.

Loss of Heat by the Skin and Other Organs.—Requisites of Dress.—Relation of Dress to Perspiration.—Evils of Tight Clothing.—The Materials Used.—Amount of Clothing Required by Old and Young.—Poisonous Dyes in Clothing.

Physiological Considerations.—The average temperature of the surface of the body in man is 98·4 to 98·6°. It varies within slight limits, but not more than one degree. The maintenance of a tolerably uniform temperature is an essential condition of life. The factors governing the temperature of the body are *the amount of heat produced* and *the amount lost.* If more heat escapes, more has to be generated; and the source of all the heat produced in the body is the food taken. This becomes oxidised in the body, and the chemical oxidation produces heat. The more copious the supply of oxygen (by respiration) and the more complete is oxidation. Hence, we find that in birds, whose respiration is very active, the temperature is higher than in ourselves.

Heat is lost, (1) by the *skin;* (2) in *respiration,* the expired

air having been heated during its stay in the lungs; (3) with the *food and drink* taken, if not at the temperature of the body; (4) with the *excreta;* and (5) by transformation of heat into *mechanical motion.* Of the whole loss by these different channels, probably eighty to ninety per cent. is through the skin.

The Loss of Heat by the Skin is in three different ways. First, by *conduction,* when the skin comes in contact with anything cooler than itself; secondly, by *radiation* into space; and thirdly, by *evaporation* of the perspiration. The last cause produces a considerable reduction of temperature, even when the perspiration is not so abundant as to be visible, but is in the form of insensible perspiration. The losses by these different sources vary in amount; when one is increased, another is diminished, by way of compensation. Thus, in very cold weather, the amount of radiation and conduction of heat are increased; but evaporation greatly decreases, and the diminished loss of heat in this respect counterbalances in some degree the increased loss by radiation and conduction.

When the external warmth is considerable, increased evaporation occurs; while when the weather is cold, the cutaneous arteries become smaller, and less blood goes to the skin, and so the loss of heat is diminished. In most climates, however, this action of the skin requires supplementing by some kind of clothing.

Requisites of Dress.—1. The first and most important requirement is, that *clothing should maintain a uniform and equable temperature* in all parts of the body.

In hot climates clothes are required in order to protect the body from external heat. In this country, they are required to prevent the too rapid escape of heat from the body. For both these purposes, dress must be of a non-conducting material, and one which does not encourage radiation into the surrounding atmosphere.

The loss of heat by the skin may be prevented by interfering with radiation or conduction of heat, or with evaporation from its surface. Radiation of heat from the skin is prevented by clothing, the dress taking the place of the skin as a radiating surface. The

Conduct^{n} fr. indiv^{l} can be proved by delic^{e} anemom^{r}: betw. coat & waistcoat. Ea. indiv^{l} is a sort of stove.

Can apprec^{e} powers of conduct^{n} by rememb^{g} cold & almost kill^{g} effect of stand^{g} in H$_2$O w. clothes on, same temp^{r} as air (even thro. Evap^{n} & rad^{n} have ceas^{d}). Loss by cond^{n} gtr the gtr the diffce of temp^{r} & the gtr the vel^{y} of air. A warm air in mot^{n} appears cooler than a calm one of same temp^{r}.

Rad^{n} is the stronger, the gtr the diff^{ce} of temp^{r}. betwn two bodies. In a hot room, one natur^{ly} fans, in order to incr. loss of heat by the two other sources — Evap^{n} & cond^{n}

Dir^{n} of wind can be ascert^{d} by moist^{d} finger feel^{g} colder on side look^{g} tow^{ds} the wind — does not answer so well when air is moist.

Clothing not the source of warmth

The moisture veil intercepts w. radn, just as cloud in sky prevents formn of dew.

Colour of dress no great influe. on radn of heat — but for rays of heat f. lumin.s bod.s diffe. is very great. Dress in black we feel much hotter in sun.

amount of radiation from the dress will depend on the rapidity of conduction of heat from the skin. The amount of conduction and of radiation of heat will vary considerably with the *material* and *colour* of the dress.

As regards conductivity, the two extremes are represented by linen and fur. It is found that if the conducting power for heat of linen = 100, then that of wool = 50 to 70. This partly explains why woollen goods are so much warmer than linen. We shall find that there is another explanation in the comparative hygroscopic properties of the two materials.

As regards radiation of heat, in one experiment it was found that while a piece of linen took $10\frac{1}{2}$ minutes to cool, a corresponding piece of flannel took $11\frac{1}{2}$ minutes.

Apart from the material, the *colour of dress* has some influence in regulating the loss of heat. Dark-coloured materials absorb more light and heat than lighter coloured materials; they may be good or bad conductors of heat, according to the nature of the material. White reflects the rays of light and heat; hence it is a poor absorber. In summer it prevents the passage of heat inwards, and, in winter, may prevent its passage from the body. It is thus well adapted for both winter and summer clothing, and has the additional advantage of being the cleanest colour.

Franklin placed a number of squares of different coloured cloths of the same material on snow, and found after a time that the snow covered by the black piece was most, and by the white piece least melted. In another set of experiments, shirting materials dyed various colours were taken, and it was found that if the rays of heat received by white were represented as 100, pale straw received 102, dark yellow 140, light green 155, Turkey red 165, dark green 168, light blue 198, black 208.

The influence of colour is antagonised to a large extent by the nature of the material; the increased heat absorbed by a dark material may be counterbalanced by the material being a good conductor. Also the influence of colour is only exerted

Isaiah BC. 760. was scandalised by luxurious dress? of Jewish women (Chap. 3.)
350 yrs later Euripides savagely remarks "the woman is an animal fond of ornament".
apices of lungs (vis? above clav?) compar? uncov?

A very mistaken concept? to suppose that cloth? is an appr to keep air f. us. Those text? are warmest, wh. most perm? to air.

With movt? of diaphragm 1½". descent 18 times per min in deep inspir? = 2160 cub? per diem, c.w. ord? resp? 720 cub?.
Liver doubles this amt? (2½ to 3") Suct? power of R. vent. removes
system disgorged thep? (circ? helped by this movt?
Post? origin of gast? ulcer f. press? also uterine flex?

heated. This is seen especially in female apparel; petticoats are piled one over the other in the lower part of the trunk, while the neck and upper part of the chest are left comparatively bare, and the legs are but imperfectly protected. The same evil is seen in the short sleeves, and short and low-necked dresses of young children. The adoption of "combination" garments for women, and of sleeves and leggings for young children, is a most desirable reform, and one which will doubtless greatly diminish the diseases due to exposure to cold.

4. *The clothing should not be tight;* and this for three reasons. First, because *loose clothing is warmer* than tight; this everyone has experienced in the case of gloves. The retention of air in the meshes of clothing is one of the main causes of its warmth. Air is a bad conductor of heat; the tighter the clothing, the less air it contains in its meshes, and consequently the cooler it is. The imprisonment of air in the meshes of the material largely explains the warmth of eider-down quilts, furs, and flannels as contrasted with linen.

Secondly, clothing should not be tight, in order *to avoid interference with the action of muscles.* Tight sleeves prevent the muscles of the arms and chest from being exercised. Tightly laced corsets imprison the trunk muscles, prevent their contractions, and so lead to muscular weakness and occasionally spinal curvature. Tight skirts similarly prevent free play of the lower limbs, leading to a halting gait, a diminished amount of exercise, with all the evils following deficient exercise. Tight clothing is however not confined to one sex, and in all cases leads to hampered movements and deficient muscularity.

Thirdly, tight clothing tends to *impede the functions of circulation, respiration, and digestion.* The fashion which more than any other interferes with important functions is *tight-lacing.*

This produces (1) compression and displacement of the viscera; the liver and the stomach especially suffer. (2) Respiration is interfered with, the action of the diaphragm being impeded. (3)

Circulation is to some extent obstructed, and so we get the fairly characteristic bluish-red nose of tight-lacing. (4) The muscles of

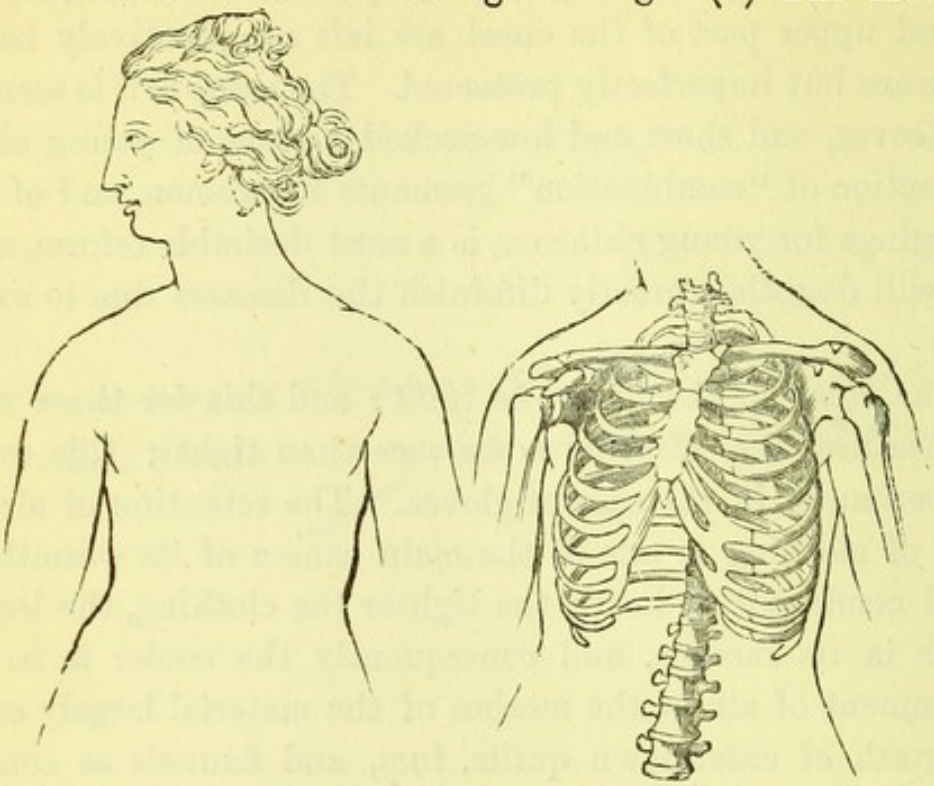


FIG. 23—THE NATURAL FIGURE.

the trunk being tightly encased, are incapable of movement, and consequently tend to waste and atrophy. (5) The general outline

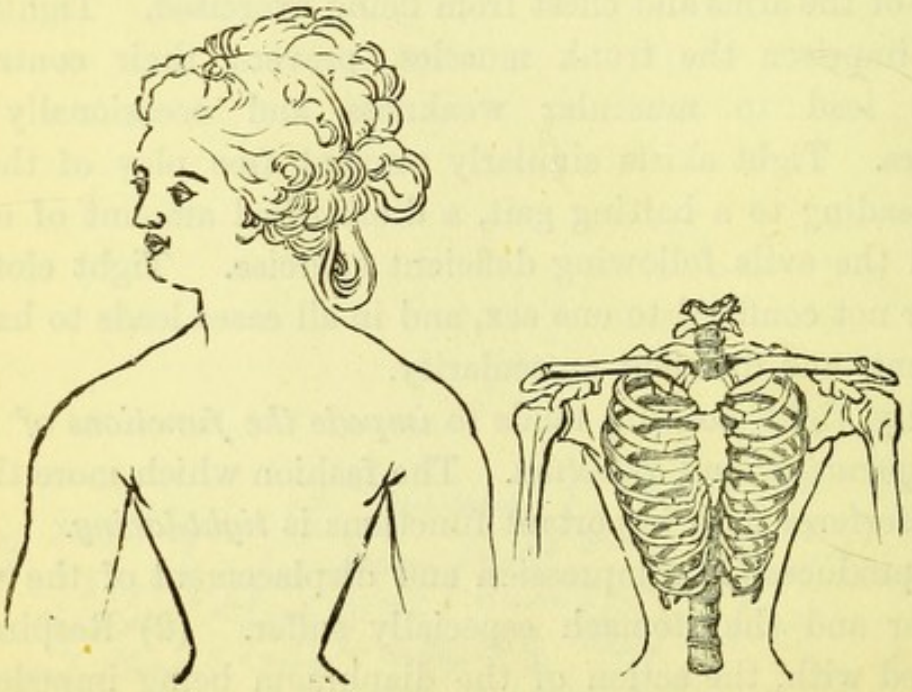


FIG 24.—THE FIGURE PRODUCED BY TIGHT-LACING.

The nose is the knocker of the respiratory organs (W. K. Parker).

Punch said: "the girdle of beauty is not a stay lace"

No adult woman's waist shd measr under 24".
This only permits too slender women. Rule of beauty
is that waist shd be twice the size of throat.
The celebd statue of Venus de Medici, the acknowld type
of beauty has waist of 27", height of fig. being 5 ft 2 in.

Gorillas, orang-outangs & other tailless apes walk on toes,
so high-heeled boots wd appear to be a reversn to an ancestral type

of the body is altered. Instead of the waist being elliptical, as it naturally is, it becomes nearly circular; and instead of its circumference averaging twenty-six to twenty-seven inches, it is eighteen to twenty-one inches, or even less.

Garters are another constricting agency to be carefully avoided. Varicose veins may be caused by them, and not uncommonly cold feet, from the impeded circulation. Stockings are best supported by suspenders from the waist.

Tight sleeves and skirts, by restricting the movements of the limbs and so preventing proper exercise, are likewise injurious.

Tight boots, again, are injurious, as they tend to destroy the natural elasticity of the movements, and confine them within narrow limits. They act to some extent the part of splints. During childhood they are very apt to produce permanently weak ankles. Moreover, by interfering with the circulation of blood through the feet, they cause cold feet, and not uncommonly chilblains. *High-heeled boots* are extremely injurious, as they do not allow the natural elasticity of the foot to come into action. This accounts for the uncertain and ungraceful gait of many ladies. Supposing the heel of the foot can rise six inches from the ground in walking, if the boot-heel props it up $1\frac{1}{2}$ inches, the extent of possible movement is reduced to $4\frac{1}{2}$ inches. High heels throw the weight of the body on the front part of the foot; the consequence is that the balance of the body is disturbed, and more strain is thrown on the spinal muscles. This may result in spinal curvature, in extreme cases; while corns and bunions are common consequences. Supporting the skirts from the waist alone is injurious, as important organs are compressed and displaced; this effect is not entirely prevented by fastening them over the corset.

5. *The weight of the clothing should be the smallest amount consistent with warmth, and it should be evenly distributed.* The chief weight should not be suspended from the waist, as here the parts are not well supported by bones. The shoulders and hips should share in the suspension of clothing, thus diminishing the

danger of compression and displacement of internal organs. In order that clothing may be as light as possible, it should be made to fit to each limb separately, thus diminishing the amount of material required. The protection from cold afforded by petticoats is at the best fortuitous; and a much smaller quantity of clothing fitted to the limbs is equally warm.

6. *The materials of dress should be as far as possible uninflammable.* This may sometimes be disregarded, but is often important, as in the nursery. In this respect, as in many others, wool possesses great advantages. Woollen fabrics smoulder rather than burst into flames, and thus the injury resulting from any accident is limited. Cotton is more inflammable than linen, linen than silk, and silk than wool. A closely woven cloth is less inflammable than one with open meshes. Women's apparel is most liable to be set on fire, and especially if crinolines and long trains are worn. A muslin dress, *plus* a crinoline, is one of the most dangerous combinations. A long cotton pinafore is a common source of burning among children, when playing near the fire.

Dress materials, and more particularly muslin, have been rendered non-inflammable by treating with a solution of ammonic phosphate, or ammonic phosphate and ammonic chloride mixed. The best material, however, is sodic tungstate, which, unlike the others, is not affected by ironing. Sodic molybdate is used in arsenals to render the workmen's clothing non-inflammable. All the above plans are objectionable, as the weight of the material is increased 18 to 29 per cent., and they all wash out. To remedy this, a "fire-proof starch," containing sodic tungstate has been devised.

Perfect non-inflammability is only required in certain dangerous occupations. The plans hitherto mentioned simply prevent the fabric breaking out into flame. The only cloth absolutely unaffected by fire is asbestos cloth.

7. *Elegance of dress*, although not so important as utility, is not to be neglected, and the two are perfectly compatible. In fact,

Merino - made orig.ly f. wool of Spanish merino sheep - now chiefly grown in Australia. Botany wool same as merino wool. Name chiefly used for dress mat.ls

elegance is indirectly associated with utility, for nothing which is awkward, or leads to obstructed movements or distortions of the body, is really elegant. A sudden constriction, as in a very tight waist, is not only bad from a hygienic point of view, but is also ugly.

Materials for Clothing.—The materials used are derived partly from the vegetable world, as hemp, flax, cotton; and partly from the animal world, as silk, wool, hair, feathers. The most important materials are wool, silk, cotton, and flax.

1. *Wool* varies somewhat in character, according to the animal from which it is derived. In all its varieties, however, it preserves the character of a bad conducting and porous substance, the two most important requisites in a dress material.

(1) Wool from the sheep is really a soft and elastic hair, composed of fibres three to eight inches long, and about $\frac{1}{1000}$ inch thick. The finer and shorter wools are used for fine cloth, the longer and coarser for "poplins," "worsted pieces," etc. Flannel is a woollen stuff of rather open and slight fabric. Wool is irritating to delicate skins, and may be so much so, that it cannot be worn next the skin, whether as flannel, worsted, or merino. In these cases, it may be worn outside a linen or gauze vest, and so all its advantages secured. It is one of the worst conductors of heat, and ought always to be worn in winter; while even in summer, it ensures a greater immunity from chill after perspiration than any other material.

(2) *Cashmere* is made from the down found about the roots of the hair of the Thibet goat. Imitation cashmere is made of various materials mixed together.

(3) *Alpaca* is obtained from the fleece of the llama, alpaca, and vicuna. It is longer than the fleece of the sheep, the fibres, which are soft and strong, averaging six inches in length. It is commonly made up with cotton or silk.

(4) *Mohair* is the hair of a goat inhabiting the mountains near Angora. It is woven into an almost waterproof cloth, and used in making plush, braid, etc.

2. *Hair* derived from the horse or cow differs from the hair usually called wool, in the greater solidity of its structure, which makes it ill-adapted for clothing. Its chief use is in the manufacture of felts, of which hats are made.

3. *Leather* is a kind of natural felt, very close and firm in its texture. It is used in this country chiefly for boots, but in some colder climates also for coats, etc. It is impervious to moisture, like sealskin, and is consequently not very healthy. The same objection applies to *chamois-leather underclothing*, which is non-porous, and consequently keeps the skin hot and clammy; also, it cannot be washed without becoming stiff on drying. This necessitates wearing the material after it has become impregnated with excretory matters from the skin.

4. *Silk.* The thread spun by the silk-worm is composed of filaments $\frac{1}{2000}$ inch wide, and is the strongest and most tenacious of textile fabrics. Its thread is three times as strong as a thread of flax of the same thickness, and twice as strong as a thread of hemp.

Its fibres are round like those of linen, but softer and smaller; it gives an agreeable sensation of freshness to the skin even more than linen. It is a worse conductor of heat than cotton or linen. Its great disadvantage for wearing next the skin, apart from its expense, is that it irritates delicate skins, and may even produce a rash on the skin.

Satin is silk so prepared as to form a smooth, polished surface.

Velvet is a silk fabric of which the pile is due to the insertion of short pieces of silk thread under the weft or cross-thread. Cheaper kinds are made, containing a certain proportion of cotton.

Crape is made of raw silk gummed and twisted to form a gauze-like fabric. Taffety, moire, brocade, and plush are made of silk alone or combined with cotton.

5. *Cotton* consists of the downy hairs investing the seeds of the gossypium plant. The threads of which it is composed are flat, ribbon-like, and twisted, about $\frac{1}{800}$ to $\frac{1}{2000}$ inch wide. Owing to

Com^{n}. Flax (Linum usitatissimum) Mummies wrapt in linen cloth. Linen wears & keeps its colour bet^{r} than calico. Reg^{d} adult^{d} by cotton Not easy to detect when new: but after being wash^{d} a cloth in wh. cot^{n} thds mixed w. linen never has a perf^{y} smooth glossy appear^{ce} Exam. by magnif^{g} glass Easy test – take sm. piece of cloth, soak it for a few mins in a boil^{g} mixt. of eq. pts KOH & H_2O in glass vessel. Then press between sheets of white blott^{g} paper until perf^{y} dry, then draw thds apart in succ^{n} & inv^{e}. White or pale yellow thds cot^{n}, dark yel. thds linen

its flat fibres with sharp edges, it is apt to irritate delicate skins; linen is always preferred for dressing wounds for a similar reason. Cotton is warmer than linen, being a worse conductor of heat. It also absorbs moisture better, not becoming wet so soon; but it lacks the "freshness" which makes linen materials pleasant to wear.

Calico, fustian, jean, velveteen, and muslin are the chief cotton fabrics.

6. *Flax* is formed from the fibres of the flax plant. Linen is made from it. Cambric and lawn are very fine and thin linen materials. The fibres of linen are round and pliable; thus it is smooth and soft, and peculiarly agreeable to the skin. It is, however, a good conductor of heat, just the opposite of what a warm dress ought to be. In consequence "it feels cold" to the skin. In addition, its fibres, being porous, attract the moisture of perspiration, the air in the pores being displaced. As water is a much better conductor of heat than air, a feeling of general chilliness results. Most of the advantages of linen and flannel combined, may be obtained by wearing linen next to the skin, and flannel outside this.

7. *Mackintoshes* are valuable as a temporary protection against external wet. Worn for more than a short period, they produce great heat and a sense of closeness, owing to retention of the perspiration. They would be cool were it not for their impermeability to moisture, as they are good conductors of heat.

The best form of mackintosh is that having a cape, with a space for evaporation between it and the rest of the garment. It is also preferable to wear a mackintosh in which the waterproof material is outside, uncovered by a thin cloth, so as to simulate an ordinary overcoat; as the latter increases in weight when it becomes wet.

The Amount of Clothing required varies with circumstances. 1. *Health;* those of robust constitution require less than the feeble. The more active are digestion and assimilation, the less is the amount of clothing required. It is well to remember that if heat is preserved by clothing, less food is required. Thus a distinct

saving of food is effected by warm clothes. Warm clothes are the equivalent of so much food that would have been required to keep up the temperature of the body, if the clothes had not been worn. This is well shewn in cases of starvation, as after a shipwreck. Thinly clad persons in such situations die much more quickly than those who are better protected.

2. *Climate and season.* Clothing requires to be adapted to these. In winter and in cold climates the amount of clothing must be increased, and warmer materials chosen. In the changeable climate of Great Britain, it is difficult to adapt the character of one's dress to the requirements of each day, or even to various parts of the same day. It is important, however, to remember that *clothing ought not to be changed according to the calendar*, but according to the weather. The tendency is to assume summer clothing too early in the spring, and to continue it too far into the autumn. The sudden changes of temperature in autumn and spring are particularly dangerous, and should be guarded against by flannel. According to Boërhave, winter clothing should be put off on Midsummer day, and resumed the day after. This, although rather exaggerated, may serve to impress the caution required. The same authority says that only fools and beggars suffer from cold, the latter not being able to procure sufficient clothes, the former not having the sense to wear them.

3. *Age.* Those at the two extremes of life are specially susceptible to cold. The mortality of infants during the first few months of life is nearly doubled in winter. It has been said that one-sixth of the deaths of young children result directly or indirectly from cold.

After the age of thirty-five, it is better to exceed than to be deficient in clothing. A degree of cold that would act as a useful tonic to the robust and middle-aged, produces serious and even fatal depression of the vital powers in children or aged people. For the same reason it is advisable to discontinue cold baths as age advances.

Power of generat^{n}. heat is at its minim. in all anim^{s} as demonst^{d} by M. Edwards — inures^{s} after birth

The younger a chd & the larger its surfe as compared w. its bulk, for the area of a body varies as the sq. of its dimens^{ns}, while its mass varies as their cube. Thus a cube 1." in the side has 6 sq. in. of surf^{e}. to 1 c. in of bulk, while a cube 10". in side has 600 sq. in. of surf. to 1000 c. in bulk. Thus if chd is $\frac{1}{10}$ sized of mother, besides feebler power of prod^{n}. heat, it has 10 times as much surf^{e} in prop^{n} to its size by wh. heat lost.

Clothes shd be "suppl^{t} to" in the indiv^{l} case to protect the body effect^{s} of an abn^{l} sensation of cold, however slight" (A Combe)

Insect as to how far we ought to hand over the regn. of our heat-loss to our dress, & how far trust to the self-help of the org^{sm}. One ought to possess the capab^{y} of reading for self-help but not trust & use it (Pettenkofer)

Binders & swaddlers for infants pernicious.

A very pernicious delusion is prevalent, that children ought to be "hardened" to the influences of cold, and that too much clothing "makes them tender." Excessive clothing may possibly increase the tendency to "catch cold," owing to its exciting perspiration, or owing to the fact that the extra clothing is commonly thrown off at irregular intervals—witness the effects of wearing a scarf round the neck occasionally. But to suppose that children can be hardened by exposure of arms and legs, and other parts of their bodies, is irrational. A large amount of heat is lost from these bare surfaces, and apart altogether from the danger of chill, more food must be taken to compensate for this loss of heat, and keep up an equable temperature. Also if the food taken is expended in preserving the warmth of the unprotected body, less material is left for the purpose of growth. From these causes it frequently happens that children remain stunted in growth, even if latent disease is not actually developed by the extra strain on their resources.

Gutter children are often pointed to as demonstrating the power of hardening. It is forgotten, however, how many of these poor children have perished under the hardening system, and that the good health of those remaining is in spite of the hardening—is, in fact, due to the survival of the fittest.

Poisonous Dyes in Clothing.—These, like poisonous wall-papers, were formerly much more common than at present, and, as in wall-papers, the poisonous agent has most frequently been arsenic, large quantities of which are used in the preparation of certain dyes. *Magenta*-coloured materials have been the most common source of poisoning, and it has generally been found that the material contains arsenic—in some analyses as much as 2 per cent. of arsenic trioxide and 7½ per cent. of arsenic pentoxide.

A few years ago many cases of poisoning were produced by *coralline*, which forms a brilliant red dye; probably here the active cause was arsenic.

Scheele's green (arsenite of copper) has been occasionally employed

to dye fabrics green, and it is extremely noxious, as it is apt to get rubbed off and inhaled by others as well as the wearer.

Cochineal red is said sometimes to contain an injurious amount of arseniate of alumina. When a fabric dyed with this is worn next the skin, the latter becomes red and inflamed, and may even ulcerate, severe constitutional symptoms being also produced.

Yellow and orange chromates of lead have been used for dyeing clothing materials, and would doubtless be very injurious.

There is scarcely any material worn next the skin, which has not been at one time or another the means of poisoning the wearer. A red "chest protector" has produced a copious rash; and arsenic poisoning has followed the wearing of red flannel shirts. Red socks and stockings have occasionally produced inflammation of the feet. Occasionally black silk gloves have produced inflammation of the skin of the hands, and still more frequently those lined with magenta-coloured wool. Shoes lined with yellow leather have produced a copious rash on the feet, though the nature of the poison in the leather does not seem to have been ascertained.

The means of detecting arsenic in any fabric or wall-paper, will be described in Chapter XXVIII.

CHAPTER XXIV.

HOUSE DRAINAGE.

The Amount of Sewage.—Rain-water Pipes.—Bath-room Pipes.—Disconnection from the Drain.—Sinks.—Water-closets.—Varieties of Water-closets.—The Soil Pipe.—Ventilation of Soil Pipe.—The House Drain.—Traps.—Insecurity of Traps.

The **Removal of Impurities.**—In order that health may be maintained in any inhabited house, it is essential that the impurities, that is the excreta, necessarily connected with animal life, should be removed. These excreta may be divided into two classes,—the first including the gaseous and volatile products

Gt mistake in suppos^{n} fæc. ten. the nuisance to be cared for.
Masses of decay^{g} effluvia f. basins & baths, of^{g} scourings f. decay^{g} soil^{d}
clothing fertile culture media: culinary outpourings are virtually
weak of^{g} baths

Sewage defined by Sewt Comm of Brit. Assn '69, as incl.g all refuse fr. human habitns that may affect pub. health.
Includes 1. human excrem.t 2. kitchen aq. 3. wash-hse aq.
4. Drainge fr. stables & cowhses (anim. & vegl. refuse) & fr. slaughter hses.

Matrs to be disposed of in towns are – 1. fæces & urine.
2. Slop water, incldg cookg, ablutn, house cleang & laundry water.
3. water fr. cleang & watering streets.
4. waste water of factories. 5. rainfall. 6. stable manure
7. Kitchen & market refuse.

Spite of the lge propn of H2O, the amt of solid matr in the daily urine is abt 1/3 gter than the amt of dry matr in daily fæces & its manurial value is 6 times greater. (Voelcker)

Sir J Lawes & Dr Gilbert estimd fresh fæces of adult man at 4.17 ozs, urine 50.18 ozs
When dried fæces = 1.041 oz. urine = 1.735 oz – thus total solid = 2.776 oz
water = 51.574 oz. (W)

Presence or absence of fæces makes but little diffce in foulness of sewage. One ton of Lond. sewge contns but 2–3 lbs solid matr.

evolved from the lungs and skin; and the second, the liquid excretion from the kidneys, and the solid from the bowels. The former are got rid of by efficient ventilation; the latter, ought to be as quickly removed, but require more elaborate arrangements to ensure this.

The **average daily amount** of solid excreta is about 4 ounces, and of fluid excreta about 50 ounces for each adult male. Taking all ages and both sexes into consideration, Letheby gives the mean amount per head as 2·784 ounces of fæces and 31·851 ounces of urine.

When urine and fæces are mixed, after a variable interval they begin to decompose, ammonia and fœtid gases being disengaged in large quantities. In analyses of sewer-air the chief gases found were carbonic acid, nitrogen, carburetted hydrogen, sulphuretted hydrogen, and carbo-ammoniacal volatile compounds.

In addition to the excreta, house-slops have to be got rid of, and "dust." **House-slops** vary greatly in quantity, but probably amount to as much as sixteen gallons per head daily. They consist chiefly of the water used in cooking and washing and for baths.

The **Dust** consists chiefly of the ashes from fires, but the dust-bin also forms a favourite refuge for kitchen refuse, composed of various animal and vegetable matters, as well as for broken pots and tins. It is dealt with apart from the house-slops and excreta, except in certain dry methods of disposal of sewage.

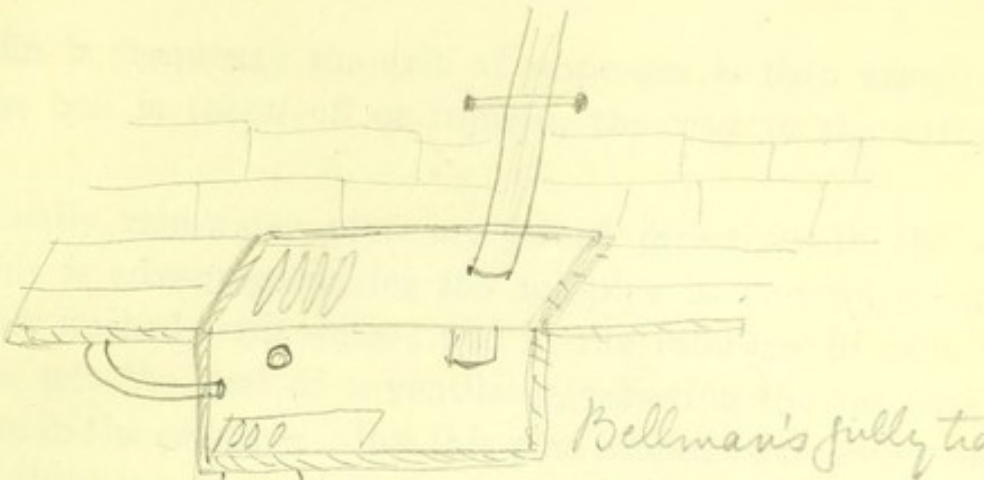
Two chief plans of getting rid of the sewage have been proposed, though there are many varieties of these. They are—

1. The Water Method, and
2. The Dry Methods.

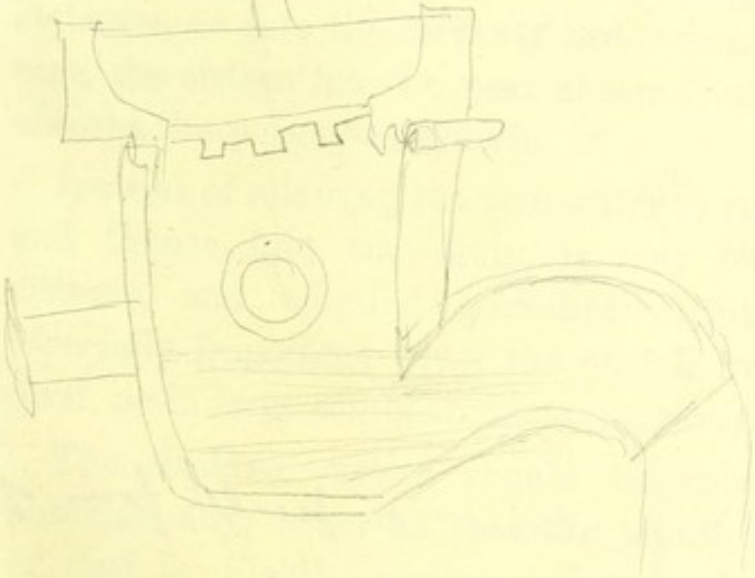
Each of these has its advocates, and with both a good result can be obtained. For large towns, however, the water carriage of sewage is preferable, and in this chapter we shall confine ourselves to the part of this system, which relates to the **Drainage of the House.**

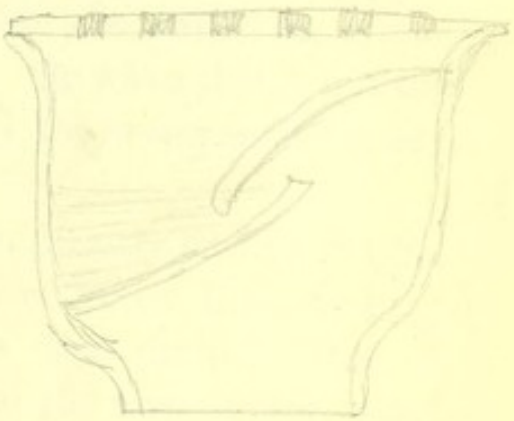
The chief appurtenances of a house, which empty their contents into the drain and thence into the street sewer, are—(1) Rain-water Pipes; (2) Bath-room and Sink-pipes; (3) Water-closets; (4) Soil-pipes; and (5) The House Drain. We will consider these in detail.

Rain-water Pipes collect the water from the roof by means of gutters, and carry it down to the house drain, except in the few cases in which the rain-water is collected for use. The connection with the drain may be direct, the rain-water pipe opening into the drain, with or without the intervention of a syphon trap. In either of these cases, though chiefly when there is no trap, foul gases ascend the pipe; and if the upper end of this is near a window, they are blown into the house, and thus form an occasional cause of diphtheria, sore-throat, and other diseases. When there is a trap, the rain-water pipe tends to become blocked by leaves or other matters washed down from the roof, and then water overflows the gutter and runs down the side of the house. It is evidently preferable, therefore, for rain-water pipes to end a short distance over a grating, which communicates with the drain. In this case, if sewer-gases, by any failure of the trap, escape, instead of mounting the water-pipe, they become diffused in the atmosphere outside the grating; and foreign particles are intercepted before they can block up the junction with the drain. The opening in the yard, into which the rain-water falls, should be provided with a water-trap, which prevents the escape of sewer-gas from the drain. A syphon-gully, with a galvanised iron grating, is a good form for this purpose, though a *Bell Trap* is commonly employed. The latter ought, on no account, to be allowed. It consists of a perforated plate, which has a bell-shaped piece of iron fastened on to its under surface. The edge of this piece of iron, when in position, lies below the surface of the water contained in the iron trough. Thus, water flows through the perforated plate, and under the edges of the bell, into the drain below. The chief objections to this form of trap are that (1) the water in the trap tends to become dry, unless the

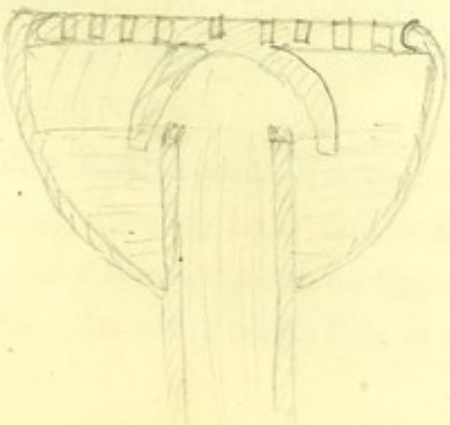


Bellman's gully trap.





Anti-D trap.



Field's syphon depds for its actn on peculr form of lip of inner tube

fall of rain is frequent; the exit of sewer-gas is then easy. (2) When the bell is taken off or injured, the way to the drain is direct.

Occasionally rain-water pipes are joined directly with the soil-pipe. This is advantageous for the soil-pipe in two ways: it is occasionally flushed with water; and in the intervals of rain, the water-pipe acts the part of a ventilator, relieving the pressure of sewer-gases in the soil-pipe. But this plan cannot be recommended. For when there is a heavy fall of rain, the ventilating action of the rain-pipe ceases, and the gases contained in the soil-pipe are driven in some other direction, often through defective traps into the house. And even when it acts as a ventilator, the top of the rain-pipe is often near some window, and impure gases are wafted in at the staircase, or into the servants' bed-rooms. Or when this is not the case, the cistern may be near at hand, and the water in it eagerly absorbs the poisonous effluvia.

Instead of allowing the rain-water to run directly on to a grating and thence into the drain, it may be collected into flushing cisterns, and emptied periodically into the drain. This is especially important when the outfall into the street-sewer is not good, or in large establishments, however good the fall may be.

The *flushing cistern* should be constructed to empty itself automatically, when its contents attain a certain depth. This is effected by Field's annular syphon, and other cisterns by various makers.

The *overflow-pipe from the cistern* should be made to end directly in the external air on the leads, so as to join the rain-water pipe. It must on no account be joined to any part of the water-closet system.

The Bath-room Waste and Over-flow Pipes are very frequently carried directly into the soil-pipe, thus helping to keep the latter properly flushed, but at the same time ventilating it into the bath-room. In some cases this is ostensibly prevented by a syphon bend

in the waste pipe from the bath. This does not answer the desired end; for if the bath is not frequently used, the water in the trap dries up, and then the connection between the bath-room and the soil-pipe is direct; and if this does not occur, sewer-gas may be absorbed by the water in the trap, and given up on the other side to the air of the bath-room. The waste-pipe of the bath (and the same applies to its over-flow pipe) ought either to open into the rain-pipe, or be carried down to the outside of the house, and open a short distance above a grating with a syphon gully attached, like the rain-water pipe.

Under the bath is usually placed a leaden tray, called a *safe*, to catch any accidental spillings of water. The small pipe leading from this must not be connected with the soil-pipe, or in any way directly with the drain. It is preferable to allow it to open in the external air, and have it so far prolonged, that if there is any leakage, the water will not run down the sides of the wall.

The importance of attention to these rules is very great. The bath-room is a frequent source of poisoning by sewer-gas, and especially so now that bath-rooms are commonly made to communicate with bed-rooms. The danger is still further increased if the bath-room contains a water-closet.

Sinks are not uncommonly the source of offensive smells, when made of stone. The use of a clean and hard glazed sink, such as the one shewn in the accompanying figure, is much to be preferred.

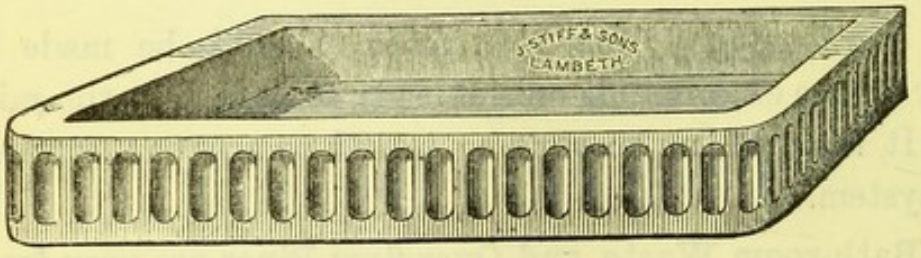


FIG. 25.

STIFF'S STONEWARE KITCHEN SINK.

The sink should, where possible, be placed against an external

wall, as it is then much easier to carry the waste pipe outside the house. Very commonly, the sink pipe passes directly into the drain, the only thing preventing the entry of sewer-gas into the kitchen being a bell-trap at the sink. The futility of this in preventing the passage of sewer-gas has been already stated. In addition, if any obstruction to the flow of water occurs, it is removed, and then foul gases ascend into the house, with sad results in many cases as regards health. Occasionally a syphon trap is substituted for the bell-trap, being placed just under the sink. This is better than the bell-trap, but alone is not a sufficient safeguard. The syphon should have an inspection opening at its lowest point, fitted with a screw cap, so that it can be cleansed if necessary.

The safest way, however, of preventing the entry of sewer-gas into the kitchen, is to disconnect the sink-pipe from the drain, making it open over a grating, below which is a water trap, as in the case of the rain-water pipe.

Where it is inconvenient or objectionable for the sink-pipe to open into the outer air, the use of some such trap as that shewn on *Fig. 26.* is advisable. This is equally serviceable for bath-room or other waste-pipes, and presents several advantages. The waste-pipe discharge is concealed from view; no splashing or overflow is possible; while, at the same time, the disconnection from the house-drain is perfect. The waste-pipe is connected with the trap at A, while D is the exit into the house-drain. A B is a syphon-shaped inlet tube, which curves sideways, so that the water entering at A is never sent through the ventilating grating E. The exit pipe C D dips three inches below the water-level, forming a second powerful water-trap. The water in the trap A B is completely separated from

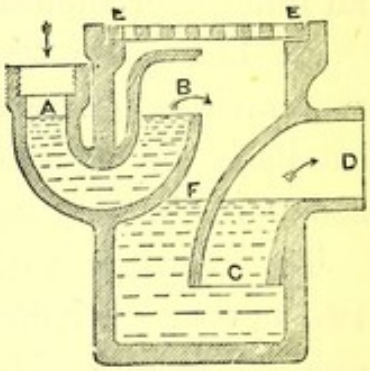


FIG. 26.

THE WEATHERLY DISCONNECTOR WASTE WATER TRAP.

that in F C, so that if any sewer air enters the latter, it will at once make its exit through the grating E E. This trap also forms a good grease-trap, preventing the entry of soap and fatty matters into the drain,—a fertile source of obstruction. They collect at the point F, and can be easily cleaned out, as well as the rest of the trap.

Water-closets require to be skilfully constructed and well-situated, if they are not to become nuisances and fertile causes of disease. In building a house, the *position* of the closet should be carefully considered. In all cases it should be in an out-standing part of the house, and against the external wall. Instead of this, one commonly finds it in any convenient recess, abutting on a bed-room, or where it cannot be properly ventilated. Usually the closet is placed at the back of the house; and as the main-sewer is often situated in the street, as a necessary consequence the soil-pipe has usually to pass under the house. This is a bad arrangement, and should be avoided when possible. The closet should be connected with other parts of the house by a passage, and an inner door should separate it from them.

As bad gases tend to ascend, a closet on an upper floor is preferable. There should be no closet on the same floor as the kitchen. Water-closets in bath-rooms are very liable to be a source of danger, unless the hygienic arrangements are perfect.

The *ventilation* of the closet should be good—if possible, by two opposite windows. If there is only one window, it is advisable to have a perforated brick or iron grating in the wall. If there are several water-closets, they should be directly over one another, and the junction between the pipes should be curved, and not at a right angle.



FIG. 27.
PERFORATED VENTILATING BRICK.

The *water-supply* to the closet should be abundant. Every flush of water should be sufficient to carry the contents of the

basin through the soil-pipe into the sewer. The quantity allowed by the Water Companies is limited to two gallons, which is barely sufficient for this purpose. The source of the water-supply is commonly either the main water-pipe or the drinking-water cistern, the latter mode of supply being shewn in *Fig. 2.* Both these plans are dangerous, as they occasionally lead to the contamination of drinking water with effluvia from the closet, if not also with sewer gases. Each closet should have a separate cistern or service-box; and it is a good plan to have water-waste preventers, by means of which a certain quantity of water, and no more, can be discharged each time the handle is pulled. For wash-out or hopper closets, one of the best of these is the *syphon waste-preventer* of Messrs. Purnell, shown in *Fig. 28.* When the handle of this is

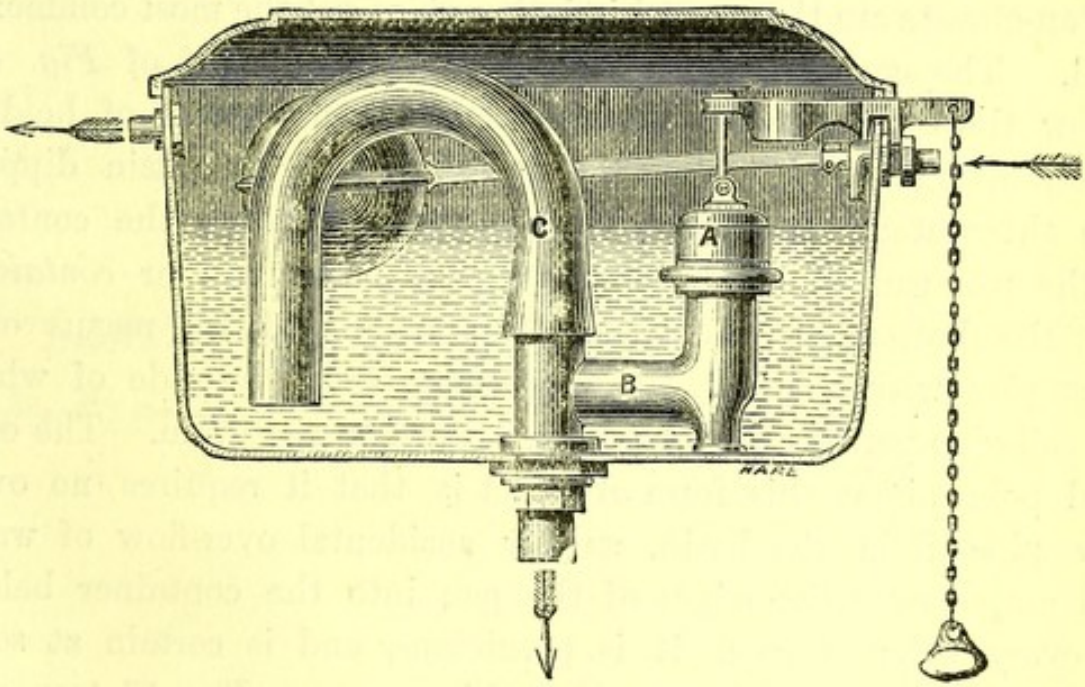


FIG. 28.
SYPHON WASTE-PREVENTER.

pulled, the whole of the water in the cistern is syphoned out by the syphon C and carried down to the water-closet, whether the handle be held down or not. The amount of fall from the cistern to the closet should not be less than three or four feet, in order to ensure a thorough scouring of the soil-pipe; and the flushing-pipe

should have an internal diameter of not less than $1\frac{1}{4}$ inches. It is commonly supposed that a small flow of water, trickling continuously down a closet, tends to keep it clean, and prevent smells; but the water thus used is simply wasted. Others fasten up the handle of the closets occasionally, so as to allow a large flow of water. This does not answer the desired end, and renders the offending person liable to a penalty of £5 for wasting water.

Many different forms of water-closet are in use. In all of them the main requisites are that there should be (1) a good flush of water, (2) a rapid removal of the excreta, and (3) no possibility of reflux of gases. The chief varieties of closets are the pan-closet, the valve-closet, and the wash-out closet, but there are endless modifications of these.

Pan-closets are the worst kind, though as yet the most commonly used. The construction is shown in the left half of *Fig. 30.* Below the conical basin there is a metal pan capable of holding a certain amount of water, the lower end of the basin dipping into this water. By means of a pull-up apparatus the contents of the pan can be tilted into a second larger pan or *container*, and the bottom of the container is connected by means of a short pipe with a leaden ᑌ shaped trap, from the side of which the soil-pipe passes out to be carried down to the drain. The only good point about this form of closet is that it requires no over-flow pipe from the basin, as any accidental over-flow of water will escape over the edges of the pan into the container below. In every other respect it is pernicious, and is certain at some time to produce a nuisance, if nothing more. The ᑌ trap and container always arrest a certain amount of foul matter; foul gases accumulate and escape into the house, whenever the closet is used. Occasionally the ᑌ trap becomes corroded by the filth it contains, and then there is free communication with the drain.

Valve Closets differ from the last in having no container, but only a small box containing a movable water-tight valve, exactly fitting the lower edge of the basin. They are much superior to

Leaving tap on of W. C. Dangers, bec. if intermt supply, gases & even soil may be suckd up into water-pipe.

Pan & valve closets both essentl valve closets.

Doulton's have introd a glazed Earthenwr container, wh. prevts any corrosn

Valveless closets (1) much less liable to disord. than valved.
(2) do not req^e an overflow pipe, nor (3) a safe.
(4) Price less & less mech^m than valved.
(5) more ready for disch^e of bedroom slops.
Shd never be adopt^d where restrict^d supply of aq.

'Hopper' closet a simple form of valveless.

Wash-out closet manuf^d in one piece – obj^ns (1) back pt of outlet of basin is oft^n than not cov^d w. filth, even where a flushing rim. (2) If used as a urinal (expan^e urinals objects in private hses) mine trickles over basin & causes smells. (3) If W.C. bec^s choked, whole appar^s has to be taken up to unstop it.

Macfarlane's trough-closet made of Fe, absorbs & ret^ns offens^e odours, defic^t in flushing power, as foul surf^s can^t effly water stand^g in trough.

the pan-closet, but require an over-flow pipe in order to avoid accidental flooding of the closet. The over-flow pipe should be made with a syphon bend in it, and the flushing of the closet should be so arranged, that each time it is performed water enters the over-flow pipe. The valve may be in the form of a ∪ trap or a syphon. The syphon is decidedly the better form, as it is not so easily fouled. It is preferably made of glazed earthenware. The water remaining in the syphon as a rule prevents sewer-gas getting through the valve into the house, and its preventive action is aided by the water contained in the pan. In certain circumstances however, these may both be sucked dry; the soil-pipe should therefore be always ventilated.

An excellent form of **Wash-out Closet** is shewn in *Fig. 29.* It is called the "National" closet, and is manufactured by Mr. T. Twyford, of Hanley. The water-supply pipe is opposite the outlet, and water "flush" removes the excreta immediately. The outlet into the trap is large, preventing any possibility of its becoming choked by paper, etc., while the "flush" is, owing to the formation of the basin, concentrated at the outlet, thus driving the excreta through the trap at the first flush. The trap has a water-seal of about an inch, and a ventilator is placed on the soil-pipe side of this. The illustration shews the best method of fixing the closet, and syphon cistern water-supply.

Where water-closets are required for large collections of people, as in manufactories or schools, the ordinary forms get blocked up, and cause great trouble. Under these circumstances, trough and tumbler-closets have been found very useful.

The Trough-closet consists of a series of seats, under which is a water-tight trough sloping towards a common drain, which leads to the sewer by an opening which is closed by a plug. The plug is removed by an attendant once or twice per day, and the contents of the trough allowed to run into the drain; and after washing out the trough, as much water is let in as will cover the contents and prevent any smell in the interval. This plan has been found to

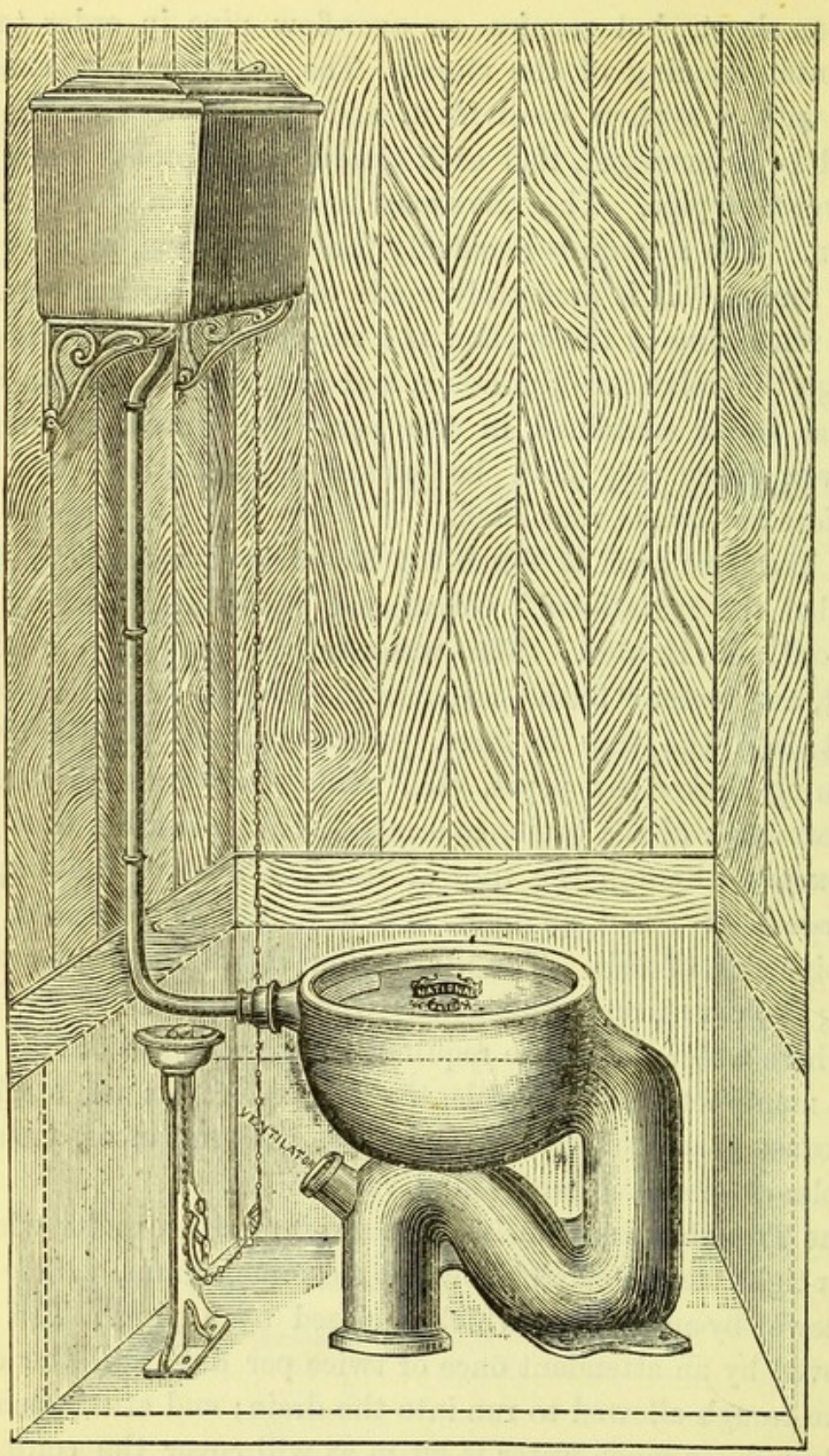


FIG. 29
TWYFORD'S "NATIONAL" WASH-OUT CLOSET.

x. This plan resp.ly had for valve-closets, prod.s drawg.s
Ifnot prod.s to have a separ.e anang.t, let closet be valveless,
& the wooden seat cover a lead seat or "overall."

Joint of Pb pipe shd not be a slip joint, nor a cotter bit joint, but a wiped joint

Sheet lead w. a told vert.d joint is not advis.e Drawn lead pipes
with.t seam are best.
Glass pipes recomd.d by some, but the only kind suit.e is the glass lined
Te pipe made in New York.

work admirably in Liverpool, and to compare very favourably with water-closets (often such only in name) in London and other large towns. (Buchanan).

The Tumbler-closet resembles the last, except in its arrangements for flushing. There is no plug, but at the upper end of the trough a bucket is placed into which water constantly drips, and so arranged that when the bucket is full it tips over, and washes the contents of the trough into the drain. With both these systems it is essential that the soil-drain should be thoroughly ventilated. If this is ensured, they are extremely efficient.

Under water-closets as well as baths, a leaden tray or *safe* is usually placed to catch any accidental overflow of water, occurring if the trap of the closet becomes blocked up, or if slops are emptied into the basin. The discharge pipe from the safe should never be connected with the ᑌ trap of a water-closet, or with the soil-pipe, but end (like the waste pipes of sinks and cisterns) in the open air.

The waste-pipe from the housemaid's sink is not uncommonly connected with the trap of the water-closet, as in the left half of *Fig. 30.* × It should have a special discharge pipe, and be ventilated like the soil-pipe.

The Soil-pipe carries the contents of the water-closets into the drain. Its connection with the trap of the closet should be perfectly made, and the soil-pipe should pass directly from the closet into the open air. It is much preferable for it *to be carried outside the house* altogether, even though, in order to do this, it has to perform a circuitous course. It may be made of glazed earthenware or of iron, but lead pipes are objectionable, as they are rapidly corroded by the action of sewage (De Chaumont). Dr. Corfield advises that the soil-pipe be made of drawn lead, and not a seam pipe. If an iron pipe is used, perfect joints are more difficult to make than with a lead pipe. If there is any risk of the pipes becoming frozen, they may be covered with Smith's patent felt, or some similar non-conducting material.

The soil-pipe should be throughout its course under observation. Even when it has to pass under the house, it would be a great improvement to have it contained in an accessible subterranean passage, well ventilated at its two ends. Such a subway would also tend to keep the house dry.

The soil-pipe should be four inches in diameter for ordinary-sized houses, and should be continued from its highest point above the roof by a pipe of the same diameter, with its end wide open. This *ventilation of the soil-pipe* is essential, if the house is to be safe from the entry of sewer-gas by the closets, traps alone being unreliable. If no such ventilator is provided, the water discharged out of one closet often draws all the water out of the trap of another, and so leaves the way open for the entry of foul air from the upper part of the unventilated pipe. Where there are two or three water-closets, it is as a rule sufficient to have the uppermost branch of the soil-pipe connected with the ventilating shaft. The junction should be made at the highest point of the syphon of the water-closet. The upper end of the ventilated pipe should be made to open remote from any window. It may terminate in a dilated opening, or have a cowl attached, in order to aspirate the gases contained in the soil-pipe upwards. In the latter case there should be an inlet for fresh air at the other end of the drain, between the house and the water-trap, which we shall see it is desirable to place near the junction of the house drain with the street sewer. This inlet ensures a constant current of fresh air up the ventilating shaft (or *stench pipe*, as it is sometimes called). Some prefer not to have such an inlet, but to allow the stench-pipe to ventilate the street sewers. If every house were provided with a stench-pipe, this would probably be unobjectionable; but under present circumstances it is advisable to disconnect the sewer from the house-system of drainage, so far as possible, by an efficient trap.

The accompanying illustration of Mr. Banner's method of ventilating the soil-pipe is almost self explanatory. A revolving

Shd not be built into a wall where it can be pierced by nails
Shd not be inside hse - fault for such ? f. weak points in pts. W

4" Enough for a series of 3 or 4 WCs over one another (W.)

Vent? pipes shd never be of Zinc, as it is impss to
make secure joints with these.

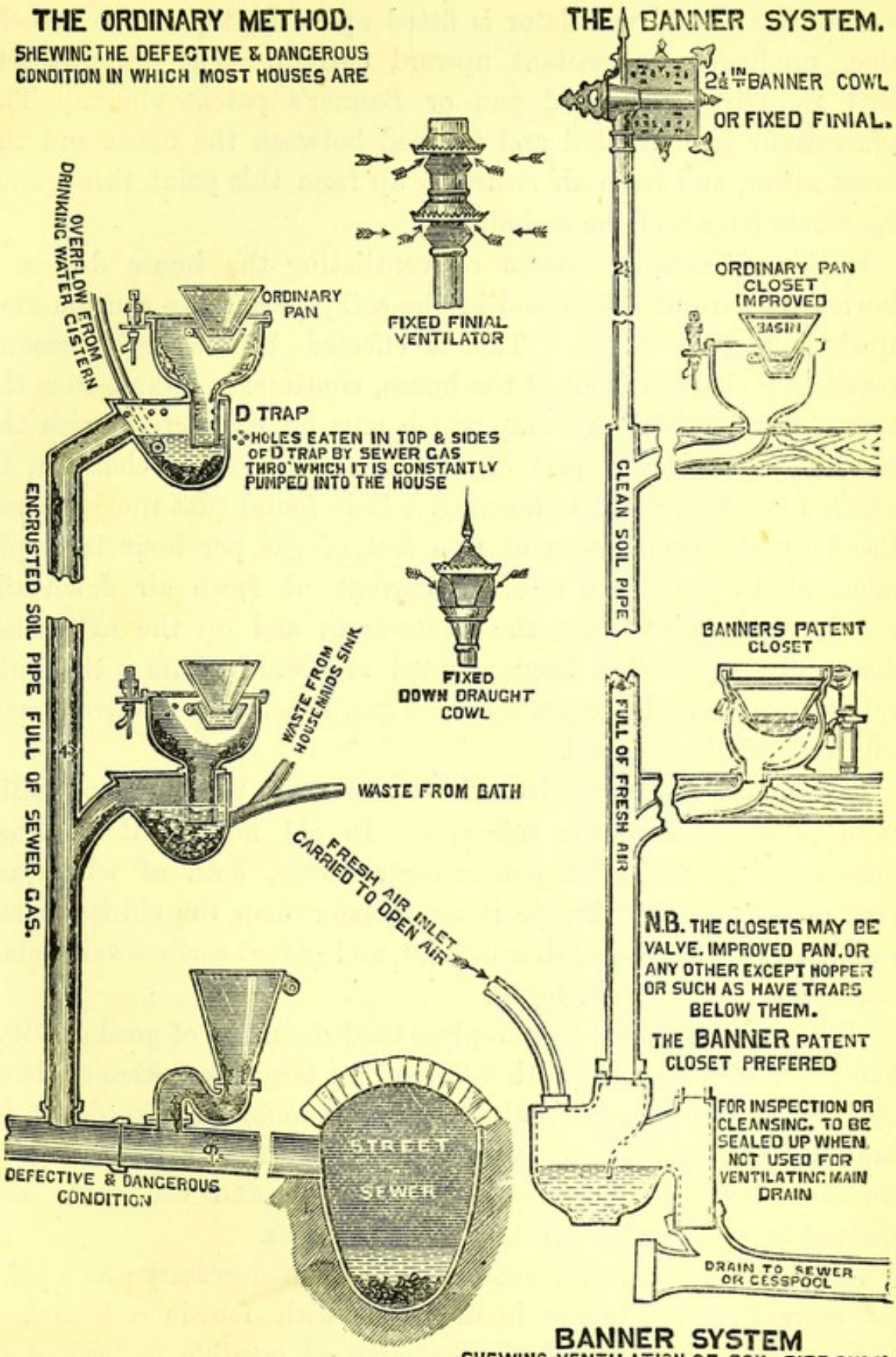


FIG. 30.—COMPARISON OF THE BANNER SYSTEM OF VENTILATION OF SOIL-PIPE WITH AN UNVENTILATED SYSTEM.

cowl or fixed finial ventilator is fitted upon the top of the stench-pipe, producing a constant upward current. The water-closets used are either improved pan or Banner's patent closet. The house-drain is ventilated and trapped between the house and the street sewer, and fresh air is drawn up from this point throughout the whole length of the soil-pipe.

In Mr. Mineard's system of ventilating the house drains, a downward current is induced in the soil-pipe and its continuation upwards to the eaves. This is effected by having a second ventilating shaft in front of the house, continued upwards from the house-side of a Weaver's trap which cuts off connection with the sewer. In the lower part of this shaft is a small chamber, in which a small gas-light is burning. It is found that the heat produced by the combustion of two feet of gas per hour is amply sufficient to produce a constant current of fresh air down the ventilated soil-pipe along the house-drain and up the extraction shaft. This plan has been adopted at Sandringham; the only objection to it is the expense of the gas, but this is not great, and will probably be reduced.

The House Drain receives the contents of the sink and bath-room pipes, and of the soil-pipe. In old houses, it is often constructed of bricks or porous earthenware, both of which are very objectionable. A pipe is much safer than the old-fashioned quadrilateral drain—well-burnt, hard, and glazed earthenware being the material usually employed.

It is essential that the drain-pipes used should be of good quality. According to competent authorities, a very large proportion of those used do not bear investigation. They should be laid down in straight lines, and without any right-angled junctions. If bends are necessary, bent pipes should be used, and the curve not effected by opening the joints of straight pipes.

The drain-pipes should not be larger than necessary; as a rule, not more than six inches in diameter, with four-inch branches. The practice of making drains as large as possible instead of as

As to drain note 1/. allignment 2/. inclinⁿ 3/ junctⁿˢ
1/ straight as posˢ

Have a plan of yr drains, as may thus save yr expense.

Arnold's fashᵈ. drain has been well called a retort for the manufᵉ of sewer poisons wh. 'laid on' to ea. house.

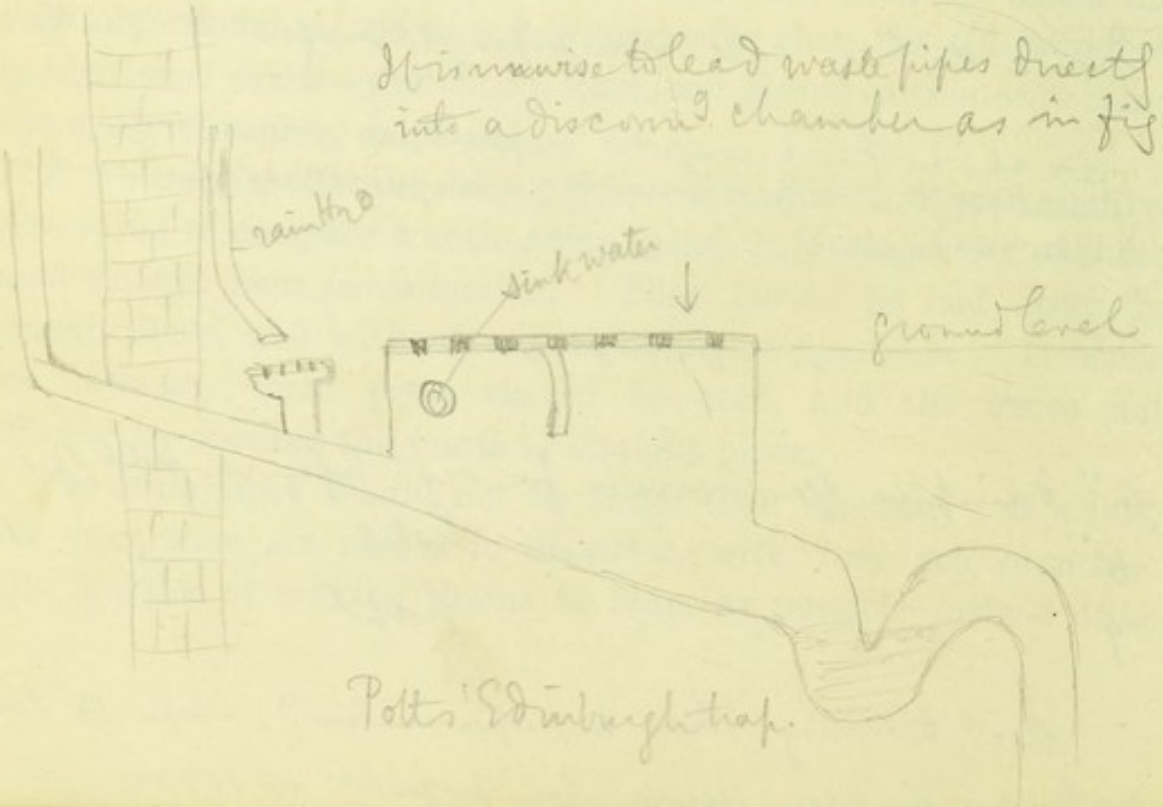
Inside the hse cast-iron pipes yr's preferˢ to Earthenware.

Pipes shd be free f. cowpats or inequals on inner surfᵉ.
cement for jt, not to project inwds. Where junctⁿˢ reqᵈ. specˢ constructed
lengths shd be introd?

4" drain pipe 1/2 enough for ordⁿ hse, wᵈ. fall of 1 in 40 ✓
6" " " " " Hotel " " 1 in 60 ✓
9" " " " " hospl " " 1 in 80 ✓

Accᵍ to Waring, where a proper inclinⁿ, a pipe 18" diamᵗ,
makes an ample sewer for populⁿ of 10000

Stanford's sanitary drain-pipe has a bet: joint.
shd be if poss: a little extra fall at junct^ns or bends.
Manhole cover shd be air-tight, as Angell's.



small as possible, is inexcusable. It is the large drains which become choked, not the small; for, in the latter, the pressure of the water being greater, the rate of movement is also greater; and so all foreign matters are driven along. A fall of at least one in thirty, or four inches in ten feet, should be allowed to a drain, in order to ensure the proper velocity in the transit of the contents, and to prevent the formation of deposits. Where this amount of fall is not obtainable, an automatic flush-tank should be employed for flushing the drain at intervals.

The joints between the pipes must be properly secured; and if cement is used for this purpose, it is important to take care that the cement does not form a hard ridge at the joint. When houses have to be drained from back to front through the basement, the drain-pipes must be bedded in concrete, and have ventilating traps at the back and front of the house. For pipes running under the floors, iron pipes coated with Dr. Angus Smith's patent preservative solution, or treated by Professor Barff's process, have often been used, the joints being made with lead. According to Mr. E. Turner, these present some practical disadvantages, and there is still wanted a glazed stoneware pipe, with a better joint than is at present in the market.

Where the drains are laid in concrete, *manholes* should be arranged, so that the drainage system may be accessible, and, if necessary, may be brushed out from end to end without opening up the ground.

The junction of the house-drain with the street-sewer should be oblique, and not at right angles. It should be efficiently trapped, the common flap-trap not being sufficient for this purpose.

Traps are now very properly required for house-drains of all new buildings, under the bye-laws issued by the Local Government Board. Bye-law No. 63 requires that all house-drains shall be trapped from the public sewer or cesspool. Various traps have been devised for this purpose, all being modifications of the syphon, with ventilating openings. *Weaver's ventilating sewer-air*

trap is an excellent contrivance of this kind, being simple in arrangement, and not liable to become blocked. The water in D prevents sewer-gas proceeding towards the house; but a much more effectual preventive is furnished by the opening at E, which can be connected with an upright ventilator, just as is the soil-pipe. If the street-sewer is provided with a ventilating shaft, this is unnecessary. Any foul matter which may have become dissolved in the water D, is immediately diluted with a large volume of fresh air descending through the inlet C.

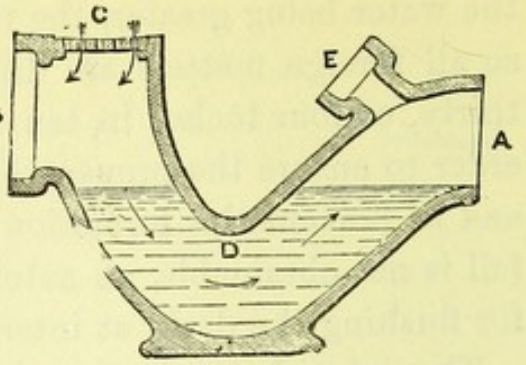


FIG. 31.
WEAVER'S VENTILATING SEWER-AIR TRAP.

Bye-law No. 65 requires the provision of two ventilating openings for the house-drain. One of these should be on the house side of, and as near as possible to, the trap, and is furnished at C in Weaver's trap. The other is provided by carrying the water-closet pipe upwards without any diminution in its calibre, and where practicable, without any bend or angle, as required by Bye-law No. 66.

Another form of trap, known as the *Intercepter Sewer-Air Trap*, may be used instead of the previous one. Ventilating pipes from B and D are carried just above the ground level. The two water seals F and G with intermediate ventilation effectually intercept any sewer-gases. Even should the pressure of sewer-gas force the trap at F, carrying the sewer-gas beyond the chamber C where it is generally confined, it will at once escape into the open air through B. The much stronger trap at G excludes all sewer-gas from A which forms the only avenue to the house. The aperture at D is useful for cleansing, and also serves to carry a current of pure air

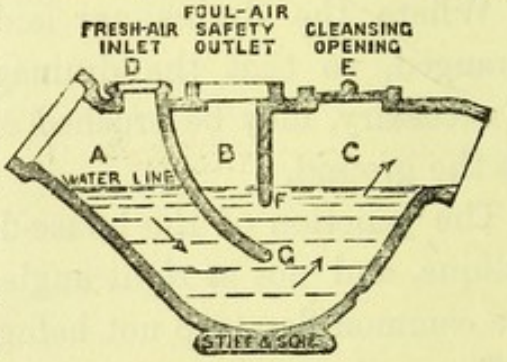
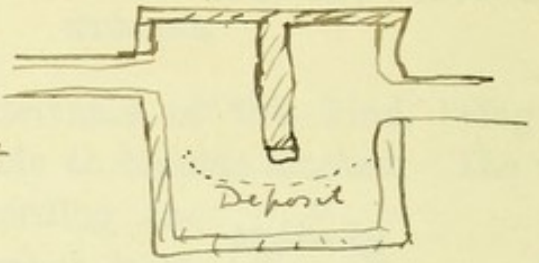


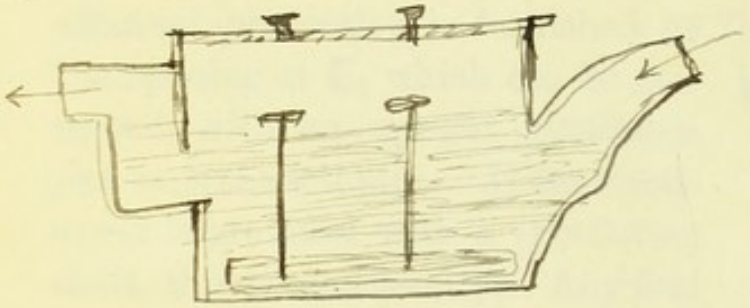
FIG. 32.
STIFF'S INTERCEPTER SEWER-AIR TRAP.

Mansergh's + Edinburgh traps not self-cleansing.
Buchan's better. Hellyer's drain interceptor is best (W)

Diaphragm or Mushroom trap should never be recommended, there is usually distinct retangular sector of drain may not admit any other. Dry when very little water & liable to accumulate sputa &c. It is a small cesspool. Not self cleansing.



Grease trap very useful in connection with kitchen sink discharges. But traps must constant attention.



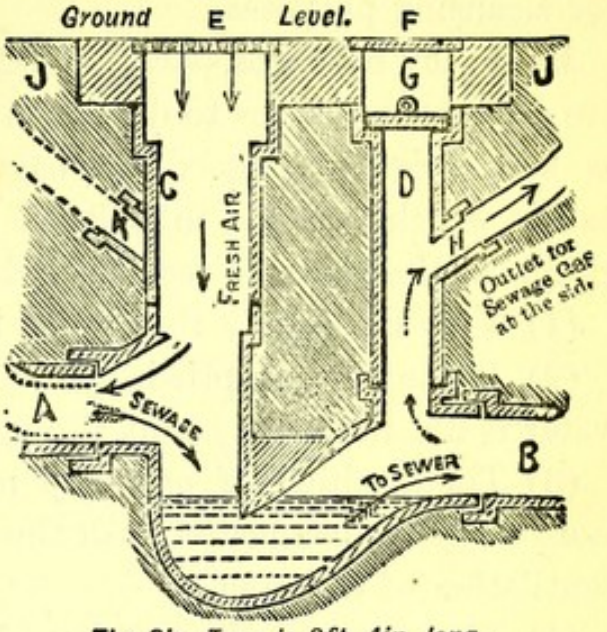
Sir R. Rawlinson recommended the Dr. at Scutari during the Crimean War from 45 per day to about 9 per week, simply by fixing a flap of canvas to the exit of sewers, thus preventing the return of sewer air past the hospital conveniences.

D trap called by Sir W. Jenner the double D, otherwise dissimilar dealing

Hellyer's Anti-D trap is the best for WCs

through the house-drain and soil-pipe to the open upper end of the latter.

Fig. 33 illustrates *Buchan's trap*, which is efficient for the same purposes as the preceding. In the illustration of Banner's system of ventilation is seen a section of another form of ventilating trap.



The 6in. Trap is 2ft. 4in. long.

FIG. 33.

VERTICAL SECTION *in situ* OF A NO. 2 BUCHAN'S PATENT DRAIN-TRAP.

Varieties of Traps.—As traps are commonly the only means used to prevent the warm house drawing sewer air into its interior, their construction is a matter of great importance. There are endless varieties, but they may be classed conveniently under four heads—the syphon, mid-feather, flap-trap, and ball-trap.

The *flap-trap* is merely a hinged valve allowing water to flow only in one direction. It is probably very inefficient for preventing the reflux of sewer-gas. The *ball-trap* is scarcely ever used in drains.

The *syphon* is a useful form of trap, most efficient when its bend is deep, and like the letter U. It sometimes gets blocked up, and for that reason it is advisable to have the limb nearest the house almost vertical, and the other limb sloped, so as to increase the rapidity of the current through it. It is also well to have means for reaching the syphon and cleaning it out.

The *mid-feather trap* is simply a box of varying shape, with the entry at one side and the discharge pipe at the other, and one or more partitions reaching down between these. The ⊍ trap, the common bell-trap, and the dipstone-trap, belong to this division, and none of them is very efficient. The presence of partitions tends to produce obstruction of solid matters, and it is therefore

essential in all traps of this kind to have means of reaching them for cleansing purposes.

Efficiency of Traps.—Eassie has said "honestly speaking, traps are dangerous articles to deal with; they should be treated merely as auxiliaries to a good drainage system." There are various causes which lead one to look on traps as *traps* in another sense, giving a false sense of security, when none exists.

(1) Very commonly the trap is badly laid to begin with.

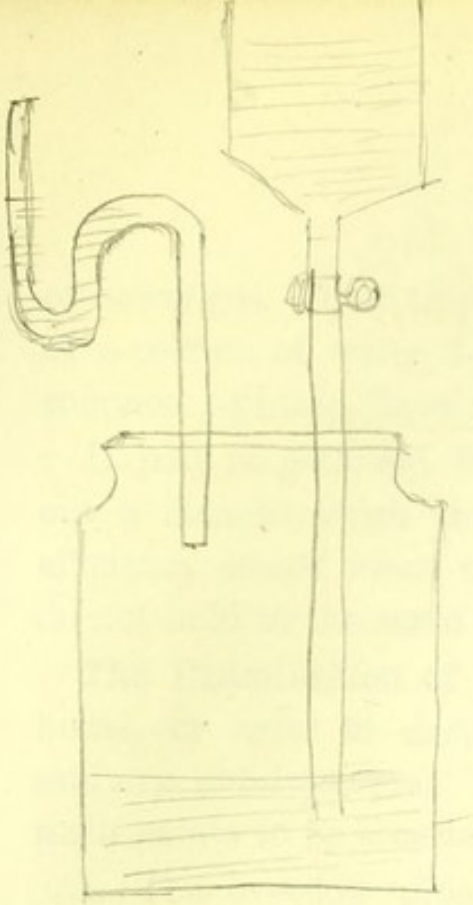
(2) It may be emptied by evaporation, or become clogged if water is not frequently sent through it.

(3) The flushing of one trap may empty others, when two or more traps are connected with the same line of pipe without any ventilation of the pipe.

(4) The water of the trap may become impregnated with sewer effluvia, and then these escape on the house side. Dr. Fergus, of Glasgow, made some interesting experiments with a syphon tube containing water, and found that ammonia passed through the water in from fifteen to thirty minutes, sulphuretted hydrogen in three to four hours, sulphurous acid in an hour, carbonic acid in three hours. When a ventilating pipe was fixed at the highest point of the syphon, similar results were obtained, only the reaction was a little slower in appearing.

(5) When the pipe is only two or three inches wide, and "runs full," especially if the descent is a rapid one, the water may be sucked out of the trap; to avoid this, the pipe must be large enough to prevent its running full, or the trap must be larger than the rest of the pipe.

(6) The pressure of the sewer-gas may force it through the water of the trap. When a sewer suddenly becomes charged with a large amount of water, as after a heavy fall of rain, or when hot water is poured down a drain, great pressure is exerted tending to drive sewer-gases towards the house. At the same time, the higher temperature of the house commonly brings to bear an aspirating force, which greatly aids the external pressure



Best to have trap vent.d to prevent unsyphoning when 2 or 3 wastes enter a stack pipe. Attach a sm. pipe to inner side of syphon of lowest branch, & join to sim.r pipes fr each branch above, & then into stack above the highest in series. This is more imp.t for basin-shaped vessels, than for those w.h flat bottoms as baths.

of sewer-gas. Few traps possess a resisting power exceeding that of a column of water 1½ inches deep; and most of them, as the common bell-trap, have a resisting power of only a quarter-inch.

It may be gathered from these statements that a trap will keep out a stench which does not want to come in, but that its efficiency ceases when most urgently required. These objections do not hold to the same extent against ventilated traps.

The Examination of Drains ought to be undertaken in every house, in order to ensure that they are arranged according to sanitary requirements. It will be convenient to recapitulate the main points to be ascertained in such an examination.

1. The overflow pipe from the cistern should open into the outer air.

2. The water-closet should not be supplied from the same cistern as that providing drinking-water.

3. All waste and overflow pipes from the bath-room should open on to a grating in the yard, over a trapped junction with the drain.

4. All sink-pipes should similarly open on to a grating in the yard.

5. The soil-pipe should be continued upwards to the roof by a pipe of the same diameter, which is open at its upper extremity.

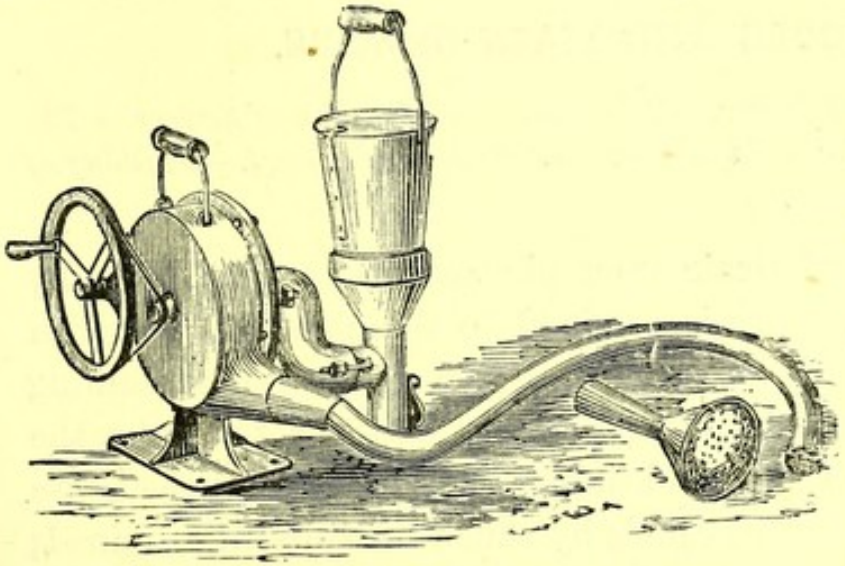


FIG. 34.
THE PATENT ASPHYXIATOR.

6. The rain-water stack-pipe must not be used for ventilating the soil-pipe.

7. The house-drain should be trapped by a ventilating trap, between the house and the main sewer.

Occasionally leakages occur in the soil-pipe or some other part of the drainage.

Such defective drains may be easily detected by Watts' Patent Asphyxiator (*Fig. 34*), which is really a more efficient means for applying the smoke test to drains. Some sulphur or smoke paper is put into the combustion chamber and ignited; if the nozzle at the end of the flexible tube is then inserted into the drain or soil-pipe, the rotation of the fan will force the fumes a long distance. All outlets or ventilating pipes must be carefully stopped during the operation, and the place where the smoke or sulphur is smelt, will then indicate any leaky point. The same apparatus may be used for disinfecting purposes.

Another test commonly applied, is to put about a table-spoonful of strong oil of peppermint down the highest water-closet in the house. If this is smelt in the lower closets, it indicates defective traps.

Rats are an important indication of defective drains. The presence of rats in a house should always lead to a thorough investigation of its drains.

CHAPTER XXV.

CESSPOOLS AND MAIN SEWERS.

Use of Terms Drain and Sewer.—Cesspools.—Construction of Sewers.—The Separate System for Rain Water.—Ventilation of Sewers.—Flushing of Sewers.—The Outfall.

The terms **Sewer and Drain** are used somewhat confusedly. By some the name of "drain" is confined to the channels in which surface or subsoil water is conveyed, and "sewer" to those containing foul water from the house. It is preferable, however, to employ the term *drain* to indicate the pipes bringing the sewage from the house into the street-sewer, and the canals by which the subsoil is drained; while the term *sewer* is confined to the trunk canals into which the house drains empty their contents.

Where the water-carriage system of sewage is adopted, involving

Chicago gentn suspectd tightness of his plumbd pipes. Confined cat in
bse wh. a few rms & rooms & then poured sols of Valerian into soil-pipe.
Cat detectd 3 leaks.

Water test for drains smooth. Diffict & Costly.

By placg a flame over ea. of sink-pipes can ascertn
whether any up-draught into hse.

Case in wh. lodger complnd of bad smells fr. drains: but landlady
said it cd not be the drains as there were none.

Where a cesspl. unavoidable, shd be kept as freeas possible from waste drain H_2O. It is preferable to have solids intercepted on way to cesspl. by a depositing platform, these collected & removed & earth for garden use.

On open & ill ventilated sites an old disused cesspl. shd not have any light near, as violent explosions are common.

For Sewers & Drains in quicksand cast-iron pipes had better be used. Earthenware sewers & drains shd be jointed w. hydraulic lime-mortar or concrete, never clay. In sandy gravelly & dry subsoils earthenware pipes shd be laid in puddle, worked into the sand, so as to make the trench watertight In main sewering, back drains shd be provided for (Rawlinson)

the use of water-closets as described in the last chapter, the sewage may be carried from the house either into cesspools or into the main sewer. The former plan is strongly to be deprecated, as the moist condition of the excreta renders them very prone to decompose and produce a nuisance.

Cesspools are only admissible in isolated country-houses supplied with water-closets. They should always be situated a considerable distance from the house, and should be emptied at regular intervals. The sewage may often be advantageously put on the land at once. The emptying of a cesspool always produces a temporary nuisance, unless it is well removed from the house and in the centre of a field.

The construction of the cesspool requires careful attention. Its walls should be of brickwork set in cement, lined inside with cement, and surrounded by clay puddle. The bottom should have a fall towards one end, where a pump can be fixed, to remove the more liquid contents. The depth of the cesspool should not exceed 7 feet, and it is a safe rule to make it in every case as small as possible. The drain emptying into the cesspool should be trapped and ventilated, near its junction with the cesspool; and the cesspool itself should be ventilated.

In connection with many of the older London houses, cesspools still exist, sometimes under the basement or near the house, and built with walls which allow soakage in every direction. The surrounding soil becomes contaminated for a considerable distance, the water in any neighbouring well is tainted, or leaky water-pipes receive the soakage. In towns where a central system of sewage exists, any existing cesspool should be cleansed out and then closed, and a direct connection made between the drain and the street-sewer.

Sewers are built of brick laid on a bed of concrete to prevent sinking of any part, the parts being most solidly put together. Their cross-section should be an egg-shaped oval with the small end downwards, it being found that this ensures the most rapid current. They should be laid in as straight a line as possible, and with an

even fall of from 1 in 244 to 1 in 784, so as to ensure a flow of at least two feet per second. Where a town is very flat, and a proper fall of sewer impossible, it is necessary to have locks at given points, which on being suddenly released flush the next section. In such cases the necessity of thorough ventilation of every portion of the sewer is specially great. Tributary sewers and house drains should join at oblique angles, in the direction of the main flow. At the junction with house drains, manholes should be placed in order that any obstruction may be removed; and the house-drain should be trapped near its junction with the sewer.

Inasmuch as the sewers have commonly to carry away the rain-water in addition to the waste matter from houses, their size must be regulated accordingly. The rainfall being very various, the sewers may occasionally become choked when it is excessive, while at another time they are imperfectly flushed. The storm-waters are got rid of, in the case of London, by having special openings into the Thames.

There are certain disadvantages in allowing the rainfall to enter the sewers. The sewage is thus diluted and rendered less useful for irrigation; larger sewers are required; and there is occasionally difficulty with the storm-water, which by overfilling the sewers may force sewer-gases up into dwelling-houses. The consideration of these facts has led in some cases to the adoption of **The Separate System,** by which the rain is carried in special conduits to the nearest river. The objections to this plan are that it necessitates a double system of drainage, and does not allow of the useful scouring effect of rain on sewers. Where it is feasible, however, it is certainly the best in principle, and is now adopted in all new schemes of drainage. In such cases the old brick drains are used for carrying off rain-water, while new *pipe-sewers* are employed for carrying the sewage. Such pipe-sewers can be quickly laid, and of any degree of curve required; they are not so liable to become fouled as brick-sewers, and on account of the decreased dilution of the sewage can be made smaller than brick-sewers. Their only

Size of conduit should be propn. to vol. of stream, wh. is as import. as rate of inclin. in secur. a cleans. flow. A 10' sewer wl req. 100 times as much sewt as a 1' sewer, in ordr to have same velr of flow.

Latham gives velr of 3' per sec. as least allowe for outlet drain of a hse. To secure this a 4" drain shd have minim. fall of 1 in 92, & must run half full

All sewers tend to bec. sewers of deposit when mater. too large for the work they have to perform.

Sewer pipes shd be salt-glazed, as thus subjd to more intense heat than in slip-glazing.

Where flow in sewer is fairly uniform, or minim. flow is $\frac{1}{2}$ the max. of day, circr sewer is best; but where flow is very varr during the day, egg-shaped gives best result w. a small flow, & also when liabil to undr. inroad of storm-water.

1 ton of Lond. Sewage contns only 2-3 lbs ~~solid sewt~~ matr

Filth removed fr. gutters & byestreets spite of dilign. scavenging is v. great - touch Horicas foul as odr sewe. Danger of men conng hse drains w. rain-sewer bec. nearest or by mistake.

Separate system - 1/. advisable in hilly towns subject to heavy storms - 2/. in lowly towns w. much subsoil water (as this drained be utilised for draing subsoil) - 3/. Where ultime treatt of sewage is to be by mechanl means or irrign. Lends enough water in sewage as is requisite for carrying purposes, any addn thereto only adds to expense & detracts fr. effcy of purificn

Where separ system may be often a want of water for flushing, after storms a large no of objectr matr may be cast into storm-water drains, to danger of banks or stream into wh. it empties.

Separ system at Memphis U.S. (W)

Experts of Cornelley & Haldane shew that micro-orgsms are diffused in sewer air by splashing - thus confirming Frankland's results f. Fr. sol^{ns}

Unventil^{d} sewers far more dangerous than steam-engines with^{t} safety-valves (Latham) Fungi wh. prod^{e} the rot in timber cant^{r} prod^{e} their germs in a cant^{r} of air, & just same principle in vent^{d} sewers.

Escape of air f. sewers often caused by entr^{e} of hot H$_2$O. Const^{ly} changing vol^{e} of water also influences g^{ts}: so do barom^{c} changes.

disadvantage is that they do not dry the subsoil, but this is unnecessary if the double system is adopted.

Sewers being closed conduits containing decomposing sewage, it is highly desirable that the gases resulting from decomposition should be freely diluted. Such gases always tend to diffuse, and if the only openings into a sewer be from the various houses in its track, they will receive its gases spite of all the traps devised. **Ventilation of the sewer** is, therefore, essential. This may be accomplished by gratings opening directly into the streets, when the latter are not too narrow. But in narrow streets, the stench is often so great that the inhabitants stop them up, and so the smell from other ventilators is intensified. There should be one ventilator for every 100 yards of a main sewer, or 18 to a mile (Rawlinson). When this proportion of ventilating gratings is allowed, generally no nuisance arises from them. Sewer gases as a rule are *only dangerous when concentrated.* Free dilution oxidises the organic matter associated with the active germs of disease, and as the latter require a soil in which to grow, oxidation of the soil obviates the danger of their development. Charcoal is occasionally used at the sides of ventilating gratings, or in manholes, to deodorise the sewer-gas. One cubic inch of beech-wood charcoal contains pores equal to an area of 100 superficial feet (Liebig). It absorbs 8 times its bulk of carbonic acid. Not only does it deodorise, but to some extent oxidises the organic matter, changing it into nitrites and nitrates. It, however, requires frequent changing, and often gets clogged with dust; and it is much better to trust to multiplication of ventilators, than to the deodorising of sewer-gases by any means.

Ventilating shafts may be erected at the highest point of the sewage system of a town, and again at the point of discharge. It has also been proposed to erect shafts at intermediate points, and by some to make the lamp-posts useful for this purpose. When sewers are laid with too deep a gradient, they act as chimneys, the gases mounting to the higher part of the town, and frustrating

any attempts at ventilation on lower levels. This explains why, in a few cases, typhoid fever has increased after the introduction of a general sewage system (*see page 267*).

Artificial ventilation of sewers is, as a rule, not advisable. Any attempt to drive the air along in a sewer (plenum system) will force the traps of houses, while attempts to exhaust it (vacuum system) only affect a very short length of sewer.

Flushing of Sewers is required at intervals, in order to remove any deposits of solid matter. Such deposits, with occasional choking, are due to the sewer being badly constructed, or having sunk in its bed, or presenting sharp curves in its interior, or the flow of water through it being deficient. Flushing is effected by damming back the water, and then allowing a sudden rush, which is generally effectual in removing the ill-smelling obstruction.

Spite of free ventilation and regular flushing, sewers will occasionally emit foul odours. The use of charcoal will diminish this nuisance, but is obviously only a palliative. Very commonly the fault is in the construction of the sewer. If this is old and leaky, it practically constitutes an elongated cesspool, and the sooner it is replaced by a perfectly built sewer the better.

Whenever there is stagnation, a foul odour is certain to be emitted. The cardinal rule with regard to sewage is to keep it in rapid onward motion, until it has passed the outlet of the sewer. *The introduction into a sewer of hot water* is to be greatly deprecated. It facilitates putrefactive changes, and as a comparatively high temperature is necessary for the development of the microscopic organisms to which specific fevers are probably due, it may also aid in propagating these. Dr. A. Carpenter has suggested a close connection between washing days and the origin of diphtheria.

The Outfall of a sewer requires to be large and perfectly free in order that the progress of the sewage may not be impeded. When the sewage is discharged into the sea above the low water level, it becomes backed up in the main sewers when the tide is high. This backward pressure has occasionally been so great as to

Sewers - Egg shape formed of 2 circles touching one another so that diam upper x 2 diam of lower.

Thus when depth of stream is diam, wetted perim the factor for friction, is propl reduced, instd of as in wt other forms of sewer being increased

Velocity shd be mean of 3 ft per sec - 4 ft shd not as a rule be exceed
Fall shd be generally 1 in 240

In sewers $V = 55\sqrt{H \cdot F}$ V = vel in ft per min. F = fall in ft per mile
H = hyd mean depth = $\frac{\text{area of cross sect of stream}}{\text{wetted perimeter}}$

In circ sewers $H = \frac{\text{diam}}{4}$ - in fact.

Vel varies as sq. root of H or F & vice-versâ in circ sewers wh the sq. roots of their diams, & qts discd by such sewers vary as the sq. roots of the 5th powers of their diams Vars in size of streams of other fig. of cross sect cause vars in vel proptl to the sq. roots of their respect hyd mn. depths.

Vars in vol. (or area of cross sects) do not necessly vary hyd mn. depth & consequ velocity; the hyd. mn depth & velocity of a circ sewer are the same whether running full or ½ full. A V shaped channel (to wh. Egg-Shaped sewer approxs) wd have same vel in ft at any depth of stream, for its bed & area preserve the same propns

force the sewage even into the cellars of houses. The same condition of things has occurred when the outfall is into a river below the water line, or into a tank out of which the sewage has to be pumped. In all these cases the ventilation of the sewers requires to be perfect, and great precautions taken to prevent obstruction of the outflow; otherwise the mortality from typhoid fever does not decrease, according to the general rule, after the establishment of a water system of sewage.

CHAPTER XXVI.

THE DISPOSAL OF SEWAGE.

Discharge of Sewers into Streams.—Discharge into the Sea.—Treatment by Subsidence.—Precipitation by Chemical Means.—Filtration.—Intermittent Downward Filtration.—Irrigation.—Objections to Sewage Farms.—Dust and Dustbins.

The water-carriage system of sewage is as Dr. Parkes puts it, "the cleanest, the readiest, the quickest, and in many cases the most inexpensive method." But when the sewage is conveyed to the outfall of the sewer, its ultimate disposal is still one of the most difficult problems of the present day. Various plans have been adopted, of which the following are the chief:—

1. Discharge into running water.
2. Discharge into the sea.
3. Separation of solid and liquid parts { By settlement / By precipitation.
4. Filtration through various media.
5. Irrigation.

Discharge at once into Running Water was formerly the favourite plan, as it was certainly the most convenient. The sewage was turned into the nearest watercourse, regardless of the fact that this might have to supply the drinking water of people at a lower point of the stream; as well as of the facts that the mouth of the river tended to become obstructed by sewage mud, that valuable stocks of fish were destroyed, and that the river which had

practically become a sewer was a source of annoyance and danger to all on it or near it. By the Rivers Pollutions Act of 1876, any future sewage works are forbidden in which the sewage is discharged into a river or stream without previous purification.

The sewage entering rivers undergoes considerable purification by subsidence, by oxidation, and by the influence of water plants. These however cannot be depended on, especially in regard to the most important class of impurities, namely, those which cause typhoid fever and other diseases.

Discharge into the Sea is resorted to in seaboard towns. The outlet pipe should, if possible, be always under water. If not, special care must be taken to prevent the wind blowing up the sewers. There should be a trap at the mouth of the outlet opening outwards, to partially prevent the rise of the tide banking up the sewage. If the sewage cannot be got out well to sea, it may cause a nuisance, and require to be purified before discharge.

In both these methods, there is a great waste of manure. The annual value of the sewage of London alone has been estimated at more than one million sterling.

For a single house or small village, the sewage may be stored in **a tank, with an overflow-pipe,** out of which the liquid parts escape, and are used to irrigate the land, while the solid parts are removed at intervals.

A similar subsidence system has been employed on a larger scale, the liquid parts being either turned into the stream or over the land, while the solid parts are mixed with street sweepings, and sold as manure.

If the liquid parts in any such system as this are turned into a stream, they are as offensive as the entire sewage, and the legal prohibition to discharging sewage into streams applies to them also.

The **precipitation of the solid parts** of the sewage is rendered much more perfect by the use of **chemical agents,** and at the same time the dissolved matters are to some extent removed.

Must have been freed frm its pollut.g ingred.ts by the best practic.e & avail.e means. Commiss.rs suggest.d that to be admiss.e, the effluent sew.e shd not cont.n over .3 of org.c N & 2 parts of org.c C per 100,000 parts.

3¼ mill.n tons of mud are contrib.d to Thames ev.y yr by sew.e wh. is greasy foul & in hot weather emits a disgust.g smell. The recent Com.n fr that sew.e thrown into tidal pt of river is constly liable to be thrown above outfalls, ow.g to tides & a peculr mist.g act.n. Qty of diss.d O in river water betw.n Greenhithe is practly nil, even a high water. Absence of fish fr. lower Thames prob.ly due to this.

Possib.y not all wast.d, as fish do feed on sew.e.

Sea-water does not cas.y oxid.e sewage. Disch.e shd only be allow.d below low-water level. Alex.a miss.e by sea-disch.e under where set of cur.t such that imm.d carr.d out to sea. Org.c matr takes O fr. sulphates of sea-H_2O, red.d to sulphides, whence SH_2 liber.d by CO_2 in H_2O. Flush.g sewers by sea-H_2O has proved a miss.e.

The Hills lime process is in use at Totn (Mg Cl$_2$ & can also add?)
The ord^{y} — — — — — Bradford.
Scott — — — — — Burnley.

Much better results f. use of clear lime H$_2$O.

Sew^{e} can't be effect^{y} treat^{d} by chem^{l} subst^{s} alone. But dir^{l} to clarif^{n} is v. advant^{s}. 8/10 of val^{e} constit^{s} of sew^{e} are sol^{e} & can^{t} be practic^{y} ppt^{d} f. so dilute a fld. Yet clarif^{n}, remov^{g} solids wh. impede penetr^{n} of sew^{e} into soil & give it a varnish-like aspect, is v. useful as an antec^{t} to filtr^{n}.

For clarif^{g} sew^{e} for broadirr^{n}, strain^{g} thro coke filt^{rs} usu^{y} adeq^{e} coke being util^{d} in furnaces. When land filtr^{n} adopt^{d} something more desir^{e}. Dif to pass into a stream with^{t} filtr^{n}, is indispens^{e}, as as leave under 1/2 of susp^{d} solids per gal. of effluent. Even then v. desir^{e} to have a good "run" in open chan^{l} to ensure aerat^{n} & beg^{g} nitrif^{n} bef. disch^{e} into rec^{g} stream.

Ca O need^{s} to be diss^{d} - thus 4 times as effic^{t} as milk of lime. Excess of Ca O injur^{s} bec. alk^{e} fld prefers more easily than acid, &c. Quant^{y} nitrif^{g} Ca O add^{d} should not exceed the hard^{s} of H$_2$O supp^{y}.
Subseq^{t} add^{n} of Al. Sulph^{e} conv^{s} any slight excess of Ca O into Ca SO$_4$.
Sm. qty Fe SO$_4$ useful. Hyd^{d}. perox. Fe ppt^{s}, an O carrier. Blacky^{g} mud banks by Fe^{s}. Sludge 1/ can be conv^{d} by filter presses into an odourless cake,
2/. Dried to powder by artif^{l} heat.
3/. fortif^{d} w. mat^{ls} of high fertil^{g} value. 4/. conv^{d} into cement.
A sludge f. Ca O process is of little manur^{l} value, but more so than Al. or other process. Cont^{g} least bulk w. max. manur^{l} ingred^{ts} is worth carry^{g} a dist^{e}.

(1) *Lime salts* are used as precipitants at Bradford and other places; cream of lime is usually employed, the precipitate being sold as manure or made into bricks. This plan seems to be a failure, both in respect of the purification of the water, and the value of the manure. In *Blyth's process*, a mixture of phosphates of magnesia and lime is used, but these only cause precipitation when the water contains an excess of ammonia, and the whole process is costly and not very efficient.

In *Whitbread's process*, the precipitant is a mixture of mono- and di-calcic phosphate with a little lime; the precipitation is rapid and complete, and the resulting manure apparently valuable.

(2) *Salts of Alumina* are also employed. *Bird's process* consists in the addition of crude aluminium sulphate, and subsequent filtration through coke. The resulting liquid is not sufficiently purified for admission into a river, without causing a nuisance. In *Anderson's process*, which produces a much more perfect result, the same salt is used, and the liquid is subsequently passed through a filtering bed.

(3) *Carbon* has been used, as vegetable charcoal, peat, lignite, etc. On a small scale it answers well, and produces a valuable manure.

(4) *Iron Salts.*—In *Holden's process* a mixture of iron sulphate, lime, coal-dust, and clay is added, but the liquid remaining does not contain a diminished amount of organic matter in solution.

These are only a few of many precipitation processes tried at various places. According to Dr. Parkes, the best precipitants appear to be the aluminous salts; the crude sulphate of alumina (Anderson's process); Lenk's patent solution; Sillar's A B C process, consisting of alum, charcoal, blood, and clay; and Forbes' acid solution of phosphate of alumina.

The precipitated solids are known as sludge. They are usually dried, and then sold as manures. The profit from them is never large, and in many cases they are a drug on the market.

Instead of making manures, the sale of which has often to be

subsidised, General Scott has proposed the addition of lime and clay to the sludge, and then the making of cement from it. It is doubtful whether the sewer water resulting from any of these precipitation processes is in a fit condition to be discharged into streams. It still contains in all cases some organic matter, potash, ammonia, and phosphoric acid.

Filtration of the sewage matter has been accomplished in various ways. In *Weare's process*, it is filtered through *carbon*, but this has not been very successful. *Upward filtration* has also been tried with unsatisfactory results.

Intermittent downward filtration through a considerable depth of soil has been found by the Rivers Pollution Commissioners to be attended with very good results. A porous soil is chosen, and the purified water is received in drains under it. The organic matter is to a large extent oxidised into carbonic acid, water, and nitric acid. Dr. Frankland's experiments shew that upward filtration through the same media does not purify. Downward intermittent filtration has been carried out on a large scale at Merthyr Tydvil, cabbages being planted on the surface of the filtering bed, thus helping to get rid of the organic matter.

Irrigation is the only process which at the same time purifies the sewage efficiently, is not detrimental to the health of neighbouring people, and is the source of a moderate amount of profit. The sewer water is allowed to flow at intervals over the land, different fields being irrigated in rotation. Immense crops of grass are obtained, though the grass tends to be coarse and rank.

The soil to be irrigated should have a gentle slope, and the water be conveyed by subsoil drains about 5 or 6 feet deep into the nearest water-course. The sewage should be delivered in as fresh condition as possible, and should be freed from its coarser portions by settlement or precipitation. The amount of land required is about 1 acre for the sewage of 100 persons. The irrigation must be on the intermittent plan, in order that the soil may undergo aeration; as it is only in this way that the best purifiying results

In a thickly popul? district Jewel Scott's process may be used profit? if CaO cheap. Sew? is treat? w. milk of lime, sludge deposi? in a series of tanks, effl? pass?, after filt? thro. a sm. ext? of sandy soil, into a river. Mixed sludge & lime after dry? in air is hunt, & result? slag when ground, yields good cement; just as Portld cement made fr. Thames & Medway mud.

who interv? with? d. filt?
Dr Frankl? stated that sew? of 3300 people cd be disposed of in 1 acre of suit? land. A result nearly eq. to this obt? by Mr Field at Kendal.

1 acre for 1000 pers?

Irig? is on the principle that the soil is not a warehouse to be plund?, but only a factory to be work?.

Porous agric? pipes shd be used, & yt care that no crude sew? enters pipes by cracks in soil
For irig? farms sand & chalk soils are good, but a friable loam is best, as in it the chem? & rather the bact? processes in wh. org? mat? bec? nitrites, nitrates & CO_2 are most active.
Stiff clays alone are really unsuit?, unless sand or chalk can be work? in with? excess? cost. No filt? exc. intercept? by aerating & solid mat?s shd be attempt?. Only grass-land prefer? Mdw? rye grass can bear daily soak? w. sew? Corn or legum? crops shd only be attempt? where plenty of open land. May convey sew? in culvert for a few miles if no avail? land near.

Various systems of surf. irig.n — 1). contour or catch-water system, land many? at diff.t levels. Separ.e beds prep.? & treat.? in rotat.n One of best treat.ts is by osier-beds, esp.ly for villa & country mansions
2). Ridge & furrow treat.t — under drain.? of land provid.?

In Irigat.n — nitrific.n occurs. This ceases at depth of 18"
In Filt.n minim. of land is used, & deep drain.? Warington's researches shew that by keep.? sup.l layers in good cond.n, expense of deep excav.n & prep.n can be saved. Only neces.? to prep.e 3' inst.? of 6'. (Stevenson) W.m R. Field thinks tht this wd not be suffic.t to prev.t sew.e pass.? to land drains in unclaim.? land.
By act.n of Bact.a in soil org.c matt.r not assim.? by veget.n is resolv.? into harmless forms of nitrates. It is to this prop.? of surface-soil that the Earth-closet owes all its effic.y: but it follows that so far as it destroys the excreta, it destroys their manur.l value. Not so restrict.? in choice of a soil as effect.? of Earth-closet wd suggest, for the purest sea-sand at first inst.t soon acq.s by admixt.e w. the susp.? solids, the power of nitrifn, & inst.s given by Corfield in wh. worthless peat-land now let to cowkeepers for £30 an acre, & prev.? barren sands at £25.

Sub-irig.n of soil objct.? bec. of block.g of pipes & prod.n of exc.t — sodden cond.n of soil. Roy. Field has overcome the obj.ns to algæ &c.t Objct.n in principle, as an upward rise of moist.e & chilling. (see p. 167)

can be obtained. The sewage farm should be well drained, and not laid out on the saturation principle. If the farm is converted into a marsh, marsh diseases, such as Ague, may result, but this is not owing to the water being sewage water.

Various objections have been urged against sewage farms.

(1) The nuisance arising from decomposition of the sewage has been urged. On the farm itself with good arrangements, this is not perceived, but the suspended matters may be troublesome. They may be utilised for making cement or solid manure.

(2) It is said that rinderpest, and foot and mouth disease, are more common on these farms than elsewhere; but this is not the case.

(3) The possibility of the diffusion of typhoid fever along with the irrigation has been suggested, but there is no evidence that this occurs. In regard to cholera, a disease having similar modes of progression with typhoid fever, there are important negative facts. At Milan where the sewage is removed by irrigation, during three epidemics of cholera, no case occurred on the irrigated meadows; and there is similar evidence in the case of Edinburgh.

(4) The possibility of the ova of parasitic worms being spread in irrigation farms has also been mentioned. At Edinburgh however after many years' experience of the system, it has been impossible to trace a case to this source. The examination of mud and slime from the irrigated parts failed to discover any ova; cows fed for a year or two on such a farm were examined after death, without the discovery in any case of cysts; and as Dr. Cobbold pointed out, there was on these farms a remarkable absence of the molluscs and insects which often form intermediate hosts to the larvæ of parasites.

When the wet system of sewage is adopted, the removal of **Dust** involves a special arrangement. It includes chiefly ashes and cinders, but commonly the dust-bin is the receptacle also of all kinds of vegetable and animal refuse. The more frequently the dust is removed, the less likely it is to become a nuisance.

The *dust-bin* should not be placed against the wall of the house; the model bye-laws name six feet as the least distance. It should be protected from the rain, as moisture favours decomposition; and should be of a small size. It is still better to have no dust-bin at all, but a pail or box, in which the dust is placed. This can easily be removed by the dust-man, without causing any dirt, and it ensures that no dust is allowed to collect about the premises.

In places where brick-making is going on, dust is valuable, and the scavenging is consequently well done. But in places where (as in London at present) the dust is valueless, it is difficult to secure proper attention to this matter, especially as it is commonly undertaken on contract by private individuals.

CHAPTER XXVII.

THE DISPOSAL OF EXCRETA BY DRY METHODS.

The Cesspool System.—The Pneumatic System.—The Intercepting System.—The Pail System.—The Goux System.—Disposal of Contents of Pails.—Dry-earth Closets.—Middens.—Disposal of Slops.—Relative Merits of Dry and Wet Methods.—Influence of the Water-carriage System on General Health.

It will be remembered that the refuse to be removed from a house consists of fouled water, which is at least equal in quantity to the water-supply of the house; the excreta of the inhabitants; and "dust," which contains, besides ashes, considerable kitchen refuse, consisting of both vegetable and animal matters.

In dry methods of removing refuse, the dust is commonly added to the excreta, and the two removed together. But the foul water, and to a large extent the urine, remain to be dealt with, and require special drains for their removal. Thus in large towns, whether dry or wet methods of removing sewage are adopted, drains for the removal of foul-water and rain-water will be required, and it is found that they are open to the same objections as if they contained the solid excreta.

x. Usl contents of dust-bins are filed in a dust-yard & sifted. "Breze" & fine ash is sold or given to brick-makers: "hard core" of clinkers, broken crockery &c for roadmaking; "soft core" of ashes. Veg. refuse is add to coll. stable refuse. Fr, Sn, paper, rags, bottles, corks &c are carefl coll & sold by contractn.

Sometimes the unsold contents of bins are used for foundations. By Fryer's Destructor the whole of "dust" is red to 1/7 its orig. bulk. Residue ash & clinkers may be used for road mend, or be ground by a pug-mill to a powder, the mill being worked by the waste heat of the furnace, & then the powd. mixed w. CaO to form an excellt cement. The sm. qty fuel req is furnd by the fine coal & cinders alwys fd in "dust". The furnace is smoke-consuming.

Fryer's Carboniser converts veg refuse f. markets with its misc into good charc. at a nominal price for work. If no demand for charc. the destr is quite compett to deal w. it

See Sanit Record Sept. 87. for descriptn of Destructor.
& do. for May '87 for Whitechapel Destr.

In porous soils, as chalk, oolite, or gravels, point of saturⁿ is never reached.

We shall describe briefly 1. The cesspool system.
2. The pail system.
3. The dry-earth system.
4. The midden or privy system.

The Cesspool System has been already named (*page 249*), but only to be condemned. Formerly it was not at all uncommon for each house in London and elsewhere to be provided with a hole or cesspool, known as a dumbwell, into which all the excreta and slop-water were conveyed. These were often placed under the basement of the house, and instead of being made impervious to moisture, were so rudely constructed as to allow soakage in all directions. In fact in many cases they were made with this distinct object.

The greatest improvement in cesspools is the rendering them impervious by lining them with cement. They may then be drained so as to leave the solid excreta more or less dry; or be made to retain both the liquid and solid excreta. The latter plan is adopted in Paris and many other continental towns; but the former plan is preferable from a sanitary stand-point, as it renders the contents of the cesspool much less offensive, and diminishes the danger of contamination of the subsoil by soakage or overflow. It is evident, however, that if the cesspool is drained into a sewer, the contents of the latter become as dangerous as if the whole of the excreta were emptied into it, and in fact often more so, owing to the liquids from the cesspool being stale and putrefied.

When cesspools situated in the basements of houses are large, as in Paris, they require to be furnished with ventilating shafts, reaching above the eaves. In the absence of such ventilation, the men who empty the cesspools are in danger of being suffocated. They are also very liable to an inflammation of the eyes (ophthalmia). The cesspool is usually emptied by a pump or hose leading into a partially exhausted barrel. The soil-pipes and the sink-pipes leading to the cesspool require to be trapped by means of a syphon at their upper and lower ends. The emptying by means of a closed barrel is a great improvement on the old plan of

emptying by hand and bucket, but still produces a considerable nuisance.

A modification of the cesspool system, called the **Pneumatic System** has been proposed by Captain Lierneur. In it the cesspool is not placed under the house or the courtyard of the house, but under the street at the angle of junction of several streets. It is made of cast-iron and air-tight, and is connected with all the houses of several streets by iron-pipes. By means of a powerful air-pump worked by steam, the cesspool is emptied into barrels in which it is sent directly to farms, and the barrels being placed on ploughs of peculiar construction, the manure is discharged from the bung-hole of each barrel and covered over with earth in the progress of the plough. The pipes tend in this and similar systems to get clogged with fæcal matter, and large quantities of water are required to keep them clean, so that the system merges into that of the use of water-closets, but without the thoroughness of the latter.

Cesspools have been almost improved out of existence in some continental towns, by the introduction of movable cesspools,—*fosses mobiles*,—to which would correspond strictly the tubs and pails used in some of our large towns. Such movable receptacles may be still further improved by the adoption of *separators*, by which the liquid parts are allowed to escape into the sewer, while the solid parts remain comparatively innocuous. In **Cheshire's intercepting tank** this plan is adopted.

In cases where slop water is emptied into cesspools, as well as the excreta, more rapid decomposition will occur, and consequently the danger is increased. On the other hand, if the slop water and the urine be emptied into the sewer, the contents of the latter become as offensive and dangerous as if the solid excreta were likewise added; and with the urine one of the most valuable parts of the excreta for commercial purposes is lost.

The Pail System implies in reality the use of a movable cesspool. The pail may be used alone, or may contain ashes and house

shoddy i.e.

At Halifax waste f. manufe of worsted cotton & flax, & manure wh has been dry & fallen to powder, to wh is add. a little $CaSO_4$ are used to line the pail.

W. N. Radcliffe fd that whenever a Goux pail had been in use over 2 or 3 days, capacity of absorption of liq. dejecta was exceed. Suggested that part of this due to emptying of chamber-pots into pail, but this not always so

In subsequent manufe of dejecta &c into a saleable manure, prefers Goux system less advantageous than use of tubs with absorbent lining.

Contents of pail may be manufd into poudrette by drying & exclusion in revolving cylinder heated w steam. Some H_2SO_4 is added to aid drying & fix NH_3.

In order that manure may be valuable, must have no refuse mixed but fine ashes. Hence separate service necessary, also receptacle for garbage & cinders. This system in Manchester, Salford, & Rochester.

Very important pails shd have a tight fitting lid. In Rochdale, Hanes-cough's patent spring-lid receptacle (wh has an india-rubber cushion) is used.

Firman's apparatus also applied to middens, as well as offal & condemned meat. It may be so modified as to separate the fat in a form fit for the purposes of candle & soap maker.

Where much meat condemned, Dr S. Saunders' "Devils" or Carcase-crushers useful, — wl reduce a horse to mincemeat in 30 secs, wh. can then be introduced into the Firman's rotating rendering machine, fat to separate from flesh & flesh reduced to guano.

refuse, or some deodorant. Where the pail is used without any admixture of foreign matter, it should be emptied daily, and care should be taken that the pails for different houses are not exchanged. This plan has been practised for thousands of years in China, and has been adopted in the Department of *Alpes Maritimes*, where the excreta are used for growing vegetables, and especially scented flowers, such as roses and violets.

In the **Goux System** the tubs are lined with a composition containing clay and furnished at the lowest part with some absorbent material such as chaff, straw, or hay, which serves to absorb the urine and retard putrefaction. This is, when well managed, somewhat less offensive than the ordinary pail system.

The pails may be supplied with a deodorant, such as sulphate of iron, as at Birmingham, Leeds, etc.; they may be packed with absorbent material, as in the Goux system (Halifax); the ashes and house-refuse may be deposited in the same pail (Edinburgh, Nottingham); or coal ashes may be scattered over the excreta (Manchester, Salford).

In all large towns it becomes a very serious difficulty to know how to dispose of the pail contents which have been collected. By Fryer's patent "*destructor*" and "*carboniser*," this question is largely solved. The ashes collected in ash-tubs are acted on by the "*destructor*," which pulverises all the more bulky town refuse. The slag produced is ground, mixed with lime, and sold as mortar. The heated products of combustion pass over fresh portions of material and prepare it for burning, thus preventing any loss of heat.

Street sweepings, including vegetable and animal refuse, are reduced to charcoal by a furnace called a "carboniser," the fuel required for this purpose being furnished, in the first instance, by a portion of the sifted cinders from the ash-tubs.

By means of *Firman's Drying Apparatus* the contents of the pails can be reduced to the consistence of guano and used as such.

The Dry-earth System is an important modification of the pail

Estim^d that for a pop^n of 10000 more than 100 tons dry earth wd be req^d weekly (San. News)

system. In it dry earth or some other material is added to the excreta, thus converting them immediately into an inodorous mass. Probably the best contrivance for thus deodorising the excreta, as soon as they fall into the receptacle, is **Moule's Earth-Closet.**

It is found that 1½ lbs. of dry earth, completely deodorise the closet each time it is used. Loamy earth is the most valuable material; a mixture of peat and earth or ashes is very good; sand, gravel, and chalk are practically useless. It is necessary that the earth should be very dry, and that it should be finely sifted. If the earth is damp, decomposition of the excreta speedily occurs. Sitting and rising works a hopper which scatters a supply of earth.

Charcoal and saw-dust have also been used in connection with this closet, or the next, and with good results. Charcoal has been obtained cheaply for the purpose from street sweepings, and from seaweed. Mr. Stanford has patented a process, in which he absorbs the excreta with charcoal, and afterwards dries and carbonises the mixture, thus producing a constantly increasing amount of charcoal, which may be used for various purposes.

The **Moser Dry Closet** is similar to the last in principle, and its mechanism being automatic and simple, it is not very liable to get out of order. A sufficiency of earth to last for some time is placed in a hopper behind the seat of the closet, whence it falls on to a valve capable of holding exactly 1½ lbs. The valve is so arranged that when the seat is vacated or a handle moved, the contents of the valve are upset into the receptacle below.

The dry earth system is much more expensive than the pail system, and although applicable to villages and isolated houses, is quite unsuited to large towns, owing to the practical difficulties connected with the procuring and storing of dry earth. The dry earth closet requires frequent attention, in addition to not being so convenient as the pail closet.

It is doubtful also whether the compost produced is disinfected, as well as deodorised. It is quite possible that if derived from a

"An earth-closet will no more work without dry earth, than a W. C. will work without water" – Moule.

Earths absorb moistre bec. dry, absorb odours, partly chem. & partly bec. of mechan. arrang. of its particles. So far f. being antiseptic, it really promotes decay v. energet.

In this system the food of the popul. is return. to the soil. Boussingault has shewn that there is a greater propn of O in air condens. betw. particles of a porous soil than in atmosph. above land.

W. Moule point. out the fitness for repd use of same earth.

The rapid smell in nearly all dry closets is at once due to the diffn of absorb. & deod. the whole of urine.

Dr. Gilbert (for Brit. Assoc.) fd that ord. field soil after being used twice, was not richer in N. than good garden mould.

Advance in dry earth system due largely to diffy in obtg water-supply.

a complete change in excta is effd: even paper disapp. after a time. The earth can act again: if clay is improved by its 1st use. Has been used espy 12 times without deterr of its power.

After removal f. receiver, matl should be stored dry for at least 6 wks, till excta changed, & then may be used again.

W. Stanford fd that while dry clay absorbs only 4-5 % H_2O, dry charc. prepd f. seaweed absorbs 14·7 %

X. This is borne out by cases of Ly. ?. Regn. & in a County District, where Land Cons. w. the City refuse & Hr. 0 Rents (see San. Rec. Jny '88)

Mod. Bye Laws of L. S. Bd recm. reception w. capt. of 6 c. ft:
that means for freq. appln. of ashes dust or dry refuse; no
expos. to rainf. or drain. of any waste water: comm. betw. drain &
privy forbidn. Privy not to be less than 6' f. in hab. dwell.
Privy shd have a flag. or asphalt. floor, at least 3" above level of sm. yd.

Nottingham tub closet forms the link betw. pail & mid. system
Is really a sm. mov. midden stead. used for exca. veg. & ashes.

typhoid fever patient, for instance, it would regain its contagious character when moistened.

The value of the manure derived from earth-closets is not so great as that from pail-closets. Theoretically the manure value of the excreta of each individual should be from eight to ten shillings per annum. This is, however, by no means realised in the market, though the excreta are most valuable when unmixed with foreign matters.

The advantages of the earth-closet as compared with the water-closet have been thus summarised by Dr. Buchanan. "It is cheaper in the original cost, it is not injured by frost, it is not damaged by improper substances driven down it, and it very greatly diminishes the quantity of water required by each household."

The Privy or Midden System, involving the use of a fixed receptacle, is still prevalent in many towns as well as in innumerable villages. In its worst form, the receptacle consists of a pit with sides of porous materials, allowing percolation of filth in every direction; and in this pit the excreta of whole households are allowed to collect for months, or even years. It has been improved by providing a cover to keep out the rain, and thus retard decomposition; still more by providing a drain for the excess of liquid; and by making the sides and bottom of the pit impervious to moisture. The addition of dry ashes to the excreta tends still further to prevent any smell; and the greatest improvement of all, consists in raising the receptacle above the ground level, and providing for easy cleaning from the back. The raising of the receptacle involves a diminution in its size, and so prevents the retention near a house for a long time of putrefying matters. The privy should not be situated within six feet of a house, and abundant means should be provided for its ventilation near the top.

Even when carefully supervised, middens are almost certain to be productive of evil. They possess two great disadvantages as compared with pails or dry closets. (1) The time between collections of excreta by the scavengers is much longer; and (2) the receptacle

for the refuse is part of the structure of the building, and cannot easily be renewed when it has become saturated with excreta.

The use of pails or dry-earth closets is a great improvement on the old middens, but even these compare very unfavourably with water-closets in two respects. (1) The excreta require to be retained about the house for a longer or shorter period, whereas with an efficient water-carriage system, they are at once projected into the sewer. (2) In removing the excreta, the weight of the receptacle has to be added to that of the excreta, while in the water-carriage system, the water serves as the means of transport.

In villages and isolated houses, where no drains are provided for waste water, and the dry system of closets is adopted, the **disposal of waste water** requires special provision. Very commonly the slops are thrown out of the door, and soak into the ground about the house; or worse still they are thrown into the dust-bin, to set up decomposition there. They should be carried by means of a waste-pipe into a special water-tight dumbwell, remote from the house, whence they can be pumped into a field, or carried away by special conduits.

Relative Merits of Dry and Wet Methods.—This has been the subject of much controversy, but no answer can be given in exclusive favour of either plan. Each is the best under different circumstances; the dry method being chiefly suitable for villages, and temporary collections of people, as in camps; and the wet method for large towns.

Under certain conditions dry methods may be preferable, even for large towns. Thus (1) if a sufficient *fall* for the sewers cannot be obtained; or (2) if the *water-supply be scanty;* or (3) if the climate be such as to *freeze the water* for some months in the year. And even when these conditions do not exist, many authorities favour dry methods of removing sewage, on account of (4) the *greater value of the manure* thus obtained.

The **objections to the water-carriage system** are numerous, but most of them are really due to its not being carried out in

an efficient manner. What is required to remedy such defects, is not an abandonment of the sewer system, but a greater degree of perfection of the engineering and workmanship concerned in carrying it out. When sewers are properly laid; when they, as well as house-drains, are freely ventilated; when house-drains are efficiently trapped and ventilated near their junction with the sewer; when the supply of water to the drains is abundant, and the outflow from the sewer is unimpeded—many of the objections disappear.

These objections are that—(1) the sewers, as underground channels, transfer effluvia and the germs of disease from one place to another; (2) pipes become disjointed owing to being badly laid, and the ground is contaminated; and (3) the water supply is in constant danger of receiving impurities from the sewage.

The only objections which are of any force, are (4) that water-closets require a large amount of water, and the sewage obtained is greatly diluted, and consequently diminished in value; while (5) the disposal of such an amount of water, in the case of a large inland town, is a problem of the utmost difficulty.

In view of these last difficulties, in the case of such towns as Birmingham, it is probable that a system of dry-earth closets, with separate sewers for waste water, is preferable.

There are many **objections to the dry methods** of removing excreta. (1) Whatever dry method be adopted, the excreta are retained for some time in or about the house, instead of being immediately removed.

(2) Although the initial outlay in closets and sewers is less than in the wet method, there is the constantly recurring expense of removing the excreta, as well as of cleansing the pails, etc.

(3) In the dry-earth closets, the dry earth or other material added, involves some expense.

(4) Whatever dry method be adopted, sewers are always required to carry off the foul water, as well as trade products, and a certain proportion at least of the urine. It is impossible to

supply sufficient dry earth to absorb all the urine and slops of the population.

Thus, as the Indian Army Sanitary Commission said, speaking of barracks, "to have two systems of cleansing stations—a foul-water system, and a dry-earth system—would simply be paying double where one payment would answer; or, if all the excreta, solid and liquid, are to be carried away, this must be done at a cost ten times greater than that which would be necessary, if all the excreta were removed by drains."

With some of the dry methods, as where middens or cesspits are drained into the sewers, the sewer-water is fouler from being staler, than in towns supplied with water-closets. When a midden or cesspool is drained, the principle of conservation, which distinguishes the dry methods from the wet, is practically abandoned; and not only so, but the solid matters still remain to be disposed of, by a tedious process, while the addition of these to the sewer-water does not render it practically any more offensive or dangerous than before.

(5) The dry systems, involving the retention of excreta about the house, tend to poison the atmosphere, and produce various diseases. In all towns where the refuse matters are not removed immediately, there is a high mortality, and especially among children.

On the other hand, the introduction of the water-carriage system into large towns, with the abolition of midden-heaps and cesspools, has been followed in nearly every case by a diminution in the death-rate, and generally a considerable diminution in that from epidemic diseases, especially cholera and typhoid fever. As regards cholera, towns which had mortalities of from 18 to 26 per 1000 during the epidemics of 1848-49, either entirely escaped after the introduction of the water-carriage system of sewage, or had only a mortality of 1 to 2 per 1000, during subsequent epidemics. As regards typhoid fever, like results were obtained. In one place the mortality diminished 75 per cent., and in 10

Subsoil Irrig^{n}. - piece of land 20 by 25 ft - wl suffice for surface
utilⁿ of slops if properly distrib^{d}. Subsoil I. is but little used as yet
pipes laid abt 1 ft below surfᵉ of soil within reach of roots of plants.
Contin^{s} trickling fails to reach term^{l} brs. Must have preliminᵃ subsidᵉ
or pipes wd rapidly bec. clogged. Too rapid descᵗ thwarts uniform distribⁿ
Acc. to Col. Waring not more fall than 6" in 5a. 100 ft (San. News)

For isolᵈ. hses sub-surface irrigⁿ best method. No offence to
sight or smell as in surf. irrigⁿ. Its origin not attribᵈ to Rev. H. Moule.
but acc. to Chadwick prev^{y} tried on lge scale by M Charpentier at Bordeaux
Aeration is a sine qua non of the system. At less depths than 10-12" oxidⁿ &
purifⁿ cease. Thus "sub-surfᵉ" better than "subsoil"
Liq^{d} sewᵉ is clarifᵈ by filtⁿ. Removed by deep drains. Needed for internᵗ
action. Redⁿ diffe betwn this system & a leaching cesspool. Rate of
area of purifⁿ is quite small.

(1) Sewᵉ tank for liq^{d} household wastes incl^{g} contents of WCs.
(2) Network of drain tiles a few inᶜˢ below surfᵉ w. open jts
Even distribⁿ secured by intermᵗ flush. Shd be discharged abt once daily &
regulⁿ of tank accord^{gly}
Soil of fields prefer^{s} gravelly & porous. Clay soils shd be underdrain^{d} by
deep land drains, shd not be too near a hse.
Pay attenⁿ to dirⁿ of prevalᵗ winds - tho. prop^{y} workᵈ fields shd be inodorous.
Fields shd not be near sources of water supply.

(W. Paul Gerhard, C.E. San. News Vol. 15: No. 372)

others from 33 to 50 per cent., and in some others somewhat less. The average reduction of the number of deaths from typhoid in 21 out of the 24 towns investigated by Dr. Buchanan (9th report of the Medical Officer to the Privy Council), was 45·4 per cent. In the other three cases there was an increase in the prevalence of typhoid fever. In these, however, it was found that the outlet for the sewage was not free, so that it became banked up in the sewers, and there was not free ventilation of the sewers. That this was so, was abundantly proved in the case of Worthing, by the fact that the fever attacked almost exclusively the better-class houses on a high level, where the water-closets were inside the houses; and that it disappeared when ventilation of the sewers at these parts was secured.

CHAPTER XXVIII.

THE MATERIALS USED IN THE CONSTRUCTION OF HOUSE WALLS AND ROOFS.

Bricks.—Their Conductivity and Porosity.—Mortar.—Varieties of Stone.—Slates and Tiles.—Flint-work.—Concrete.—Terra-Cotta.—Lead and Zinc.—Thatch.—Plaster.

Walls of houses are constructed of brickwork, stonework, flint and boulder work, concrete, half-timber, or terra-cotta. Half-timber walls are formed of a combination of brickwork and timber.

Bricks are generally of a uniform size, of 9 inches in length by $4\frac{1}{2}$ in width and 3 inches in thickness. Those bricks which are heaviest and hardest are generally the most durable, bricks of good quality when knocked together give a clear ringing sound. The ordinary red brick is generally more absorbent of moisture than the hard stock brick, and is commonly only used for ornamental purposes.

The relative conductivity for heat of brick as compared with other materials, is shewn in the following table, from Galton, which gives the units of heat transmitted per square foot per hour by

a plate 1 inch thick, the two surfaces differing in temperature 1° Fahr. :—

Stone—ordinary free stone	13·68
Glass	6·6
Brickwork	4·83
Plaster	3·86
Fir Planks	1·37
Brick Dust	1·33

It is evident that in this respect, brick walls compare very favourably with stone walls, and are much more economical of heat. Increased conductivity of a material may be counteracted by increased thickness.

Brick is very porous, as shewn by its power to absorb moisture. A good brick can suck up from 10 to 20 per cent. of its weight of water; while good granite only takes up $\frac{1}{2}$ per cent., sandstone usually from 8 to 10 per cent., marble only a trace, and Portland limestone $13\frac{1}{2}$ per cent.

Being porous, brick allows the passage of a considerable amount of air, unless its pores are occupied by moisture. The following table, from Galton, shews the number of cubic feet of air which every hour pass through a square yard of wall-surface of equal thicknesses, built of the following materials, there being a temperature of 72° Fahr. on one side the wall, and of 40° on the other :—

Wall built of brick	7·9	*cubic feet.*
,, *quarried limestone*	6·5	,,
,, *sandstone*	4·7	,,
,, *limestone*	10·1	,,
,, *mud*	14·4	,,

Mortar should consist of clean sharp sand and slaked lime, usually in the proportion of three of the former to one of the latter. Grouting, or liquid mortar, is merely ordinary mortar to which a larger quantity of water has been added. It is used

for filling up the crevices between the brickwork about every fourth course.

The sand used in mortar should be free from small stones. It should not contain any earthy or clayey matters, as these greatly diminish the adhesive quality of the mortar, which depends on the union of the sand and lime. Hence, it is desirable to wash all the sand used in a building, in order to remove mud and clay. Many builders use an inferior mortar, in which other materials, such as "road scrapings," are substituted for sand. Such mortar is largely used by speculative builders of suburban houses. Another feature of their work is the placing of a thick layer of this inferior mortar between the bricks, instead of only sufficient to produce adhesion and equally distribute the pressure. This readily absorbs a driving rain, and after a frost crumbles away. If good mortar is used, it will throw off the rain, and last for an indefinite time.

The lime intended for mixing with sand, should be mixed immediately after slaking, and used without delay, before it absorbs carbonic acid from the atmosphere. Thus used, it increases in strength and solidity with time. It also furnishes a means of purifying the atmosphere of a house, until all the lime has combined with carbonic acid. Sand taken from the sea-shore is unfit for making mortar, as the salt contained in it is apt to deliquesce and weaken the mortar.

Common mortar crumbles away, if laid under water before it has had time to harden. Water cements, called also *Roman cements*, will harden under water. Baked clay and the common greenstone afford the basis of tolerable water cements, when mixed with lime, though they are less durable than ordinary mortar in the open air. The Romans employed a peculiar earth, obtained at the town of Puteoli, in making their water cements; this earth being of a clayey as well as siliceous character. It was extraordinarily hard and resistant to changes, and must by no means be confounded with the modern "Roman cement."

Stone varies very greatly in character, and in deciding which variety to use, great judgment is required to ensure that the one chosen shall be competent to resist the decomposing influences to which it will be subjected. It is uncommon for the whole thickness of the walls of a house to be built of stone; usually there is merely a facing of stone and a backing of brickwork. If good stone is not available, the less it is used the better. Most of the soft Bath stone, commonly seen about the windows of small suburban villas to give them an attractive appearance, crumbles away rapidly, and requires to be replaced by other stones long before the ground-lease is exhausted.

The stone chosen should be durable, and able to resist the action of the sulphuric, sulphurous, and carbonic acids absorbed from the atmosphere, and brought in contact with it by means of rain. The stone of which a considerable part of the Houses of Parliament consists is dolomite, a double carbonate of lime and magnesia. The acid fumes in the air produce on its surface soluble sulphate of magnesia (Epsom salts), which is washed away in successive layers.

It is very desirable also that, if the stone presents any stratification, it should be laid in the wall in the same position as that in which it was originally deposited in the quarry. Thus, any planes of stratification will be horizontal, and there will be no tendency to scale off by the action of frost and rain. Comparatively homogeneous stones, such as granite and millstone-grit, can be laid in any position. In testing the character of any stone, the least porous, densest, and most resisting to crushing, will as a rule be the most durable.

Stones are used in dwelling-houses for ornamental purposes, or for building the walls, roof, floor, steps, etc.

For ornamental purposes, granite, and the numerous stones classed under the broad name of marble, are employed. Enamelled slate is frequently used as a cheap imitation of black marble, for chimney-pieces and other purposes. The use of granite or marble is greatly limited by its expense.

The chief difficulty in the use of stone for the walls of houses, is that of keeping out the wet. To obviate this, stone-houses are often built of great thickness, and are thus kept cooler in summer and warmer in winter.

In and near large towns brick is chiefly used for walls of houses, and stone employed only for window-sills, columns, steps, etc. It is even more important in these cases to carefully select the stone, as the parts where it is placed are those most exposed to the weather. If a soft, friable freestone is used, after a sharp frost large scales are seen falling off in flakes, owing to the freezing and subsequent thawing of the moisture in the stone.

Portland stone is the best-wearing stone to be had in the neighbourhood of London. *Bath stone* is also considerably used, but as it varies greatly in quality, should be very carefully selected. For landing-steps and paving, *Yorkshire stone* is extensively used. Other varieties of stone are employed; and it may be stated generally, that most kinds of stone can only be economically used near the quarries from which they are derived.

Limestones were recommended by the Commissioners appointed to select the most suitable stone for the Houses of Parliament, in preference to sandstones, on account of their general uniformity of tint, comparatively homogeneous structure, and the ease with which they can be converted to building purposes. The result has not justified their use; but it appears that the actual limestone used was derived from a different stratum to that selected.

Stones do not withstand fire so well as bricks, which are already burnt. This was remarkably shewn in the great Chicago fire. Limestone is more fire-proof than sandstone.

Several kinds of *artificial stone* have been introduced. Their wearing qualities are as yet doubtful, and they are very costly.

In addition to the stones already named, there are slates and tile-stones, only used for roofing purposes.

The *Slate* used for roofs is an altered form of clay, possessing a

laminated structure. The ease with which it splits along the planes, renders it peculiarly suitable for this purpose. The Welsh slates are considered the best.

Tile Stones are thin bedded sandstones. They are heavier than ordinary slates, and have been largely superseded by them, though still used in some parts of the country, where they are cheaper than slate. Their weight is a great drawback to their use, but they preserve the interior of a house from excessive heat and cold much better than slate.

Flintwork is scmetimes used in erecting smaller buildings. A large amount of mortar requires to be used; hence building with this material must be proceeded with slowly, in order to allow time for setting. Occasionally, buildings erected with walls of this description have completely failed, owing to a continuance of wet weather preventing the mortar setting. Houses built with flintwork should always contain one-fifth of their bulk of brick-work.

Concrete forms an almost essential part of the foundations of a house. The walls also may be built of it, and this plan has been largely adopted of late years. The concrete for this purpose should be formed of cement, as this hardens more rapidly than ordinary lime, and being harder when it is set, ensures a more secure building. If concrete walls are made of good materials, they often keep out the weather more effectually than brick walls of the same thickness. The concrete walls are built inside a plank or iron framework, the frame being fixed at higher levels after each portion is set.

Concrete, as its name indicates, is a mixture of different substances; a cement, and a substance to be cemented or aggregate. The aggregate most commonly used is gravel, from which the fine sand has been separated. This material, however, does not furnish nearly so good a hold for the cement, as stone, burnt ballast, broken pottery, coke, or slag. All these require crushing, and it is important that they should be in angular pieces. Either lime or cement is employed as a matrix. Lime answers for ordinary

Concrete of 5 parts of Ballast (broken stone) to one of Portld cement of best qual.?, w. enough gravel or burnt clay to fill up interstices

purposes, but Portland cement should always be used when great strength is required. It appears that old cement, while taking longer to set, in the end sets harder than fresh cement.

The chief objections to concrete for house walls, are the difficulty and cost in making alterations, and the necessity for some ornamental finishing.

On the other hand, it presents some great advantages. Thus, it is porous, and yet it appears to resist saturation by water. Professor Pettenkofer found that bricks made with clay were completely soaked with water in from 9 to 12 hours, while under similar conditions it took 55 to 190 hours to saturate a slag brick (composed of concrete, in which the aggregate is the slag from iron furnaces). If these statements are confirmed, slag bricks and concrete materials generally will be invaluable for building purposes.

Concrete again (like fire-clay) is extremely resistant to heat, and is practically fire-proof. For hospitals and similar buildings it presents great advantages; for not only is the building washable in every part, so that water can be freely used; but if disinfection is necessary, it can be raised by artificial means to a sufficiently high temperature for this purpose, without in any way injuring its structure; and can thus be rendered habitable a few hours after a fever patient has left it.

Mr. Lascelles has devised a system of building houses in concrete, which obviates the necessity of using a single piece of timber. The walls consist of two layers of concrete, with an air-space between; the floors are formed of concrete slabs, which are water-proof, and do not allow the penetration of dust; while the roof is formed of Staffordshire tiles.

Half-timber Work consists of a combination of timber and brickwork. It is very picturesque, and specimens of it are still to be seen in many country towns. The introduction of timber into the walls greatly increases the danger from fire. When houses are built in contact, the timber framing of the two ought not to touch.

Terra-cotta has been quite extensively used of late years for building purposes. It is made from certain kinds of clay, mixed with glass, pottery, sand, or similar materials; then ground up, strained, and kneaded; and lastly thrown into moulds and baked in a kiln. The unequal shrinking of the clay is a great difficulty in its manufacture. It is susceptible of great varieties of ornamental treatment. Its durability when exposed to the influences of a town atmosphere has not yet been completely established.

Iron and **Wood** have occasionally been employed alone in building houses. The former, owing to its good conducting powers for heat, is cold in winter and hot in summer; while the latter becomes rotten from exposure to wet, and is also very combustible.

For roofs, slates or tiles are the materials most frequently employed; but occasionally lead, zinc, and even copper are used; thatch in country places, and tarred felt for temporary buildings.

Lead is the most suitable metallic covering for roofs, as it is durable and easily worked. It is, however, heavy, and demands considerable strength in the timbers by which it is supported. **Zinc** has been largely used of late. It is cheaper and lighter than lead, and its durability is said to be greatly increased by improved methods of manufacture. Both lead and zinc require very careful laying, and are chiefly appropriate for flat roofs. Copper nails should not be used to fix such roofs, on account of the destructive galvanic action set up by contact of two dissimilar metals in presence of the acids contained in the atmosphere.

Thatch makes a most comfortable roof, protecting the interior of the house from extremes of heat and cold. It is, however, very unsanitary. Being composed of vegetable matter, the alternate wet and warmth to which it is subjected, cause its decomposition. It is also very inflammable, and may easily be ignited by sparks from the chimney in dry weather. It forms a favourite home of insects, and is frequently fouled or otherwise injured by birds.

Keene's cement used in work where expedit.n req.d. - can be
paint.d on dir.s afterds, as no damp strikes through.

Various kinds of Plaster are applied to the interior of walls, for the sake of warmth, cleanliness, or appearance, lime or cement forming an important part of their constitution. The plastered surface is healthy, in proportion to its hardness and density, and capacity for taking polish. If the plaster is porous, it absorbs organic impurities from respiration and other sources, and finally becomes saturated with them. Where a room is white-washed at intervals, the wall can be cleansed from its impurities each time this is done; but where the plaster is covered with a paper, it is highly desirable that the plaster should be as hard and unabsorbent as possible, in order that all impurities may be removed by changing the paper.

In houses built by speculative builders, the plaster most commonly used consists of a mixture of lime with sifted vegetable mould, or even of worse materials. The result is a composition which, unless supported by the wall-papering, becomes rapidly damaged.

Ordinary plaster consists usually of three layers. The first is laid on with a mixture of about equal parts of lime and sand, with long ox-hairs. The second coat consists of slaked lime, mixed to the consistency of cream, with a little hair added. The last or setting coat consists of a thin layer of lime and water, prepared in a somewhat different way to the previous coat, and called plasterers' putty. Some plaster of Paris (gypsum) may be added, to ensure rapid setting, but it should only be used in small quantities.

Keene's cement, Martin's cement, and Parian cement are all mixtures of calcined gypsum and other substances; Keene's cement being the hardest, and capable of receiving a high polish. Parian cement is said not to produce such sharp angles or mouldings as the other two.

Selenitic cement contains a small proportion of plaster of Paris ground along with lime. Lime may also be selenised by the addition of any other sulphate, or of sulphuric acid. The presence

of the sulphate causes the cement to set much more quickly, and enables it to be used with a larger proportion of sand than ordinary lime.

CHAPTER XXIX.

CONSTRUCTION OF THE HOUSE.

The Primary Requisites of a House.—The Foundation.—Concrete Bed and Dry Area.—Damp-proof Course.—Causes of Damp Walls.—Internal Wall Surface.—Paints.—Wall-papers.—Arsenic in Papers and Paints.—Floors.—Wood Floors.—Carpets.—The Roof.

In preparing to build a house, or in entering into a house already built, it is important that the following requisites should each receive careful attention :—

1. The site of the house should be healthy, and its relation to surrounding objects in accordance with the laws of health. These points will be considered in the next chapters.
2. The house should be warm in winter, and cool in summer.
3. It should be always dry.
4. There should be an abundant and uninterrupted supply of air.
5. The water supply should be abundant, conveniently arranged, and pure.
6. The excreta and waste-water should be immediately removed from the house and its annexa.

The three last requisites have already received consideration. Of those still to be considered, **dryness** is the most important. A damp house is certain to be an unhealthy one. Rheumatic and other affections are set up, the real cause of which in the walls and floors, is commonly unsuspected. Damp in the walls has another disadvantage. If the pores of the bricks are occupied by water, air cannot pass through, and thus the ventilation and purification of the house are greatly impeded. Damp may arise either from the ground on which a house stands, or from the rain beating

Analogy betw. house & clothing. Neither shd prevt access of air to body. The hat the roof of our cloth? & roof the head-gear of house.

Diffust. of air cant. occur thro.. a damp wall.
Rapid abstract.n of heat by the moist.

Metrop. Bdg Act insists on whole area of foundn being cov.d w. a 6". layer of concrete; but adviseable to supplement this w. a 1/4" layer of hot asphalte, & on this a finish of Portld cement

against the walls. Unless special means are taken to prevent it, moisture rises through brick after brick, just as it would rise through a series of lumps of sugar resting on one another, and in contact below with a little water. In both cases, capillary attraction causes the moisture to spread in all directions.

It will be convenient to consider in order the foundation, floors, walls, and ceilings of rooms, discussing the various points bearing on health.

The **Foundation** requires to be solid and substantial, otherwise sinking occurs, with cracking of the walls, resulting in an unsafe condition, and an exposure to rain and wind.

In making the foundation for a house, the ground should be excavated, so as to secure a solid bed of earth or rock not liable to be affected by the weather. A continuous bed of the best concrete should then be laid, extending on every side at least 6 inches beyond the frontage of the wall; and it should never be less than 18 inches thick (Gordon Smith), though commonly it is not made thicker than 6 inches. The concrete serves two purposes: it, to a large extent, cuts off the entrance of the ground-air through the basement floor into the house; and prevents the entrance of damp into the house from the basement or along the walls. It does not however completely ensure these objects; and it is essential, therefore, that the floor should have an air space under it to secure free ventilation. Asphalte is more impervious than concrete, and is sometimes substituted for it in making foundations.

The cutting off of the ground-air from the house is extremely important. The concrete foundation helps this to a certain extent, and while the concrete is recent, its lime serves to neutralise the carbonic acid of the ground-air. It may be done much more effectually by building the basement on open arches, as is commonly done in France.

Free circulation of external air should be allowed around the basement of a house. For this purpose a *dry area* should always be provided, that is, a closed chamber lined with stone or cement,

below the ground level of the house, and surrounding its four walls. This allows air to enter, and prevents contact of the soil with the walls of the house.

The Walls of a house require to be as carefully constructed as the foundation. The portion of the wall below the level of the ground should be constructed of damp-proof materials as well as surrounded by the dry area already named. The "*damp-proof course*" should be carried through the whole thickness of the walls, slightly above the highest point at which the ground is touched. It may be formed by (1) sheet lead, which possesses the disadvantage of being costly; (2) two layers of ordinary roofing slate, in cement; (3) a layer of good asphalte, about $\frac{3}{4}$-inch thick; (4) perforated glazed stoneware slabs; or (5) two or three courses of hard blue Staffordshire bricks, laid without mortar. The use of asphalte is an excellent plan, and is now commonly adopted in good buildings.

The damp-proof course protects the walls from damp proceeding from the soil around or beneath the house.

It is necessary also that the walls above the level of the ground should, as far as possible, be kept free from damp. *Damp walls*, not due to ascent of moisture, *may be caused by*—

(1) Rain falling on window-sills which do not project beyond the walls, and consequently do not throw the water clear of them. This is remedied by constructing the window-sills so as to project beyond the walls.

(2) Rain falling on cornices and other projecting portions of the wall itself. The evil from this source may be diminished by sloping the top of the projection, downwards from the face of the wall. The mortar joints in such projections always tend to become loosened, and the evil is commonly aggravated by using a softer sort of brick at these points.

(3) Parapet walls, gables, etc., not being properly covered with coping. All such walls should be topped with a projecting slab of stone.

Prof. Pockl's researches into nature of dry-rot in timber.

Wet walls injur. 1/. by impedg. ventn & diffn of gases
2/. by distubg. the heat econg of our bodies.

A great deal of damp is caused by want of ventil.

(4) Overflow from defective roof-gutters or rain-water pipes. In this case, either clearing out, repairing, or renewing is required.

(5) Rain beating against the walls. This as a rule produces no great harm, if the walls are well constructed. Most of the water runs off as it falls on the surface. It is advisable however to protect a much exposed wall by a coating of Portland cement, or in extreme cases with slate. Various impervious paints have also been employed.

If it is not proposed to coat exposed surfaces of brickwork, the wall may be formed of two parallel walls, two or three inches apart, and tied together by a sufficient number of bonding-ties of iron or glazed stoneware, or some other non-absorbent material.

In a few instances, the narrow space between two such walls has been filled in, as the work proceeded, with asphalte or slab slate, thus forming a *vertical damp course.*

The evils arising from damp can be avoided in every new house by proper methods of construction. In an old house, however they are much more difficult to remove. The dampness is indicated on entering, by a peculiar mouldy smell, and by the discolouration and destruction of wall-papers, and dry rotting of floor timbers. In such a case, a damp course may, with care and patience, be inserted in the wall, and the soil under the basement may be laid with concrete, and a dry-area excavated around the basement.

Damp walls, besides being unhealthy, are decidedly uneconomical, as they absorb a large amount of heat in the process of evaporation of the moisture. New walls always contain a large amount of moisture. A common brick will absorb and contain within itself a pint of water; granite about one-tenth of this amount. Thus an eleven-roomed house containing from 120,000 to 150,000 bricks is capable of absorbing 17,000 gallons of water. This amount of water has to be evaporated before the house is fit for habitation. The larger the volume of air and the higher its temperature, the quicker this will occur.

The *thickness* of the walls of a house requires to be sufficient to ensure stability, to keep out the damp, and to prevent a too rapid loss of heat from the walls. The relative merits of the different materials employed for these purposes have been already considered. A thin-walled house is hot in summer, and cold in winter. The upper stories of houses are often built with too thin walls, the result being chilly bedrooms. A single-brick wall (9 inches thick) will rarely keep out the weather effectually, and frequently a brick-and-a-half wall (14 inches thick) is insufficient for this purpose. The bricks should be so interlaced as to "bond" or tie the wall together in all directions. The strength of walls may be increased by the introduction of timber or hoop-iron between the inner and outer layers; the latter is preferable, as timber tends to rot, and is dangerous in case of fire.

In the construction of fire-places and chimneys, it is important to avoid the proximity of timber and wood-work to the inside of flues, as this is a common cause of fires.

The **internal wall-surface** for a dwelling should be, as far as possible, impervious to moisture, in order that respiratory and other impurities may not soak into it, and that it may be washed with soap and water at frequent intervals. Polished Parian cement is practically impervious, but is costly. Glazed bricks or tiles are also impervious, but the cement of the joints is porous, and harbours impurities.

The next most impervious treatment for a wall is painting, and after this distempering; paper being the most absorbent coating.

The plaster of a room, if left unprotected, absorbs a large amount of organic impurities. In an analysis of the plaster of a hospital wall, 46 per cent. of organic matter was found.

Whitewash is a mixture of ordinary lime and water. *Colour-wash* is the same, with the addition of some cheap colour. *Distempering* is done with whiting and size, colour being added.

By painting and varnishing the walls of a room repeatedly, they

The no. of units of heat lost thro a wall w. an air-space in centre is less than thro a solid wall.

may be made impervious for a time; though they are liable to be damaged, and then absorb organic impurities more easily.

Paints, whether used for wood-work or walls, most commonly contain white lead (carbonate of lead) as their base. This presents two great disadvantages. When exposed to the fumes of sulphur compounds, in sewer emanations, or the air of large towns, or evolved from decaying vegetable matter, it is apt to become black in spots, owing to the formation of black sulphide of lead. If iron is painted with lead paint, an injurious galvanic action is set up between them. The chief objection to lead paint, however, is its poisonous character. Colic, and other complaints due to lead, have been produced by sleeping in a newly-painted room, apparently from a certain amount of lead getting into the atmosphere along with turpentine.

Various *substitutes* have been proposed *for lead paints*. Mr. Wilkins used kaolin (the china clay of Cornwall, a decomposed granite), mixed with a little zinc white, as the base. The oxy-sulphide of zinc ("Charlton white") is also employed, and seems to possess great advantages.

Coloured paints are produced from white paint by the addition of various pigments. Green paints should be carefully investigated as to the presence of arsenic, which will produce arsenical poisoning. Vienna green, Scheele's green, and emerald green (arsenites of copper) are all poisonous; while Brunswick green, mineral green, and chrome green are non-poisonous. Salts of lead, arsenic, copper, and antimony are used in different ways, to give brilliancy to many colours.

The *Silicate Paint* Company manufacture paints into which none of these poisons enter, and it is also claimed for them that they withstand 200° of heat without blistering, and have no chemical action on metals. The silicate enamel is a substitute for the more expensive ordinary enamelling. It produces an impervious washable surface, and can also be used externally for damp walls.

The *Torbay oxide paint* is used for preserving iron. It contains iron, as well as other ingredients. The use of *luminous paint* (a preparation of sulphur and lime) for bed-rooms, water-closets, the names of streets, etc., is likely to prove very useful.

Asbestos fire-proof paint renders wood-work practically uninflammable. All the wooden buildings of the Fisheries' Exhibition were covered with this material, thus securing a material reduction in the amount of insurance premium required.

Varnish is a preparation of rosin dissolved in oil, turpentine, or alcohol. In order to render the surface non-porous, one or two coats of size should be applied before the varnish.

Painting wood or iron-work is valuable, not only as a preservative from the effects of the weather and the oxidising action of the air, but also because it tends, to a large extent, to prevent the absorption of organic matters; and its surface can be frequently cleansed.

Paper is the material most commonly employed for covering walls. It is, unfortunately, much more absorbent and retentive of moisture than paint or distemper; but, on the other hand, it is much more cheerful and warm in general appearance, and more suitable than paint for walls in which the plaster-work is not perfectly smooth. It is also less expensive.

Light-coloured papers should be chosen, as they are more cheerful, and are not so likely to harbour dust. Glaring patterns are objectionable, as they tire the eyes. The paper should not present any surface-projection for the lodgment of dust. Flock-papers are especially objectionable in this respect. Stamped papers and imitation leather papers, although presenting inequalities of surface, can be readily cleansed. Some papers are particularly prone to absorb moisture, and should, therefore, be avoided. Among these are the so-called satin-papers, or those which have a polished surface like the French imitation satin.

In bath-rooms and water-closets, the wall-surface should be as non-absorbent as possible. Paper, unless varnished, should be

Torbay ox. paint is a nat.l combin.n of Fe oxide w. SiO_2, Al_2O_3, & a trace of MgO: no S.

Paints — White Ph.
Kaolin
Oxysulphide Zn.
Silicate paint
Torbay oxide
asbestos

therefore avoided as far as possible. The best covering for these places is glazed tiling.

Much illness may result from the use of putrid size and paste in hanging wall-papers. Several cases of illness have been traced to the putrefactive odours arising from such sources.

Not uncommonly, a new paper is pasted over an old one; and this may be repeated several times. Remembering that the paper itself is almost entirely composed of vegetable substances, and that the paste also is vegetable, it is not strange that intolerable stenches have been produced by the decomposition of some half-dozen layers of paper. Before new papering is put on, the walls should be cleared of all vestiges of the old, thoroughly washed down, and subsequently coated with size (that is, "clear coloured"). The sizing diminishes the absorptive power of the wall, and gives a good surface for applying the paper.

Bed-room papers require to be more frequently changed than those of other rooms. Bed-rooms in regular use should be re-papered at least every two years. It is still better to use distemper for such rooms, as this can be washed off in a few hours with comparatively little expense, and can be made of any tint desired.

Rooms in the basement should not be papered, as the walls require frequent washing down and cleaning. Here also distemper colour can be used.

Various kinds of paper are now sold which are washable, and are said to be non-absorbent. Some of them require varnishing; others do not. Such papers are certainly cleaner than ordinary paper; but it would not be safe to trust to their non-absorptive character. "Lincrusta Walton" is probably non-absorbent, and can be scrubbed with soap and water; but it is expensive. If a case of infectious fever occur in a room, the papering should in every instance be removed.

Arsenic in Wall-Papers and Paints has been a not uncommon source of prolonged ill-health—the cause of which has possibly not been detected until the illness disappears, when the offending room

is vacated for a period. The symptoms produced vary greatly, and may closely simulate those of different diseases. In some cases repeated attacks of diarrhœa and abdominal pain occur. Or there may be nausea, headache, frequent griping pains, and loss of appetite. In other cases restlessness, loss of sleep, and general malaise are the chief symptoms, with the occasional addition of conjunctivitis (superficial inflammation of the eye). Out of 100 cases collected and reported on by a Committee of the Medical Society of London, diarrhœa, nausea, and intestinal mischief occurred in 85; severe depression in 16; conjunctivitis in 19; and cough, asthma, etc., in 9.

The severity of the symptoms produced will vary with the amount of arsenic contained in the paper, and the length of time daily that the patient is exposed to the fumes.

Some persons again are much less susceptible to the influence of arsenic than others. This will explain why some escape while occupying the same room in which others suffer severely. More commonly, however, the exemption is due to shorter exposure.

The most dangerous and most commonly used preparation in wall-paper printing is Scheele's green (arsenite of copper). Besides this, there is emerald-green—an aceto-arsenite of copper—for producing more delicate tints. Aniline dyes, especially the red, often contain much arsenious acid (white arsenic). The arsenic compound is made to adhere to the paper by size or some other material. When dry, it cracks and peels off, and minute particles get into the air as dust. In addition, arsenic compounds easily volatilise, and become diffused in a gaseous condition throughout the atmosphere of a room, even when its temperature is not greatly raised. The virulence of the arsenical colouring is in proportion to its volatility. Arsenic seems to be much more dangerous when associated with size. It has been shewn that a mixture of white arsenic and starch paste, or other organic substance, leads to the formation of gaseous arseniuretted hydrogen, while this does not occur when no organic matter is present (Dr. Fleck). Distemper frequently contains

arsenic, and as it also contains size, arseniurretted hydrogen is liable to be given off at any time. Size is largely used for fixing colours; thus, the proper conditions for the development of arseniuretted hydrogen—the most dangerous compound of arsenic—are present. As much as 17 grains of arsenic have been discovered in each square foot of a wall-paper. Now, arsenic is sometimes given internally for certain skin and other diseases, but the dose is only from $\frac{1}{60}$ to $\frac{1}{12}$ grain; the capacity for poisoning of such a paper as the above will therefore be evident.

Papers of other colours than green have been found to contain dangerous quantities of arsenic; thus blue, mauve, red, and brown, may contain large quantities; the delicate greys often yield a considerable amount, and some white papers are heavily loaded with it. We may mention, in passing, that arsenic is occasionally present in stockings and other wearing apparel, artificial flowers, toys, etc. In these cases, it may produce irritation of the skin, and even eczema (an inflammation of the skin).

Considering the severe illness that may be produced by the arsenic derived from wall-papers and paints, and that such illness has in some cases proved fatal, it is surely time that the Legislature should interfere, and entirely interdict the use of arsenical pigments. In other countries, this has already been effected; in Bavaria, as long ago as 1845; while in France, Prussia, and Sweden, stringent laws forbidding the sale of arsenical papers are in force.

It is always wise in buying a paper to obtain a voucher that there is no arsenic in it; though this ought to be confirmed by an analysis, as in many cases where the voucher has been readily given, an abundance of arsenic has been discovered. Green and all other colours can easily be produced without the help of arsenic, and are so by the more respectable firms.

The presence of **arsenic may be detected** by the test commonly known as Reinsch's. A portion of the suspected paper (two or three inches square) is cut into small pieces, and placed in a good-sized test tube; water is added until the tube is about a third full,

and then one or two teaspoonfuls of pure hydrochloric acid, and a small piece of pure copper foil. If the test tube is now heated for a few minutes by a spirit lamp, arsenic, if present, will be deposited as a black or dark steel-coloured coating on the copper. A mere tarnish of the copper must not be accepted as evidence of the presence of arsenic, but an almost complete obliteration of the colour of the copper.

This test may be confirmed by taking the copper covered with arsenic, drying it, and then heating in a perfectly dry test tube. Crystals of white arsenic, which may be identified under the microscope, will be deposited higher up in the tube.

Marsh's test may also be employed, if further confirmation is required. In this, the ordinary apparatus for developing hydrogen by the action of diluted sulphuric acid on zinc is employed, the suspected paper being inserted in the bottle. The hydrogen coming off is burnt, and a clean porcelain surface is applied to the flame. If there is arsenic in it, it is deposited on the porcelain.

Floors are generally made of wood, stone, or tile. Wood is certainly the best for comfort, the others being cold to the feet. A tiled floor may be warmed according to the old Roman plan; a hollow space, or flues, being carried under the floor, and warmed by heated gases from a furnace.

For *basement floors* wood is not to be recommended, as it tends to rot from the damp, and very easily admits the ground-air into the house, especially in the too numerous cases where no concrete or asphalte foundation has been laid. Stone or glazed tile is preferable, but should be covered with some warmer material.

The use of *concrete* for basement and other floors is becoming common. It is porous, and yet resists saturation with water, while it is one of the best protections against the extension of a fire from floor to floor.

Other materials have repeatedly failed in cases of severe fire. Cast-iron is commonly employed to strengthen walls and floors; but at 212° Fahr. it loses about 15 per cent. of its strength, and at

the temperature of the centre of a large fire is in a molten condition. When imbedded in concrete or fire-clay, however, iron girdles effectually resist a tremendous heat. Stone and brick do not offer any effectual resistance to the spread of a fire, and timber joists carry it from room to room with great rapidity. For all these reasons, it is probable that in future, floors will more frequently be made of concrete.

Wood Floors.—The timber employed should be close and straight in grain, having a glossy surface, and uniform colour. There are two chief groups of timbers. (1) Coniferous timbers—pine, fir, cedar, larch, etc. (2) Hard or non-coniferous timbers—oak, ash, beech, mahogany, walnut, elm, etc.

Even the best timbers are liable to rot and decay, unless precautions are adopted. The chief causes which tend to induce rotting, are damp walls, lack of ventilation, contact with mortar, damp earth, or vegetable mould, and worst of all, alternations of damp and dryness, or wet along with heat.

In order to avoid these dangers, the ends of all timbers resting on walls should have a clear air-space around them, and communicate with the external air by means of perforated bricks. The larger timbers, girders, etc., should rest on stone templates, and the smaller joists on hoop-iron bonds. The ends of oak posts, which are to be driven into the ground, should be charred, if the timber is old, or steeped in a solution of chloride of zinc. In all cases, the timber used should be well seasoned, and properly ventilated.

The floor should consist of a double row of beams, or "joists," to the upper surface of which boarding is fixed. Where fire-places and flues occur in the wall to which the joists are fixed, it is important that the ends of the joists should be kept at a sufficient distance.

In all cases the boards of the floor should be so closely in contact, that dust or particles of any kind cannot fall between. Such matters are liable to decompose and vitiate the atmosphere, as well as injuring the ceiling beneath. Various methods for

ensuring the exact juxtaposition of the boards are employed in the best houses, but need not be described.

The frequent washing of a wooden floor, to keep it clean, is unadvisable, as the wood absorbs the moisture and diffuses damp throughout the room. For hospitals this is especially important; it is much better to have the floors polished, in order that they may be dry cleaned. Oak, or some other hard wood, made with close joints, and then oiled and beeswaxed and rubbed to a polish, makes a good and almost non-absorptive floor. (Galton). One of the best floors is made of concrete, with iron joists, and oak boards laid above this.

A bad floor may be economically made non-absorptive by covering the rough deal boards with thin, closely-adapted oak boards, oiled and beeswaxed.

Carpets are commonly made to cover the entire floor of rooms. This cannot be too much deprecated. Carpets, like curtains, are mere dirt-traps, which become loaded with filth of every description. This is abundantly proved when a carpet is swept, and the dust allowed to settle on all the articles in the room. Such dust, if examined, will be found to consist of dried mud, chiefly granite or wood, but also containing every description of vegetable and animal impurities. When raised by walking about a room, it is a common cause of "colds" and bronchitis. In addition, as it consists largely of organic matter, it produces a close smell and devitalises the entering air.

The substitution of a central carpet, for one covering the entire floor, is a great improvement, the floor around the carpet being covered with parquet veneering; or if the expense of this be too great, the whole floor may be painted with four good coats of dark oil paint, and varnished, the joints of the boards having first been made secure.

The carpet should be easily removable, in order that it and the floor may be thoroughly cleaned at intervals.

In bedrooms, the less carpet the better. Good Chinese or Indian

matting is strongly recommended instead, as it does not retain the dust and other impurities which become fixed in the woolly texture of a carpet. (Edis).

Oil-cloth, linoleum, and similar materials are in common use for covering halls, passages, etc. When laid over the whole surface of wooden floors and glued down, they tend to promote dry rot in the floors, by keeping in the moisture and not allowing the access of air. Occasionally, linoleum is laid with cement, so as to fix it evenly to the floor-surface. This is ruinous to a wood floor. Linoleum may be safely used, if it is only laid over the central parts of a floor, and simply fastened down with pins.

The **Roof** of a house should be quite impervious to rain. It is usually constructed of tiles or slates; lead or zinc being employed for flat roofs.

The down spouts, for carrying off rain-water from the roofs, should be fixed two or three inches away from the wall, in order that in case of overflow, the water may not soak into the wall.

In order to diminish the loss of heat through the roof, which may be considerable, if the upper rooms are without special protection, the roof should be built with close boards covered with felt, under the slates or tiles. Such a method of construction also prevents excessive penetration of summer heat.

The ordinary lath and plaster *ceiling* serves to deaden the sounds in rooms overhead, and is a good non-conductor of heat. It allows, however, considerable passage of air and moisture. When the external temperature was 72° and the internal 40° Fahr., $1\frac{1}{2}$ cubic feet of air per square foot of plaster were found to pass through every hour.

CHAPTER XXX.

THE SOIL AND ITS DRAINAGE.

The Varieties of Soil.—Their Suitability for a Site.—Ground Air.—Water in the Soil.—Moisture and Ground Water.—The Level of Ground Water.—Temperature of the Soil.—Connection of Ague, Typhoid, Cholera, Consumption, etc., with Conditions of the Soil.—Sub-Soil Drainage.

It will be convenient to consider in turn the geological varieties of soil; the air contained in soil; the water contained in soil; and the temperature of various soils.

The Varieties of Soil.—1. **Granitic, Metamorphic,** and **Trap Rocks** usually form healthy sites for houses. The slope is generally great, and the ground air consequently dry.

2. **Clay Slate** resembles the last in its effects on health. Water is, however, often scarce, owing to the impermeability of the rocks, and for the same reason occasional floods occur.

3. **Limestone** and **Magnesian Limestone Rocks** resemble the last in possessing considerable slope, so that the water passes away quickly. The hard oolite is the best formation under this head, and magnesian limestone the worst. The absence of marsh from these formations should be carefully ascertained.

4. **Chalk Soil** is healthy when unmixed with clay, and permeable. Goitre is not so common as in limestone districts. If the chalk be mixed with clay, it is often damp and cold.

5. **The Sandstones,** if permeable are healthy, soil and air being dry. If mixed with clay, or if clay lie under a shallow layer of sand-rock, the site may be damp. The hard millstone grit is a healthy formation.

6. **Gravels** of any depth are healthy, unless they lie below the surrounding surface, and water rises in them.

7. **Sands** may either be healthy or unhealthy. They are healthy when of considerable depth, and unmixed with organic matter; unhealthy when, as in the French Landes, they contain a large

Pettenkofer said: "we do not go for change of air, but for change of soil". The soil determs humidity, radiat.n evapn & a host of factors going to make up "climate"

shallow low-lyg gravels, espy near rivers, may be water-logged, & in such sits. a tree stands on impervs clay may be drier than one on gravel.

Comᵈ not all the clay is removed fr. Lichfields, Carᵈ is fillᵈ w.
'dust' The only way in wh. offᵉ mat can be effᵗ thoroughly decomp'd is by keeping
dry, wh. only secured by subs. drainᵉ. Road scrapᵍˢ shd not be mixed
w. cinder refuse.

amount of vegetable sediment. They may also be unhealthy from being shallow, and lying on a clay basis; or from the ground water rising through them from ground at a higher level; or from the sand containing considerable soluble mineral matter.

8. **Clay, Dense Marls, and Alluvial Soils generally**, are always suspicious. Water is retained in them, and is often very impure. Only very thorough drainage can make them healthy.

9. **Cultivated Soils** are not necessarily unhealthy; but

10. **Made Soils** are always to be carefully avoided, as sites for houses. The materials with which inequalities have been filled up are commonly the contents of dust-bins, or some other refuse. The gradual putrefaction of organic matters renders the air about the houses impure. Such soils require free sub-soil drainage, in order to keep them dry. It appears that the organic matters in soil are gradually removed by oxidation and other processes. At least three years should be allowed before any such site is built on.

The following table, prepared by Dr. Parkes, places different geological formations in their order of healthiness for the purposes of a site:—

	Permeability of Water.	Emanations into Air.
1. *Primitive rocks, clay slate, millstone grit*	Slight.	None.
2. *Gravel and loose sands, with permeable subsoils*	Great.	Slight.
3. *Sandstones*	Variable.	Slight.
4. *Limestones*	Moderate.	—
5. *Sands with impermeable subsoils*	Arrested by subsoils.	Considerable.
6. *Clays, marls, alluvial soils*	Slight.	Considerable.
7. *Marshes, when not peaty*	Slight.	Considerable.

The general geological conditions have an important bearing on the choice of a site for a house. The immediate local conditions

have, however, a still greater influence on its sanitary condition. These will be discussed in the next chapter.

The soil consists mainly of mineral matter. It also contains a certain proportion of animal and vegetable matters, and it is on the amount and character of these (along with the condition of moisture and aeration), that the healthiness of a given soil depends. The presence of vegetable matter, subject to alternate wettings and dryings, and to heat, seems to be the condition on which malaria depends. The presence of animal matters leads to the evolution of poisonous effluvia, and the tainting of drinking water. The two chief agencies at work to rid the soil of organic impurities, are oxidation and the influence of growing plants. The organic matters become oxidised into ammonia, nitrites, and nitrates, and these are eagerly assimilated by vegetation.

The Air contained in the Soil varies greatly in amount with the character of the soil, and with the level of the ground-water. As the ground-water rises the ground-air is driven out. Thus, after a heavy rainfall a large portion of this air will be displaced. Variations in barometric pressure, and a rise or fall of temperature, cause movements in ground-air. A house artificially warmed is continuously fed from the ground-air, unless means are adopted to make the floors impervious. The warmth of the house acts as an air-pump, aspirating the colder air into its interior. The air from cesspools or defective drains may be similarly aspirated into the house; and the same condition explains the unhealthiness of houses built on "made soils." For these reasons the occupation of cellars as lodging-houses has been prohibited by law.

The *amount* of ground-air varies greatly. Loose sands often contain 40 to 50 per cent., soft sandstone 20 to 40 per cent., and loose surface-soil many times its own volume.

The *nature* of the air is not accurately known. It is, however, extremely rich in carbonic acid, of which it contains 4, or even

Not correct to say that surf. of earth is limit of air

A gt mistake to suppose that a calm air is motionless. & same applies to ground-air.

To measr air in soil take a litre flask, fill w. gravel, add H_2O & see how many c. c. addd bef. level of gravel reachd. This eqls amt of air displaced.

For descriptn of experts shewg movemt of air thro soils see, Pettenkofer p. 77.

Processes of putrefn & decay more rapid in porous soils, owg to actn of lowly org sms

Case in wh. persns poisd by coal-gas, none being laid on to the house. Had travld 20ft underst & then thro. found mrs cellars & flrs of lower rooms. Case of gas explosn demold a hse to wh. no gas laid on. Mem. influ of aspirn fr. hse.

Grd-air more movd & more uniformly diffused than H_2O & perhaps more pernicious (Pettenkofer).

Pettenkof. fd at Munich that qty of CO_2 mean at 5-8" than 156" deep throughout yr exce. in months June & July. In every case the CO_2 in grd air was gtr than in R. H_2O so late cd not be the source of CO_2

CO_2 in soil air may be even 10-30 %. Wollny has shewn that it is derived fr. the org. matter in soil, not by chem. processes, but by act. of Bacts. in a manner analogous to nitrification, by wh. other org. subs. convert nitrog. compds. & NH_3 compds. into nitrites & nitrates.

Two principal conds. regulate rapidity w. wh. rain percolates thro. soil - viz. total vol. of space & pores contd. in a given piece of ground: 2) individ. dimens. of pores. Vol. of pores does not vary much in diff. soils & may be reckd. as $\frac{1}{3}$ of whole. 2 vary v. much. Soil w. fine pores retains percol.: a compact soil is v. hygrometric. Level of underg. H_2O may be quite uninfluenced by heaviest rainfall, if it is low down. Separd. fr. the surface by layers, wh. retain heaviest rainf. with little or no drop fall thro. Hofmann divides soil into (1) dry soil or swapy soil (cellular soil of Prof Arnold) wh. passes thro. stages fr. complete dryness to saturation. This forms a reservoir wh. may collect the rainf. 2 a yr.: is a receptacle for pollut. germs & ferments. (2) The intermediary zone is in a const. state of humidity exc. when it yields the surplus of (1). This surplus flows passes quickly thro. to (3). It collects a qty of H_2O wh. is equiv. to the rainf. of several days.

Percolation of rainf. demonstd. by artificial gauge. Most of percn occurs Oct-Mar. Nearly alw. incr. w. rainf.

Relation of rainf. & percn vary. gtly, but diffce or loss due to evapn & vegn remains fairly const. Must not look to ratio of percn & rainf. but to diffce. When percn = 0, then all rain evapd. As 'loss' does not vary gtly in diff. seasons, can obtain nearly approx. to percn by subtracting assumed loss fr. known rainf. After wet autumn saturated grd, percn in succeeding winter will be gr.

Ground water - level gen. lowest in Oct. & Nov; highest in Feb. & Mar. Period of rise corresp. v. nearly w. period of least percn, being a little later. The "seasonal variation" in level of gr. H_2O in upper regions of chalk freq. 50' sometimes 100' - in lower districts may be only 3-4'. In New R. & Old R. Sandst. is considerably less.

On Continent natural filter-galleries used, of porous brickwork partly & deeper than river-bed. To that successful gallery supplies indefinite quantity of river, as shewn by temp. & diffce chem. constit. H_2O was derived fr. underg. H_2O flowing fr. higher grds into river bed.

At Brighton (on chalk) no streams. Rills can be seen running down shore at low H_2O. Water supply obtained by driving deep channels in chalk parallel to coast at a level of low H_2O, so as to intercept underg. streams

6 to 8, per cent. The more porous the soil, the quicker the oxidation of organic matters, and consequent purification of the soil.

THE WATER CONTAINED IN THE SOIL is divided into moisture and ground or subsoil-water. When air is present in the soil as well as water, the soil is merely moist. Pettenkofer defines the ground-water as that condition in which all the interstices are filled with water, so that, except in so far as its particles are separated by solid portions of soil, there is a continuous sheet of water.

The **Moisture** in the soil varies in amount. Open gravel will absorb from 9 to 13 per cent. by weight of water; gravelly surface soil 48 per cent.; light sandy soils from 23 to 36 per cent.; loamy soil 43 per cent.; stiff land and clay soils from 43·3 to 57·6 per cent.; sandy and peaty soils from 61·5 to 80 per cent.; peat 103 per cent. (B. Latham). The moisture being derived from the rainfall on one side, and the ground-water on the other, will vary with the amount of these. Some soils are practically *impermeable* to water, such as trap or metamorphic rocks, unweathered granite, hard limestone, and dense clay; while others, such as chalk, sand, sandstone, vegetable soils are *permeable*. Commonly the metamorphic rocks and hard limestones present fissures, which render them pervious. The rainfall which does not penetrate the soil flows into the streams and rivers at once, or is re-evaporated. On an average, it appears that in this country about two-thirds of the mean annual rainfall is at once evaporated. A smaller evaporation and a greater percolation take place in well-drained soils.

The **Ground-water** forms a subterranean sheet of water, which is in constant motion. There is first, of all, an irregular rise and fall of the water, according as it receives new additions from the rainfall, or loses a certain amount of its substance by percolation and evaporation; and there is, secondly, a constant movement toward the nearest water-course or the sea. In Munich, Pettenkofer reckoned the rate of this movement as 15 feet daily. It is impeded

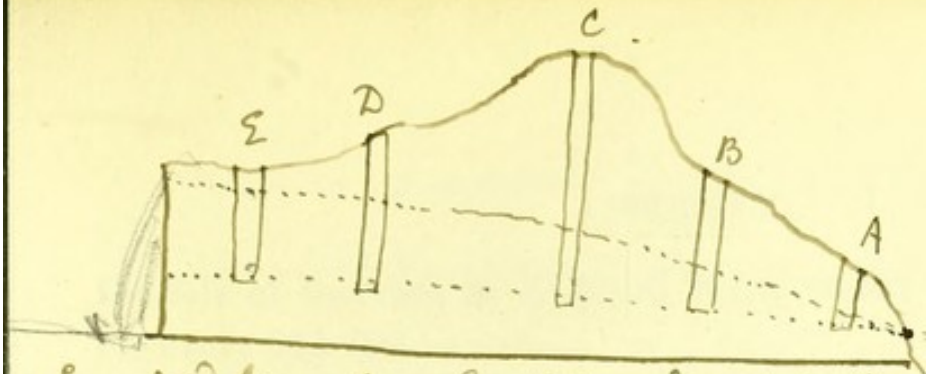
by impermeability, or a deficient slope of the soil. The roots of trees also greatly impede its flow.

The level of the ground-water is constantly changing. The alteration in level may be only a few inches either way, while in some parts of India it is as much as 16 feet.

A *fall* in the level of the ground-water may be due to a dry season, or to improved subsoil drainage. A *rise* in its level is due to an increase in the rainfall, or some obstruction in the outflow, as from a swollen river. The tide may influence the level of the ground-water at a great distance. A sudden alteration in the level of the ground-water is a common cause of floods in mines.

The distance of the subsoil-water from the surface may be only two or three feet, or several hundred feet, the difference being due to the varying level of the nearest impervious stratum of soil. Its distance below the surface of the soil can easily be measured in any given case, by ascertaining that of the water of a shallow well in the neighbourhood. It should if possible never be nearer the surface than five or six feet. Sudden changes in the level of the ground-water from inundations render any soil unhealthy, and are even more objectionable than a persistently high level. This is especially true in the case of permeable soils. A sudden rising of ground-water expels the air in the soil, together with the associated effluvia; it also washes organic impurities out of the subsoil, and carries them into neighbouring wells. Several epidemics have been traced to this source.

The Temperature of the Soil varies greatly with its geological character, as well as with the temperature of the atmosphere. The daily changes in the temperature of the atmosphere do not affect the soil beyond a depth of about three feet. The annual changes in the atmosphere will affect the soil in a varying degree, the amount being dependent on the character of the soil as regards conductivity and retentiveness for heat. Such annual variations do not penetrate below forty feet, and are very small below twenty-four feet. The temperature of the earth increases with its depth,



Lower dotd. line shews level of underg. H_2O abt Oct. & Nov. line of permant. saturn. upr. dotd line = level abt Feb. & Mar. Sectn. shews 1). that fall of underg. H_2O cant be determd by fall of land; 2). the further the wells fr. sea & gtr the varn betw. summer & winter levels. In A is 25' in E 50' : 3). this diffce is owg to H_2O level at sea outlet being nearly constt, while level of wells betw. A & E. is defd by a line drawn fr. sea to H_2O in E. : 4). Much more rapid fall of H_2O to sea in winter than in summer abt 30' per mile as agst 10' per mile. Gtr fall means gtr velty

Origin of springs explnd by impervs strata retg H_2O until lowest point of natl escape reachd.

Should denudatn lead to expose of lower stratum on a hill-side, the grd-H_2O emerges at line of outcrop as a spring.

Resistce to percolan lead to accumn of H_2O above level of outlet in streams, & thus a curvd surfce lowest point of escape determs permant level, above wh. all the H_2O tends to run off in springs: height of curve above this level gives the head of H_2O, on wh. the springs depe for their supply.

Intermt pollutn of wells by cesspools.

rise in temp 1°F for 52½' descent in soil
——— 1°F — 300' ascent in air

A dry sand absorbs heat rapidly, but also cools rapidly by radiation

Damp soils cold because of evap^{n}. If 30" rainfall in yr on an acre of grd, if its evap^{n} be spread over the whole per^{d}, daily wt of H_2O evap^{d} would be over 8¼ tons. Advant^{e} of drained same as if land had been transport^{d} 100-150 ms Southward (Buchan)

the rate of increase in England being stated to be about 1° Fahr. for every 54½ feet.

In climates where, as in the British Isles, the rainfall does not vary very widely throughout the year, the average annual temperature of the soil will be identical with that of the atmosphere. In countries where snow lies for some time on the ground, the average temperature of the soil may exceed that of the air, snow being a bad conductor of heat.

In England the water of permanent springs has a temperature of 49° to 51° Fahr., and their water being derived from the deep part of the subsoil, its temperature may be assumed to represent accurately the mean temperature of the district.

Although the average temperature of any soil depends on the climate, soils conduct heat in a very varying degree, and therefore absorb unequal quantities. This has an important bearing on the comfort of those living on a particular soil. Schübler's experiments give the absorbing power of the chief kinds of soil, 100 being taken as the standard.

Sand, with some Lime ...	100	*Clayey Earth*	68·4
Pure Sand	95·6	*Pure Clay*	66·7
Light Clay	76·9	*Fine Chalk*	61·8
Gypsum	73·2	*Humus*	49·0
Heavy Clay	71·11		

It is evident from this table that sand is very retentive of heat, while clays and humus are very cold. Green vegetation lessens the absorbing power of the soil, and radiation of heat is more rapid, evaporation occurring constantly from the herbage. The influence of trees on the temperature of the soil will be considered later.

Damp soils are colder than dry soils. Buchan finds as the result of drainage of the soil, that (1) the mean temperature of arable land is raised 0·8° Fahr.; (2) cold is propagated more quickly through undrained land; (3) drained land loses less heat by evaporation; (4) the temperature of drained land is more equable, and

(5) in summer is often 1·5° to 3° above that of undrained land These facts throw considerable light on what will subsequently be said respecting consumption, rheumatism, etc.

Diseases Arising from the Soil.—The soil may be a cause of disease in two ways; either by means of the air, or the water it contains. Diseases due to contaminated drinking water, have already been sufficiently considered. We shall therefore deal here exclusively with those attributed to **dampness** and **emanations** from the soil. The most important of these are malarious disease, typhoid fever, yellow fever, cholera, and dysentery, phthisis, and rheumatism. All of these are usually associated with the presence of organic matter in a state of decomposition, and in several of them (typhoid, yellow fever, cholera, and dysentery), contamination of the soil by the excreta of a patient suffering from the same disease, usually occurs.

(1) For the production of **malarious diseases** no such antecedent case is necessary. The soil must contain a certain proportion of dead organic matter; it must be exposed to alternations of heat and moisture, with a limited access of air, and a temperature of at least 65° F. Though most common in marshy districts, and in recent alluvial soils, malaria may develop in connection with any geological formation. That it may be removed by drainage of the subsoil, is well known. On the other hand, it has been traced in several instances to the construction of mill dams, etc., impeding the outflow of subsoil water; while it is common in the tropics, in the hot weather following the heavy rains.

(2) According to observations made by Pettenkofer in Munich, attacks of **typhoid fever** are connected with fluctuations of the subsoil-water, occurring when this is lowest. His observations have not been confirmed in this country; and there can be no doubt that the most common origin of this disease is from direct infection of water or milk by the specific contagion.

(3) In regard to **cholera**, Pettenkofer holds similar views. He advances many striking arguments to prove that, while cholera is

Range of fluct^n important rather than act^l level.

15 yrs obsern^s by Pettenkofer shew^d that prevale of Typ^d was radic^y by water-level in wells. He believes that cause of Typ^d in 'org^c processes' in the soil. English say that when H₂O in well is low, its area of drain^e is extend^d. Thus Typ^d pois^n drawn fr. gtr dist^e.

Pettenkofer's law — "betw. fluct^ns of subs. H₂O & amt & severity of Typ^d an inv^e connⁿ: in this wise, that the total cases of sick^s & d^s fr. Typ^d falls w. rise of subs. H₂O, rises w. fall of it: that the level reach^d by dis. is not in prop^n however to the then level of subs. H₂O, but only to the var^n in it on ea. occas^n; or in other words, that it is not the high or low level of subs. H₂O that is decisive, but only the range of fluct^n!"

Estim^n level subs. H₂O by amt rainfall, height of stream by water mark — marelia & measures

Measurts of subs. H_2O by Lewis & Cunningham in Calcutta shew that highest level reachd in Septr, steady fall thence to May. Thus if any causal relationship betwn. pert. of C. in Calcta & level of subs. H_2O, not a direct simple one dept on mere mass of H_2O in soil

Pettenkofer's law — wet weather if not excess. spreads C; excess. rainf. puts it down and (must be still pert. bain).

Chol. as a rule follows rivers, but as often up as down stream. (Farr deduced the law that prop. of inhabts f. Chol. is inversely as elevn of grd)

B. Latham shewd by diagram connn betwn. low grd H_2O + typh. fev. in Croydon fr. 1866-84, a very marked connn

Dr Buchanan shewd also that rapidly inclined geolog. formts had a less d. r. f. Phth. than those in wh. same formts cumpard flat.

Also that while a pervious formt saturd w. fresh H_2O is fav. to phth., simt formt saturd w. salt H_2O, has, as in case of some sea-towns, little or none of this effect. (Post rise & fall of tide influences)

due to fermentation of cholera-stools, as agreed on all sides, the contagion can only be developed when there is a damp porous subsoil to receive the stools. There can be no doubt that under such conditions, the atmosphere would become impregnated with the cholera poison; but the water of the district would be still more likely to become tainted, and would form a ready means of communicating the disease. Pettenkofer however considers that the damp porous subsoil forms a second host in which the poison of cholera must pass through one stage of its existence, before it is again capable of producing the disease. Such an essential relationship of the soil is not borne out by observations in India.

(4) The close connection of **consumption** (phthisis) with a damp soil has been proved by Dr. Buchanan. After careful investigation he found that in the districts where improved sanitary arrangements had led to a drying of the soil, the death-rate from phthisis diminished; but where with sanitary improvements, the soil was not dried, the death-rate from phthisis remained stationary. In Salisbury, Ely, Rugby, and Banbury, the death-rate from phthisis decreased nearly 50 per cent. In other towns (such as Stafford, Morpeth), in which the same improvements had been made, with the single exception of not drying the soil, the death-rate remained the same. A subsequent investigation confirmed all these results, and shewed in detail the geological conditions which co-existed with a high phthisis death-rate. Dr. Bowditch, of Boston, U.S.A., independently arrived at similar conclusions, with regard to Massachusetts.

(5) Other diseases, such as **rheumatism, catarrh,** and **neuralgia,** are favoured if not produced by a damp soil. Since acute rheumatism is a frequent cause of heart disease, the latter may also be ascribed indirectly to a damp soil. How far these are due to chilling of the skin, and how far to other causes, is yet uncertain.

Drainage of the Soil.—There are two chief plans for rendering the soil drier—deep drainage and opening the outflow.

Sub-soil Drainage is of great importance in relation to health. There are two plans for doing this: either the sewers may be employed for this purpose, or a separate system of pervious drains may be laid. In order that sewers may be utilised for draining the soil, they must be penetrable to moisture. They are generally made so at their upper part, and water-tight below. This is, however, not a good plan. If the sewer is full, its contents soak into the surrounding soil, and contaminate it. In all new plans for drainage, there should be separate sub-soil drains. These should be constructed of brick or perforated earthenware; they should preferably be carried into the nearest water-course. If it is necessary to join them with a sewer, they should not pass directly into it, but into a disconnecting man-hole.

The importance of separate sub-soil drainage is shewn by the observation of Dr. Buchanan, that the death-rate from phthisis diminished more in the early years after the establishment of sewers than in later years; the difference being due to the tendency of the sewer-trunks to become consolidated and impervious to moisture (Baldwin Latham.)

Opening the Outflow, in order that water may not remain stagnant in the soil, is occasionally required. This may be done by clearing water-courses, removing obstructions, and forming fresh channels.

The provision of sufficient **surface-drains** to carry off ordinary water and storm-water, in order that percolation into the ground may be diminished, is also important.

Vegetation tends to diminish dampness of soil by causing rapid evaporation, and at the same time uses up the organic matter in the soil. Certain plants are more active in producing these effects than others: the *Eucalyptus* genus, including many species, and represented by the well-known *blue-gum tree* of Australia, is noted for its power in this respect; and the common sun-flower, which is very easy of cultivation, has a powerful influence in the same direction.

In water-logg.d free soils a single drain often covers f. 1½ of a wide area, & may cause settle.t of hses In clay soils numer.s drains req.d Subsoil drains shd be made secure f. entry of vermin & roots of trees, by caref.d joint.g pipes with tarred gaskin & Portld cement.

Unglazed earthenw.e pipes to be used having butt joints – cov.d w. a thick.s of clean gravel to allow of percol.n of water. The upper ends of land drains shd have comm.n w. open air, admit.g a free current to flow f. intercept.g manhole up thro drains.

outflow

surf.e drains

vegetat.n

Effic.t land drain.g is benefic.l not only to farmer but also to resid.t popul.n, prevent.g local fog, & prod.g a warmer & drier climate. A well drain.d area of land is a good specimen of modern engineering (Rawlinson).

In deciding on a climt v. deceptt to draw conclusns f. comparn of mean temps: or rainfs: Means are gent truths but partict fallacies.

Guy's-Ballot law stand w. yr back to wind ∴ barom: wl be lower on yr L. than R. hand in N. hemisphere.

Isobars = dotd line conn: all places havg same atmc. pressr.
Distce betw. 2 isobars = 1/10" Hg, calld a gradient. Isobars close togr = high grad.

Atmc pressr w. incrd elevn falls alng w. tempre
1/1000" depresn of barom: = 1 ft of height.

Fall of barom: may be due to 1. higher altde - rarer air
2. incrd temp. of air.
3. " moistre " "

Barom: falls w. warm S.W. winds.

CHAPTER XXXI.

LOCAL CONDITIONS.

Conditions producing Climate.—Elevation.—Hill, Plain, and Valley.—Relative Elevation.—Mountain Air.—Influence of Forests.—Influence of Vegetation.—Relation of Sea to Climate.—Winds.—Moisture of the Air.—Rainfalls.—Site of a House.

The Climate of a country has an important influence on the health and character of its inhabitants.

The character of a climate depends on four main conditions:—

1. The distance from the equator.
2. The height above the sea.
3. The distance from the sea.
4. The prevailing winds.

There are other conditions which are of subsidiary importance, but which have great influence in modifying the climate of any given locality. Thus:—

5. The nature of a surface—its aspect, shelter, slope; the colour of the soil or rock, the reflection from rocks or sheets of water, and the influence of vegetation.
6. The cultivation of the soil.
7. The drainage of marshes and damp soils.
8. The planting and clearing away of forests.

The Distance from the Equator is the most important factor in relation to climate. The sun's rays become less powerful as they fall more obliquely, in travelling from the equator. This primary factor in producing climate is largely modified, however, by the relative distribution of land and water, and by the character of the prevailing winds of a district.

The Elevation of a locality has an important influence on its temperature, the temperature falling as the height is increased. The amount of fall varies with the latitude of the place, with its situation in regard to surrounding districts, the degree of moisture of the air, the presence of winds, the hour of day, and the season of the

year. It is usual to allow 1° Fahr. for every 300 feet of ascent above the level of the sea.

Hills, Plain, and Valley.—The law of decrease of temperature with increase of altitude, is liable to great modifications, and even subversions from various causes. The chief cause producing such modification of the law is the *relative elevation to the surrounding district.* Thus, in the case of rising ground, the higher parts become rapidly cooled by radiation. The air here is likewise cooled by contact, and becoming heavier in consequence, flows down to low-lying ground. It follows that places on rising ground are never exposed to the full intensity of frosts at night. A familiar proof of this is the frosting of potatoes at the bottom of a valley, and not on its slope.

Valleys surrounded by hills and high grounds, not only retain their own cold and heavy air, but serve as reservoirs for the cold air falling from neighbouring heights. One finds, in consequence, mists in low situations, while adjoining eminences are quite clear. Swiss villages are generally built on eminences rising out of the side of a mountain, with ravines on both sides of them, thus escaping to a large extent the downward currents of cold air, and the colder air at the bottom of the valley. In ascending the slope, of a hill, the increased warmth can often be readily felt.

The **air of mountains** is (1) cooler than that of lower districtss with the exception already named. (2) It is less dense in proportion to the altitude ; its pressure at the height of 16,000 feet being only half that at the sea-level. (3) Its absolute humidity is decidedly diminished ; there is some difference of opinion as to the relative humidity. (5) The air is as a rule purer. It is generally free from dust, and to a large extent aseptic (that is, free from the tendency to produce putrefactive changes). (6) The amount of ozone is commonly greater than in lower regions. In addition to these characters, (7) the light is intense, and (8) the direct heat of the sun is greater, and the difference between sun and shade greater than in lower regions.

More rainf. in Mt. Dists. even when further fr. sea than plains.

"The low. temps. to some extent compensates for defict of R.
depends on its elevat.
Neighb. of a glacier import. in a mt.ous air resort, as moist. in
air is all condens. & air itself is somewhat concent. by the cold
This is one of advants of Pontresina, U. Engadine

proportion of the deaths occurring in the winter months, are either due to or hastened by a low temperature.

Forests tend to modify a climate, and mitigate its extremes, whether situated on the slopes of mountains or on plains. Trees are heated and cooled by radiation like other bodies, but from their slow conducting power, the periods of their maximum and minimum temperatures are not reached for some hours after the same phases of the temperature of the air, and the effects of radiation are not confined to a small surface on the soil, but distributed to the level of the tree-tops. For these reasons, trees make night warmer and day cooler, thus giving to forest districts something of the character of an island climate. Evaporation occurs slowly from the damp soil beneath trees, as it is screened from the sun, and the trees prevent a free circulation of wind. Hence the relative humidity and rain-fall are increased.

Ground Covered with Vegetation has a more uniform temperature than bare soil, the effect being much the same as that of forests, though on a smaller scale.

All growing vegetation evaporates a large quantity of water. A plant evaporates 200 pounds of water while it forms one pound of woody fibre; the effect of a forest must, therefore, be enormous. At the same time, vegetation, and especially trees, retain moisture in the soil. The water-supply of barren regions may be greatly increased by planting trees.

The absence of vegetation leads to extreme fluctuations of temperature. An extent of sand, for instance, raises the temperature of the air greatly during the day, as it is a bad conductor; but at night, radiation is very great, and the temperature falls accordingly. The alternations of heat and cold are further intensified by the extreme dryness of the air of sand deserts.

Relation of Sea to Climate.—Water has the greatest specific heat of any known substance, being four times greater than that of the earth's crust. On this account it takes longer to heat and to cool than the earth. Unlike the earth, likewise, it allows free

In Amer. result of destr. of trees already seen in
ster. variab. of annl. rainf., length. per. ds. of drought,
incred. power of floods & cloud-bursts.
O. W. Holmes hopes that the people will allow the
country to ret. "leaves enough to hide its nakedness,
tho' it is already bec. ashamed".

Well known that floods follow the reckless destr. of forests
Apart (1) f. prevent. these floods: (2) forests mit. more O than C in
air abt forests than treeless plains acc. to Ebermayer of Munich
But (3) plant. of cities w. trees useful, as veg. growth prest. cool. of
noxious gases. (4). Trees act as barriers agst. typing winds dust carg.
They intercept in foliage grosser particles in air. Shade soil & keep it
cooler. Shelter: reduce sootfalls like an egg-douche. More ozone in woods
Processes of agricult. & artificial drainage, as well as life in cities
const. these locals into bact. preserves.

Proxim.ty to sea affects climate_ 1. by red.n mean daily range of temp.e
2. by rais.g temp. in winter months. 3. by lower.g temp. in summer months.

Gulf Stream a broad body of warm H_2O sweeps out of Gulf of Mexico thro. Strait of Florida; runs N. nearly par.l to coast of U.S., then across Atlantic in N.E. dir.n. Warm curr.s contin.g dir.n of G. Stream set on to W. coasts of Ft Brit.n Scan.a Norway; others turn S to coasts of Spain & N. Africa. The G. Stream due to Trade Winds, wh. blow.g fr. N.E. give a W. impulse to the inter-trop.l surf. waters of Atlantic
Temp. of G. Stream near Florida is 80° F Rate of move.t 4-5 ms per hr.

Isothermal lines bend.g up & down, the bend.gs being determ.d by places of continents & oceans. Labrador & London coincide in latitude, but by no means in temp.e
New York has same mean temp. as London, tho. N.Y. is as far S. of London as Madrid. Necess.y in compar.g places to have map of range of temp. as well as of mean annl. temp.e

penetration of the sun's rays,—in clear water probably to a depth of at least 600 feet; consequently, the surface of the water becomes less rapidly heated. The freezing point of fresh water is 32°, while that of sea-water is 27·5°—28·4°. Thus, the sea remains open at a temperature at which inland lakes freeze, and has, therefore, a greater influence in moderating winter cold and summer heat. Another factor rendering it more competent to mitigate extremes of temperature than lakes, is the presence of currents, causing admixture of the water of different climates. Deep water, wherever found, has the same influence on the atmosphere. In summer it cools it, and in winter increases its temperature. Cold water descends to the bottom of the sheet of water, and is there somewhat warmed by the deep lying, and therefore warmer, earth.

It is important to distinguish between the *surface* temperature and the *deep-sea* temperature, the latter being fairly constant. The whole of the depths of the sea is filled with water at or near 32° Fahr., which in the tropics is 40°—50° below the temperature of the surface-water.

The influence of seas on climate is so great as to lead to a classification of climates into oceanic, insular, and continental.

An *oceanic climate* is least liable to violent changes of temperature; and for this and other reasons is very valuable in the treatment of chest complaints. It can only be obtained by a sea-voyage.

An *insular climate* presents smaller differences between the temperature of summer and winter than in the interior of great continents, especially when the island is small and in the midst of the ocean. In the British Islands, the prevailing winds being westerly, places on the east coast are less truly insular than similarly situated ones on the west coast; and their climate approaches more nearly that of inland countries.

A *continental climate* is drier and more subject to extreme alternations of temperature than insular and oceanic climates.

Winds are due to differences in atmospheric pressure. Inasmuch as the temperature and degree of moisture of air depend on the prevailing winds, their consideration becomes very important. Winds bring with them the temperature of the air they have traversed: thus, in England, south winds are warm, while north winds are cold. Winds coming over an ocean cause less variation in temperature than those which have passed over an extensive tract of country. Thus, moist ocean winds are accompanied by a mild winter and cool summer, while dry continental winds cause the reverse conditions. The amount of moisture capable of being carried by a current of air increases with its temperature; therefore, equatorial winds become moister as they proceed, while north winds become drier. The south-west winds, in the British Isles, being both oceanic and equatorial, are very moist, while the north-east winds, being both northerly and continental, are peculiarly dry and parching.

Owing to the atmosphere pressure diminishing from the south of Europe northwards to Iceland, south-west winds are the most prevalent in Great Britain; and as this diminution of atmospheric pressure is greatest in the winter months, south-west winds are most common at this season. The result is that the temperature of these islands is higher than that due to mere latitude, averaging 39° in Shetland and 38° in London, instead of 3° and 17° respectively, which it would be if only latitude were concerned. As the temperature on the west coast is fairly uniform from Shetland to Wales, there is no advantage for invalids in going south, unless they go to the south-west coast.

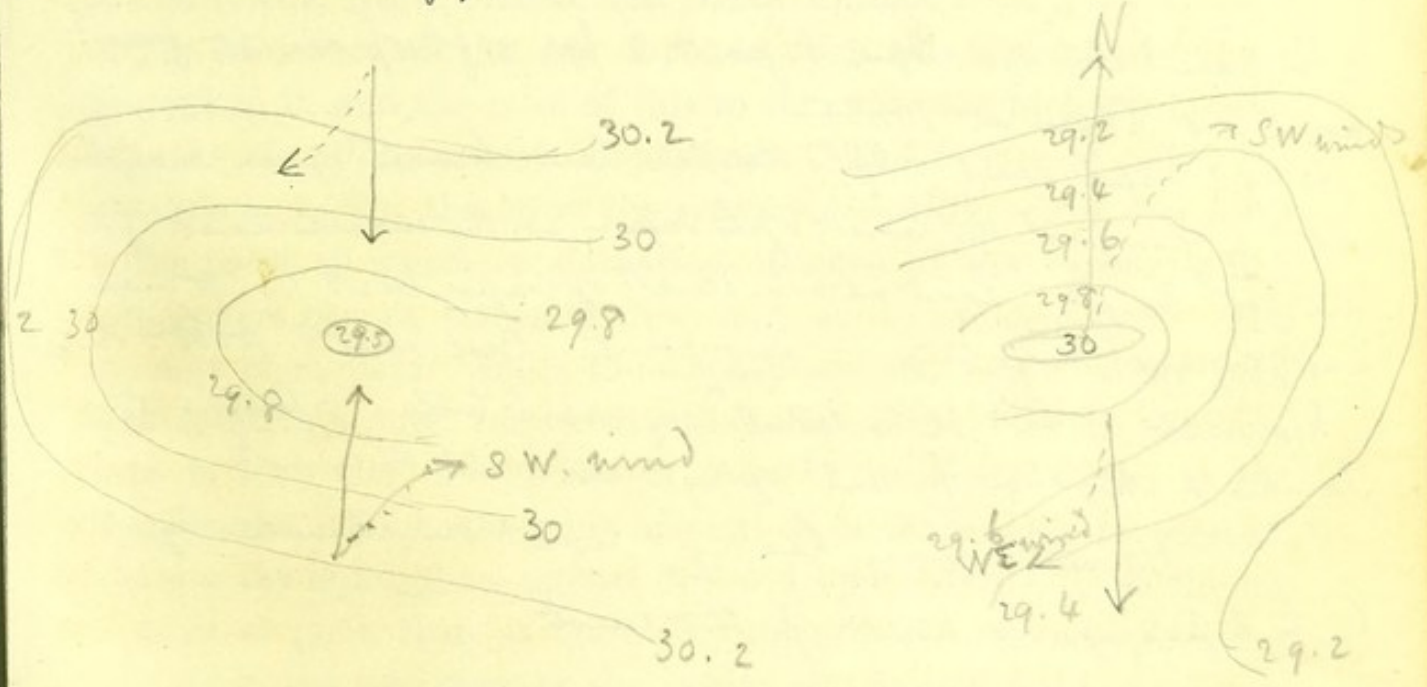
Mountain ranges have an important bearing in determining the character of the prevailing winds. If the range is perpendicular to the direction of the winds, the latter lose the greater part of their moisture, and the places to leeward being exposed more completely to solar and terrestrial radiation (from comparative absence of aqueous vapour), winter becomes colder and summer hotter. The difference between the climates of the west and east parts of Great

In a Cyclone wind moves in oppos. dirn to hands of a watch : baromr lowest in centre, area compar. small, & gradient f. centre to circumfce is steep ; velty being usly great & attd w. much rainf.

In an Anticyclone — reverse condns : clear skies, gentle winds, fine weather, hot in summr but cold & frosty in winter.

Low pressre in Medtn w. high pressre to N. are the condns of worst winter weather in S. of Europe. A cyclone in gulf of Lyons r of Genoa & an anticyclone over centl & Russia, also attd by mistral, blowg freshly & dryly on Medtn coasts of Spain France & N. Italy Algiers, Greece & Malta are thus liable to sudn alternns of temp. in cold weather mths.

No places in Europe or even Algiers so free f. risk of cold weather in winter, as Egypt & Madeira.



Trade Winds — N. wind becs a N E. wind in travelg towds Equator.
Wind f. S. pole becs S E. (shewn by rotn of globe & chalk line)

Air can hold as vapor 2 grs H_2O per c. ft of air at freez.g point, & 20 grs at 100° F.
As aq.s vapor nearly fulfils Boyle's law, humid.y of air may be obt.d by compar.g the tens.n of its vapor w. the maxim. tens.n for the act.l temp.e. Point at wh. dens.y of vapor becs eq. to max. dens.y corresp.g to the temp. = dew point. Best inst.t to obt.n this is Regnault's: usl it is calcul.d by empir.l tables & factors of Glaisher & Apjohn, fr. read.gs of dry & wet bulb thermom.rs

Humid.y of air has a gt influ.e on climates by hinder.g passage of heat fr. the earth

See also p. 142

Vapors in air protects earth fr. too gt intens.y of solar rays in day, & fr. too rapid loss of heat by rad.n dur.g night. Were it removed, we shd be burnt up by day & frozen hard at night.

Wherever air is dry, we are liable to daily extremes of temp.e

Britain is largely due to this cause. In Ireland, the mountains are not grouped in ranges running north and south, but in isolated masses, and the difference in climate between the east and west coasts is consequently less marked.

The **prevailing winds** have a great **influence on the rainfall.** (1) Thus if a wind has traversed a considerable extent of ocean, the rainfall is moderately large. (2) If a wind reaches into a colder region, its saturation point is lowered, and the rainfall is greatly increased; and if a range of mountains lies across its path, the rainfall on the side facing the wind is greatly increased, but diminished on the opposite side of the range. (3) If a wind after reaching land proceeds into lower latitudes or warmer regions, the rainfall is small, or absent. This accounts for the rainless summers of California, North Africa, and South Europe.

The **Moisture of the Air** depends upon the amount of vapour present in it, and the ratio of this to the amount which would saturate the air at the actual temperature. The former is called the *absolute humidity*, the latter the *relative humidity*. The *dew point* is the point at which condensation of some of the vapour in the atmosphere occurs, either as dew, rain, snow, or hoar-frost. The amount of moisture which the atmosphere can retain before such condensation occurs, varies with the temperature. If the temperature is low, the dew point is speedily reached; while, if the temperature is high, the same amount of moisture may be present, and yet the atmosphere appear dry and oppressive. Thus the air is drier at noon than at midnight, though the amount of vapour present in the two cases be the same; and it is for the most part drier in summer than in winter. This refers to the relative humidity, which is highest in cold weather. The absolute humidity is higher in summer than winter; it varies more in continental than in maritime and insular climates; and there are daily variations according to the state of the sky, the movements of air, etc. The relative humidity is expressed as a per-centage of what would be required to produce saturation at the given temperature. The usual

relative humidity is 50 to 75 per cent. If the air were constantly near the point of saturation, clouds which consist of drops of water, would obey gravity, and descend as rain more frequently than they do. The reason why rain is not constantly falling is that there is usually a non-saturated region between the clouds and the earth.

The Rainfall is caused by over saturation of a column of moist air. This may be due to the contact of the air with a cold surface, as the ridge of a mountain or a large surface of water, or to the impact of a colder wind.

The amount of rainfall varies greatly. In some parts there is no rain, as in the desert of Sahara; while on the south-east slopes of the Himalayas, which are exposed to winds laden with moisture, it may be several hundred inches.

The amount of rainfall does not depend on the absolute humidity of the air. In Lima on the coast of Peru, there is no rain although the air is moist; while in the gulf of Genoa there is a considerable rainfall with a moderately dry air and soil; the difference being due to the presence of cold winds in the latter case (increasing the relative humidity).

The *latitude* of a place has a great influence. As a rule the rainfall decreases with increasing distance from the equator; but local conditions may produce great modification, or even alterations of this law.

The *elevation above the sea-level* has a varying influence. In the Swiss Alps it is said that the rainfall increases with the elevation; but this rule does not hold good in America.

The *nearness of large surfaces of water* in summer tends to increase the rainfall, when water is colder than its surroundings, while in winter it has the opposite effect. The neighbourhood of the sea is for the west of England and islands adjacent, a cause of increased rainfall.

The *influence of winds* on the rainfall has been already considered. In Great Britain south-west winds more especially increase the rainfall. In their course they have travelled over the Gulf

Greatest rainf. in world at Khasi Hills 100 miles N.E of Calcutta.
Rivers are the rain-gauges of nature.

30" = 3000 tons of H_2O to the acre. Aver. poprn of Gt Brit = 1 pers. to 2 ¼ acre, so if Govt one allowd 100 gals per day, enough H_2O for × 40 present popul.

In Engl. Dists. hav. aver. rainf. of from 20–25" have most of rainfall in summ. mths; w. rainf. 25–30" eq. amt summ & winter; w. rainf. above 30" most in winter.

.01" in 24 hrs suggest. by Symons as constit. a rainy day.

Latitude	60 – 50°	— 161 ds per annum
—	50 – 46°	— 136 —
—	46 – 43	— 103 —
—	43 – 12	— 78 —

Lockyer has collect. evid. of an 11 yrs periodical of rainfall coincid. w. periodicity sunspots & cyclones

Stream and the general equatorial current, and have thus received warmth and moisture. The condensation of their moisture liberates a large amount of latent heat, thus raising the temperature of this country. In summer, however, south-west winds are *cool* and moist, as the Atlantic is not so hot as the continents of Asia and Europe over which other winds have travelled.

In England the average rainfall is 30—32 inches, but there are great variations in different parts. In the west of Great Britain and Ireland, and near hills, the average rainfall is over seventy-five inches. In the east of Great Britain, the rainfall is from twenty to twenty-eight inches. The average rainfall must not be relied upon entirely. In this country it has been estimated that the maximum annual rainfall exceeds by one-third, and the minimum annual rainfall is less by one-third than, the average rainfall of a series of years.

The *number of rainy days* by no means corresponds with the amount of rainfall. On the contrary, there are fewest rainy days at the equator, where the rainfall is greatest. A considerable rainfall by no means renders a place undesirable as a health-resort, if it does not prevent out-door exercise. The rain diminishes the relative humidity of the air, and purifies it from dust.

A certain amount of moisture in the air is essential to both animal and vegetable life. It moderates the heat of the sun's rays, and prevents excessive radiation from the earth's surface, absorbing the heat rays as they leave the earth. Thus, the moist air forms a warm garment in which the earth is enclosed.

The amount of absolute moisture in air has an important influence on respiration. The inhalation of a dry air increases the loss of water vapour through the breath, and thus diminishes or checks perspiration. A dry climate is, therefore, an important part of the treatment of consumption and certain cases of bronchitis.

The degree of relative moisture exerts great influence on the functions of the skin. If the skin is moist, the amount of

evaporation from the skin is diminished. A feeling of oppression results, the tissue changes are diminished, and there is a disinclination for work. Much of the exhilarating effect of a mountain atmosphere is due to its dryness during the day, though its rarity and purity have much to do with the effect produced.

Site of a House.—It will be convenient to recapitulate under this head the local conditions to be considered in the choice of a house.

1. The *Aspect* should be such as to allow the free approach of both air and sun. Light is essential to health; it is important, therefore, that the house should not be hemmed in closely by surrounding buildings, walls, or trees, and that the windows should be large and numerous. Taking all seasons of the year, a southerly or south-westerly aspect receives most sunshine; an easterly receiving very little. As Mr. E. Turner puts it:—"A *northerly* aspect is always bleak and cold, and almost always damp. An *easterly* aspect is cold, especially in the spring; but it is fairly dry, though a good deal of rainy weather comes at times from the south-east. A *southerly* aspect combines as much of warmth, dryness, and sunshine as the peculiarities of the climate will in any way allow. A *westerly* aspect is warm, but inclining to damp, and exposed to the most boisterous and rainy gales which, especially on the Channel coast, come almost always from the south-west."

A workroom or study requiring steady light, should point north or some point between north-east and north-west. A breakfast room should face north-east to south; while one aspect of a drawing-room should be south-east to north-east. Rooms requiring coolness, as store-rooms, dairies, larders, should have a northerly aspect.

Invalids should avoid the north and east sides of a house. It is preferable, as a rule, for the house not to face in the direction of the four points of the compass, but diagonally to these, as thus extremes of heat and cold are mitigated.

2. *The influence of surrounding objects.*—The neighbourhood of cesspools and middens is to be specially avoided. If the house is

Bacon said – "he who builds a fair house upon an ill seat committeth himself to prison."

N. aspect may convenᵗ be dead, so as to allow of vent.ᵍ pipes

Thos Fuller says – "Light (God's eldest daughter!) is a principal beauty in a bᵈˢ, yet it shines not alike fᵒ. all pᵗˢ of heaven. An S. wind welcomes the beames of the sun bef. they are of strength to do any harm, his offenᵗˢ to none but a sleepᵍ. A S. wind. in Sumᵗ is a chimn. w.ᵗ a fire in it, & needs the screen of a fire curtain. In a W. wind. in sumᵗ. towᵈˢ night, the sun grows low & even faintˡʸ, w. more light than delight. A N. wind. is best for butteries & cellars, where the beer is not to be sour'd by the sun shining on it."

Streets shd be wider than height of hses, if poss. twice as wide.
Squares shd be open at the corners.

When a gravel hill overlies clay, not infreq. springs at the outcrop. & hse at this level will be damp.

one of a number, and especially if it is at a lower level than others, it is important to ascertain that its drainage relationships to other houses are satisfactory.

The influence of *trees* close to a house is bad. They render it damp, and prevent the free access of sun and air. If the trees are somewhat removed from the house, they form a useful shelter, especially when to the north or east.

The neighbourhood of *water-courses* of any kind is to be avoided, it is apt to be damp. If the house must be on a plain, its site cannot be over-drained. If there is a choice, the *slope of a hill* should be selected; and it is essential that the building be kept clear of ground at a higher level. This is secured by raising the site, so that the surface slopes down from the house towards the rising ground. High positions are not always free from the dangers of valleys, as winds may waft marshy effluvia several miles. It often happens that a low-lying district near a marsh, if protected by a screen of wood, is safer than a higher part lying to leeward.

Ground covered with rank vegetation is to be avoided, because of the amount of decaying matter in the soil, and because such vegetation generally indicates the presence of much sub-soil water.

3. The *Soil* has an important influence on the healthiness of a site. The relative merits of the different kinds of soil have been already discussed. Undrained soils of whatever kind are bad, and made-soils are always to be regarded with profound distrust.

CHAPTER XXXII.

PERSONAL HYGIENE.

Influence of Constitution, Heredity, Idiosyncrasy, Temperament, Sex, Age, and Habits on Health.—Attention to the Action of the Bowels.

There are certain personal factors which are very important in relation to health. The chief of these are constitution, temperament, heredity, idiosyncrasy, age, sex, and habits. We will consider each of them in turn.

Constitution.—Health may vary in degree without the presence of actual disease. This fact is expressed by the use of such terms as "perfect," "strong," "feeble," "delicate," in speaking of the health of the same person at different times, and also as distinguishing one individual from another. The constitution is an important factor in resisting disease, and a robust constitution may determine recovery from a severe illness, while the patient with a feeble constitution falls a victim to it.

The constitution of an individual is either *acquired or inherited.* A feeble or delicate constitution is frequently acquired by unhygienic conditions, such as deficient exercise, the prolonged breathing of impure air, unhealthy occupations, some imperfection in diet, or dissipation.

But while many a robust constitution is enfeebled by such conditions, a weak constitution may happily be strengthened by careful and prolonged attention to the laws of health. This is especially well seen in the case of those who strengthen their muscular system by carefully-graduated and not excessive exercise.

Heredity has a great influence on health. As a rule the children of healthy parents are robust, and on the contrary, any "weak point" in the parents' constitutions is liable to be participated in by their children. Both *mental* and *physical* conditions may be inherited. A peculiar habit of mind, as well as the same expression of features, is commonly hereditary. So also is the tendency to excel in certain directions. This was well seen in the case of a compositor, who had acquired his art after considerable trouble, while his daughter subsequently was able to read type sideways or inverted without any tuition at all.

As regards physical diseases, the influence of parents is not less remarkable. The son of a gouty father requires to be particularly abstemious in order to avoid his father's disease. Rheumatic fever and St. Vitus' dance, again, are commonly hereditary. Insanity, epilepsy, asthma, neuralgia, and hysteria are also hereditary, and it is noticed that they often alternate; thus an epileptic parent may

Health may vary just as the temp.e of ice may – eg. Canad.n & English ice. Degree of health is as little a fixed qty as temp.e of ice.

Hutchinson believes that 3 gt diatheses – 1). catar.l, 2). rheum.c, & 3). scrofulous.

Life Assur.e Exam.rs also. conf.l enquire into fam.l hist.s

Dr. Rey. Thompson distings 3 forms of inheritance, –

1. maternal contag.n – eg Sm. Pox, in wh. transmis.n only fr. the mother; atavism impos.e

2. Parental infect.n – eg. Syph.s, the dis.e in chd only the result of declared dis.e in parent; atavism unknown

3. The form of hered.y seen in misan.s, monstros.s &c.

Trans.n fr either parent; dis.e due to or anticip.g declared dis.e in parent; dis.e in offspring rather predisp.g to future attacks; atavism a freq.t & important char.c

Inher.e of Phth. exactly like that of misan.s. Syphs extinct in 3rd gener.n but there rather free, until extinct.n of family

(see also p. 406)

Hered? tendencies when once firmly root?, persist. hered? even when orig? factors have ceased to exist. Thus hered? transm? of goitre, tits grad? aggrav? into cretinism in alp? villages where stagn? air, priv? of sunlight, bad vent?, filthy pers? habits & some ill-understd local cond?s

They then bec. like persist? of fam? peculs, the rule rather than exception

Acq? predisp? - in reg? to fevers must be some predisp? cond? not afford? by the normal human body. Nitrog? mat? in a decomp? or read? decompos? cond? affords best pabulum for devel? of bac? &c. Dr Carpenter concl? that the com? fav? cond? is presence in bld of excess of decomp? effete mat?s - 1/. introd? f. witht, e.g. Chol? f. H_2O. 2/. gener? in abnorm. amt in body, e.g. in puerp?, after injuries &c. Suppl? of fatty? matches - 3/. Elim? by st emunct? obstd. - as in overcrowd? - pest? also in intemp?

Rel? of famine to pestilence - gen? bld contam? prod? by accum? of waste mat?s

Marriages of Consang? - restrict? in such man? imposed 1st in 4th cent? fr. eccles? rather than physiol grounds. From exper? of idiot institns wd appear that marr? of 1st cousins must be reg? as a factor in prod? of imbecile ch?. Perhaps this dep? on whether any original taint in parents.

Dr Langd. Down once tg. to write a paper to prove that imbecil? & idiocy prod? by such marr? but the fact he came across in investig? cond? him to oppos? view

The nervous tree & its branches

Power of phys.ᵗ to diminish. hered.ᵗ dis.ᵉ lies in 2 directions: (1) forestalling of morbidity by prev.ᵗ of ill-assort.ᵈ marriages. (2) special guidance of tainted childᵗ by control.ᵈ moral, mental social & phys.ᵈ educ.ⁿ & hygiene. (K. Reynolds)

have an insane or asthmatical child. Cancer, consumption, certain skin diseases, and a tendency to the early onset of degenerative diseases, are also hereditary.

It is important to note that it is the tendency to disease which is transmitted, and not the disease itself, in most cases.

All these diseases may be acquired without any hereditary tendency. Thus, consumption is very common among compositors, owing probably to the bad air and constrained position in which they work. Gout is often acquired by painters, through the influence of lead-poisoning. Again, hereditary tendencies may be eradicated by careful attention to the laws of health. Thus, by an abundant supply of fresh air, by moderate exercise, and the avoidance of severe colds, even the offspring of consumptive parents may escape that disease.

A peculiarity of form, character, or tendency to disease has been known to disappear in one generation and re-appear in the next; this variety of heredity is termed *atavism.*

Temperament is a word somewhat lacking in precision, but embodying a useful generalisation. It indicates a peculiarity in constitution, causing a liability to particular diseases, or to a special character in any disease to which a person becomes subject. Four temperaments are usually recognised—the sanguine, phlegmatic, bilious, and nervous.

The *sanguine* temperament generally manifests itself by a fair complexion, active circulation, quick movements, and excitable passions.

The *phlegmatic* temperament (or lymphatic) is distinguished by a languid circulation, a pale face wanting in character and expression, and a tendency to general torpor of mental and bodily functions.

The *bilious* temperament is generally accompanied by strongly-marked features, dark hair, and swarthy complexion. The circulation is strong, but not easily excited; and there is great power of mental and physical endurance. If there is mental depression with it, it is called a *melancholic* temperament.

The *nervous* temperament is characterised by a spare form and small muscles. The features are delicate, the complexion pale or slightly red, the pulse quick and easily excited, the senses acute and the imagination lively.

Pure specimens of these temperaments are rarely seen; more often they are mixed, and it may be difficult or impossible to say in any given case, which temperament is most prominent. The above classification (which is the same as that described by Dr. Guy) is somewhat artificial, and is only useful as indicating certain differences in the character and physique of individuals.

Idiosyncrasy.—By idiosyncrasy is understood a peculiarity limited to a comparatively small number of individuals. It means that certain persons are specially sensitive to the action of certain things, or are peculiarly affected by them. Four varieties of idiosyncrasy may be described.

The first consists in an extreme susceptibility to the action of certain things, or an extreme lack of susceptibility. Thus most people at some time or other inhale the pollen of grasses, but only in a few cases does it produce that troublesome and distressing complaint—hay asthma. In certain persons a very minute dose of iodide of potassium produces distressing symptoms; in most cases these symptoms arise if the drug is taken for a prolonged period; but in a few cases it may be taken for an indefinite period without troublesome result. The case of a well-known physician at Bath is very curious. The smell of hyacinths in bloom always made him faint away; so constant was this result, that before entering a room during the hyacinth season, he always asked the servant if there were any hyacinths in it.

The second form of idiosyncrasy consists in the production of poisonous results by common articles of diet. Thus some people cannot partake of shell-fish or lobsters without having severe nettle-rash. In rare instances the smallest amount of egg, or in other cases mutton, or pepper, or some other substance will produce severe indigestion or nettlerash.

Idiosyncrasy a diathesis but to a point (Hutchinson)

Contempl^n. of waves f. terra firma prod^s. sea-sick^s. in some.

Cases in wh. sev^l attacks of sc f ac in same person

S^r. L. Brunton knows a Lady in whom a single strawberry prod^s. such intense articul^r. swelling of face as to block up eyes.

Ext cold chief danger
Inter the body, the Spirits suffer
Infects dis
Richets -

Shakespeare's div of life of man is into 7 ages, but
in best classifn of Hall's ants 5 periods is given

The third form consists in an inversion of the usual effects of certain substances, especially drugs. Thus opium in rare cases produces convulsions; while the aperient Epsom salts have been known to produce constipation.

A fourth form, that of mental idiosyncrasies, may be added, as where there is a strange preference or aversion for objects usually regarded as indifferent. Many cases of mental peculiarity, short of actual insanity, will come under this head; as will instances of depraved appetite for food, etc.

It may be well to mention at this point the tendencies to disease which most people have peculiar to themselves. Each person commonly has a "weak point" in his constitution; and so it comes to pass that the "cold" which in one would produce a sore throat, in another leads to bronchitis, and in another to acute rheumatism.

Age and Sex.—According to the period of life, danger arises from different sources. In *infancy* and old age extreme changes of temperature are especially dangerous, and additional protection is required. Thousands of deaths occur in the first year of life, from substituting starchy foods for milk, the natural food of infancy and childhood. In *childhood* the danger from bad feeding is still present, and is evidenced by the frequency of the bowed legs and great misshapen heads, due to rickets; infectious diseases claim their thousands; and dentition (teething) is a frequent source of irritation and disorder. In *youth* rapid growth is proceeding, and so the food must be abundant and nutritious. A proportionately larger amount is required than by an adult, as the functions of the body not only require to be carried on, but material is necessary to build up the growing tissues. The effects of over-pressure in school work at this period are especially to be lamented; and these effects will doubtless be felt more severely in board schools, where the boys who are badly fed and clad are expected to learn as much—involving an equal expenditure of force—as their more fortunate comrades. The result of this over-pressure if continued must inevitably be a deterioration in the physique of the working classes.

In *manhood* the constitution is supposed to be established, and this is the period of greatest stability of health. The health now depends on the use made of the previous periods of life, and on the habits acquired.

With the onset of *old age* come various weaknesses called degenerative diseases. The tendency is to death by gradual decay—a *euthanasia* or easy death, which is far too seldom seen. Commonly, bronchitis, or apoplexy, or kidney disease bring the scene to a somewhat permature end.

The mortality of man is greater than that of woman at nearly all ages. This difference is seen even in childhood, the mortality in children under five years old being at the rate of 73 boys and 63 girls per 1,000.

Habits.—The immense power of habits in the formation of character is perhaps duly appreciated; but their influence on physical health is not so well appreciated, though it would be difficult to exaggerate it. The lamentable lack of knowledge of Physiology is to a large extent the cause of the many unhygienic habits which are fruitful in disease.

The laws of health are as inexorable and unaltering as all other laws of nature; and whether broken through carelessness or ignorance, the Nemesis of disease inevitably follows. Whatever a man sows he reaps, in health as in other matters.

Habits are easily formed; but, when once formed, not so easily broken. They ought to be our servants; very commonly they become our masters.

In reference to *eating and drinking*, habits regular as to time and moderate as to quantity are especially important. The habit of eating hastily and masticating the food imperfectly, is certain, sooner or later, to produce disease. Over-eating, again, is a fertile source of disease, especially when the excess is in animal food. The importance of good habits, in reference to alcoholic drinks, is very great where wine, etc., are taken for their stimulating effects. The amount of stimulation produced by a given dose of

A ctn of skin bec. more [illegible] to stain on lungs & kid.
Chron. Smpbys. [illegible] to 1st
Ster. mort. of males f. habits, exps. &c. but holds in infancy.
7s more subj. to can. cr, also to Wh. Cgh, Dipha & Contin. fevs. but
less to S.T. Vear. & S.P.

O W. Holmes says: Habit is the approx. of the animal system to the organic His substituting a vis a tergo for the evolution of living force. Habit is a labour saving Contriv. wh. enables a man to get on with less fuel

"How use doth breed a habit in a man"

Acts bec. autom. by repetit.

"Practice makes perfect" – Work becomes easier & frequent repetition. By practice expenditure is saved. We sooner get tired of that kind of work wh. requires the least effort of will for its performance. The less conscious effort the easier the work is. E.g. walking, piano-playing? A skilled pianist may talk while playing. Same in intellectual work – work done heartily is done easily. How soon tired of work wh. is task work!

alcohol, gradually diminishes with its repetition; the consequence is, that in order to produce the amount of stimulation to which the system has become habituated, the stimulant requires to be gradually increased. Persons of finely-organised nervous temperaments are much more liable to acquire habits of alcoholic excess than others, though they by no means enjoy a monopoly in alcoholism. The craving for stimulants is often a sign of ill-health, owing to disregard of hygienic laws or actual disease. Not unfrequently it is due to a badly-ventilated room, or long hours of work without food, producing a sense of depression which food does not immediately allay. When the cause is unknown, recourse should be had to competent medical advice, and not to the brandy bottle.

Attention to the Action of the Bowels is a matter which is commonly neglected. The importance of a regular habit in this respect cannot be exaggerated; the bowels should always be relieved at a particular part of each day. Where this does not occur the condition of *constipation* results. Owing to the retention of the fæces in the intestines beyond the normal period, the stomach and higher parts of the intestines do not perform their functions normally; indigestion is the consequence, accompanied by flatulence, a sallow complexion, and a tendency to "biliousness." Hæmorrhoids (piles) are another frequent consequence. At the junction of the small and large intestines is a dilated sac (in the cæcum), and the fæces tend especially to collect at this point, when constipation occurs; consequent on this, inflammation is set up, and sometimes perforation of the bowel, with a fatal result. The effect of purgative medicines on constipation is only temporary, and they usually leave the intestines in a worse condition than before, and less able to contract on and expel their contents. It is better to take slowly-acting purgatives than violent ones, and better still not to take any at all, but relieve the condition by means of such articles of diet as stewed fruit, pears, figs, olive oil, or brown bread. As a rule more exercise is required in this condition, and always a prompt attention to the calls of nature.

CHAPTER XXXIII.

PERSONAL HYGIENE (*continued*)—EXERCISE.

The Physiology of Exercise.—Effects of Healthy Exercise on the Various Organs.—Effects of Excessive Exercise.—Amount of Exercise Desirable.—Effects of Deficient Exercise.—Rules Respecting Exercise.—The Forms of Exercise.

Physiological Considerations.—In the strict sense of the word, exercise signifies the performance of its function by any part of the body; thus, digestion is exercise of the stomach, respiration is exercise of the lungs, thinking is an exercise of the brain. But the term has become restricted in its application, and now is chiefly applied to muscular contraction—the exercise of the muscles of the body. Here, again, there has been a restriction of the term exercise in the ordinary sense, to the contraction of voluntary muscles, those under the control of the will. Involuntary muscles, which are concerned in the carrying on of the unconscious organic functions of life, are not directly controllable, and so their growth and state of nutrition cannot be regulated. There are two sets of involuntary muscle, which are of special importance—the heart and the muscles of respiration. The heart contracts—that is, it is exercised — at least sixty times per minute; the respiratory muscles contract about seventeen times per minute; and this amount of exercise goes on throughout the whole day. But although we cannot make our hearts beat quicker by a direct volition, and cannot breathe more rapidly than usual beyond a few seconds, yet a brisk walk will cause increased action of the heart and respiratory muscles, as well as a vigorous contraction of the muscles directly concerned in walking. And there can be no doubt that the vermicular contractions of the intestines are to some extent increased by voluntary exercise, through the indirect excitation of the whole system; thus, exercise is an important element in the treatment of constipation.

The muscles are estimated to contain about a fourth of the whole

blood of the body. Even during muscular rest (so far as this is possible, for nearly every posture involves the exercise of certain muscles), the ultimate molecules of which muscle is composed become oxidised to a certain extent. By exercise this oxidation or combustion is increased. To live is to oxidise; to exercise is to oxidise more actively. It is necessary for the health of the body that the molecules of which it consists should be disintegrated and die, to be replaced at frequent intervals by new materials from the blood. The strength of the body, and of every part of it, is in proportion to the activity of its nutritive changes. In the same proportion as disintegration is hastened by muscular activity, so always is the flow of blood bearing the renewing material. Thus, active exercise, if not excessive, increases the action of the heart, and so strengthens this organ likewise.

It is a common fallacy to suppose that exercise wears out the human machinery, just as it will wear out any piece of human mechanism. On the contrary, it increases the working power of the muscles, owing to the self-renewing powers they possess.

During the period of growth, that is, up to the age of about twenty-five, the new materials added to a muscle when it is exercised exceed the old, and so a gradual increase in bulk and power occurs; even after this age the same may occur, owing to the fact that very few attain to the normal development of their muscular powers in the earlier part of their lives.

The same rules as for muscular exercise apply to brain exercise. The more the brain is exercised,—if proper intervals of rest are allowed, and the muscular development is not allowed to lag behind,—the more perfectly the brain will perform its functions. The powers of memory, observation, judgment, speech, etc., may be greatly increased by careful cultivation and persistent attention. The great danger is of not equilibrating the muscular and nervous functions. One sees a nervous, excitable boy with overwrought brain, feeble muscles, and a tendency to premature decay; or a young athlete whose mental powers are

far from vigorous. The ideal condition is where neither mental nor muscular culture is neglected, but both are co-ordinated to the production of a perfect man.

Effects of Healthy Exercise.—1. *The Nutrition of the Muscles* is improved by exercise. The blood which they contain is increased, and in consequence of this increased afflux of blood and the more rapid disintegration going on in the muscles, they become harder and larger, and respond more readily to the commands of the will. In other words, the volume, density, and energy of the muscles are increased.

2. *The action of the lungs is increased by exercise.* Dr. E. Smith found that if the air inspired while lying down be represented by unity, the amount inspired when erect is 1·33; when walking at the rate of one mile per hour, 1·9; at four miles per hour, 5; at six miles per hour, 7; riding on horseback, 4·05; swimming, 4·33. Or, putting it in another way, under ordinary circumstances a man inspires 480 cubic inches per minute; if he walks four miles an hour, he inspires 2,400 cubic inches; if six miles an hour, 3,260 cubic inches.

At the same time the amount of carbonic acid gas expired is correspondingly increased. Its amount bears a nearly constant relation to the amount of muscular exercise, and consequently the amount of carbonic acid eliminated in various forms of exercise affords a just estimate of their relative value. If the carbonic acid resulting from respiration is not quickly got rid of, as in ill-ventilated warehouses and shops, especially where the work is severe, the substance of the muscles soon becomes loaded with carbonic acid, and their activity diminished. For this reason, if for no other, it would be economical for large employers to provide an abundant supply of fresh air to their workpeople.

Besides the presence of abundant oxygen (from the air), and an easy and complete riddance of the carbonic acid produced by muscular exertion, it will be evident that a third factor is required in the performance of muscular exercise, viz., a supply of carbon:

17
30
1870

Pettenkofer states that in hard labour a man evolves twice as much CO_2 as in gentle exert^{n}, & 3 times as much as at rest.

With same amt of exert^{n} less CO_2 evolv^{d} in summ^{r} than winter. Dr E. Smith concludes that viabil^{y} of those chn is greatest who are born in winter & spring months.

Corresp^{g} to this, fd that wt increas^{s} dur^{g} summ^{r} months, but increas^{s} dimn^{s} dur^{g} winter, loss beg^{g} at beg^{g} of Sept^{r} & gain at end of Mar.

Pettenkof. & Voit shew. that under simt. circumsts, qty of evapn. H_2O alw. & rose in propn to an incn. metamorph. of tiss. whether this due to incn. nutrit.n or musc. exertn Thus man on day of rest evapn. thro. skin slungs abt 2 lbs in 8hrs, on d. of hard work 4½ lbs of H_2O. In one case 2016 in 8hrs 4480 calorie units left the body, (1 unit = amt heat necest to raise 1 lb av. of H_2O by 1°F). This expls why at hardest work, bld may bec. even cooler instd of warmer, the periph.l circuln being incd.

If anything checks perspirn, temp. incs Hangt prod.

this is obtained from the assimilated food, brought to the muscles by means of the blood.

Fatty food supplies the necessary combustible material more perfectly than amylaceous (starchy) and saccharine (sugary) foods. Alcohol diminishes the excretion of carbonic acid, and should therefore be avoided during muscular training.

Not only does muscular exercise increase the activity of respiration, but the size of the lungs is increased, and their *vital capacity*, that is, the amount of air capable of being expired after a forced inspiration, is considerably increased. Corresponding with this increase of vital capacity, exercise, especially that in which the arm and chest muscles are systematically developed, increases the size of the chest. A perceptible difference in the circumference of the chest may be noticed after only a few weeks' methodical exercise.

3. *The action of the skin is increased.*—Sensible perspiration is commonly induced, but less readily in those habituated to hard work. Insensible perspiration is always increased, the amount of water escaping in a gaseous condition being at least doubled during moderate exercise.

4. *The temperature of the body* is not perceptibly increased, so long as the skin continues to act. Every muscular contraction involving oxidation also necessitates the production of heat; but this is counteracted by increased evaporation from the skin, and by the circulatory current carrying the hotter blood to every part of the body, and so rapidly equalising its temperature. But although the actual temperature is not increased, it is rendered more equable owing to the increased force of the heart's contractions. Chilblains are due to the defective circulation of the blood, and can in most cases be cured by active exercise aided by warmer clothing and an abundant supply of oxidisable food.

5. *The Heart and Blood-vessels.*—By exercise the heart's action is increased in frequency and force. The pulse usually increases from ten to thirty beats per minute above the rate while at rest.

After prolonged exercise it may temporarily fall below the normal standard.

6. *The digestive system* is aided indirectly, though active exercise impedes digestion. Following exercise, one has an increased appetite, especially for fatty and nitrogenous food; digestion becomes more perfect, and absorption of food is more rapid, owing to the loss of water by the skin. The effect of exercise on appetite and digestive power is greater if the exercise is taken in the open air; and outdoor exercise is in this way a valuable aid in the treatment of indigestion.

7. *The nervous system* is improved in nutrition and power by a moderate amount of exercise. In fact, a certain amount of muscular exercise is essential for a healthy mind. The intellect is only made less active by excessive exercise; and in this case it is probably because no time is devoted to mental culture, rather than in consequence of any direct effect of excessive muscular exercise on the brain.

8. *The elimination of urea* has important bearings on muscular exercise. Urea (CH_4N_2O) represents the ultimate stage at which nitrogenous tissues and food arrive, in their course from their entry into the body as food to their ultimate oxidation and elimination. The substance of the muscles is largely composed of nitrogenous material (myosin), and it is very interesting to note that the amount of urea excreted from the body (chiefly by the kidneys) is only slightly increased by muscular exercise. Evidently then it is not the oxidation of the nitrogenous substance of the muscles which supplies the force of muscular contraction; but the other oxidisable and non-nitrogenous substances (such as glycogen and sugar) contained in it.

The conclusion arrived at by Dr. Pavy in his investigations on Weston during a pedestrian match, was that although there was a greater elimination of urea during severe exercise than could be accounted for by the increased nitrogenous food taken, yet that the motor power did not arise from oxidation of the muscle tissue, and

A motor pt of brain corresp.ᵍ to M.ˢ, in wh. are stored ideas of M.ᵗ, distᵉ resistᵉ, & fp. wh. are cand. the volᵃ impulses resultᵍ in musc. exᵉ. Each newˡ centre requ exᵗˡ stimⁱ to develope its potentˡ power. If chickens hatched on a carpet they mimick & do not attempt to scratch until a little gravel is scatᵈ on it. In this case congenˡ absence of l. hand catisphy l. arm pron. fd to be assocᵈ w. an atrophᵈ. condⁿ of convolⁿ of brain wh. is Ferrier's centre for movtˢ of hand. If the same ops after amputⁿ of limb of adult no corresp.ᵍ atrophy of brain. Hence the importᶜ of exᵉ in young. Blindᵈ of fishes in dark caves of Kentucky.

16

Soon after promulgn of Liebig's view that oxidn of muscle tissue was cause of muscle exercise, J. R. Mayer (the first expositor of the idea of the conservation of energy), attacked it & threw out the view that muscle acts by combustion of food & not destruction of muscle, shewing that if W. of heart be destroyed in doing mechl work the heart wd be burnt up in 8 dys.
Test this. Wt of M. destroyed in work on a treadmill is not sufficient to prodce combustion enough heat when heat transformed into mechl exercise to do the work. Actual energy prodd is x 2 that shewn by elimn of urea.

(1) Blacksmith's palsy - wasted muscle.
(2) Seamen's palsy. N. & centres involved. N & Vs nat. mixed up (J.R. W.)

that the greater part of the urea eliminated was probably derived directly from metamorphosis of nitrogenous food (which had never become built up into tissue). Thus, supposing the elimination of one grain of nitrogen (chiefly as urea) to represent $2\frac{1}{2}$ foot tons (that is, the force required to raise $2\frac{1}{2}$ tons one foot high), he calculated that the urea eliminated was only sufficient to account for one half the force expended. Therefore considerable force must have been developed from the oxidation of the non-nitrogenous substances in the muscles. These results were obtained from the investigation of excessive exercise. But other observations have proved that the urea and other nitrogenous excretions may not be at all increased, and may even be decreased by muscular exercise. Commonly it is found that the increase of elimination of urea is in the period of rest succeeding exercise. One finds practically that with moderate exercise a little more nitrogenous food is required, and with laborious work a somewhat larger quantity; but that the quantity of non-nitrogenous food requires to be increased in a somewhat larger proportion.

Effects of Excessive Exercise.—After prolonged exertion muscles become *exhausted.* This is associated with an accumulation in the muscles of the products of their action (especially sarcolactic acid), and to a less extent with exhaustion of the supply of oxygen. Then rest becomes necessary, in order that the effete products may be removed, and the reserve force of the muscles may be renovated.

Long-continued over-exertion produces *chronic exhaustion*, which may, if excessive, result in wasting of muscles. Exhaustion is much more liable to occur when a small group of muscles are exercised out of all proportion to others. Thus, in clerks, we have what is known as the *writer's* or *scrivener's palsy.* The muscles of the hand, and especially of the thumb, cease to respond to the volition of the writer, but are seized with spasm every time writing is attempted; and the muscles of the thumb tend to waste. A similar condition sometimes arises in violinists,

tailors, etc. The practical inference from these facts is, that one group of muscles should not be exercised disproportionately to the muscles of the rest of the body, and that proper intervals of rest should be allowed.

Excessive exercise of the whole muscular system is particularly pernicious when undertaken by those of previously sedentary habits. A walking tour entered on with more zeal than discretion, and not taken by easy stages for the first few days, is often productive of more harm than good. The same evil is seen in the case of volunteers camping out for certain weeks in the year, and subjecting themselves to great exertions and vicissitudes, who have at other times of the year had no preparatory training.

In the intervals of great mental labour, as with students, the amount of exercise should not be *suddenly* increased, but should be regular and moderate in amount.

Competitive exercise is not desirable, as the tendency is for the strength to be over-taxed. The Oxford and Cambridge crews have been said to acquire heart-disease more commonly than the average, but this is not correct. Doubtless hypertrophy of the heart may occur as the result of severe exercise, and this within certain limits is not an abnormal condition. In those who have a weak heart, occasionally dilatation and even rupture of the heart have been produced. The latter is, however, extremely rare,—"a broken heart" being much commoner in novels than in actual life. Aneurism, that is, a local dilatation and bulging of a blood-vessel (especially affecting the aorta), is more common among soldiers than civilians, but it is doubtful whether this is due solely to the excessive exertions which they occasionally undergo, or to this acting along with their heavy and tight accoutrements.

Sudden and severe exertion may cause rupture of some of the air-vesicles of the lung (the condition known as emphysema). A horse suffering from this condition is called "broken-winded," or "roaring," and the cause in this case is probably the same.

Amount of Exercise Desirable.—According to a careful estimate

hypert? & palpr= of heart prod= Occ? haemoptysis

34

Moleschott's stand^d diet (for adult Europ^n in moderate work)

Water-free subst^s given daily	ozs avoir.	grammes
albumin^s subst^s.	4.587	130
fatty "	2.964	84
carbo-hydrates	14.257	404
salts	1.058	30
	22.866	648

This is Eq. to 316.5 grs of N, 4862 of C & 461 grs salts.

Proportn of the three first is 1 : .6 : 3.

Now 1oz dry albumin^s yields 174 foot-tons potent^l energy

" " fat " 378 " " " "

" " starch " 135 " " " "

" " Cane-sugar " 129 " " " "

Therefore total obt^d fr stand^d diet = 798.138
1120.392
1853.41

= 3771.94 foot tons " "

Of these foot tons abt 260 tons used for int^l mechan^l work of hrt, resp^n, dig^n &c. Ext^l work is 300–500 tons. These together equal $\frac{1}{7}$ – $\frac{1}{8}$ of all free obt^d from food.

Prof. Haughton has shown that walk^g on level surf. at 3 mls per hr = raising $\frac{1}{20}$ wt of body thro. dist^e walked. Thus if W = wt of person, W' = wt carr^d. D = dist^e walk^d in ft. 20 = coeff^t of friction. 2240 = no. of lbs in a ton.

$\frac{W + W' \times D}{20 \times 2240}$.

Eg. Thus march of 10 mls w. wt of 60 lbs

$$\frac{(150+60) \times 10 \times 5280}{20 \times 2240} = \frac{495}{2} = 247\tfrac{1}{2} \text{ ft tons}$$

Eg. A man weigh^g 150 lbs goes 30 miles w. an ascent of 5500 ft in 30 hrs carry^g 80 lbs wt – what is the work per day?

Work of ascent $\frac{(80+150) \times 5500}{2240} = 564$

Work of 30 miles = $\frac{230 \times 30 \times 5280}{20 \times 2240} = 813$

Total work = 564 + 813 = 1377. Total daily work = 459 ft tons

of Dr. Parkes, the average daily work of a man engaged in manual labour in the open air is equivalent to the work involved in lifting 250 to 350 tons 1 foot high; this is a moderate amount, 400 tons being a heavy day's work. The amount of muscular exercise involved in this may be easily known by remembering that a walk of 20 miles on a level road is equivalent to about 353⅓ tons lifted 1 foot; and that a walk of 10 miles while carrying 60 lbs. is equivalent to 247½ tons lifted 1 foot. (Haughton.)

We may estimate that every healthy man ought to take an amount of exercise represented by 150 tons raised 1 foot, which is equal to the work done in walking 8½ to 9 miles on a level road. A certain amount of this exercise is taken in performing one's daily work; but apart from this, out-door exercise should be taken equivalent in amount to a walk of five or six miles. It is impossible to lay down rules to suit all cases, but a less amount of exercise than that named is probably incompatible with perfect health.

Effects of Deficient Exercise.—The *muscles* themselves become enfeebled and wasted; they respond less readily to one's wishes when called into use. Some wasting of muscle occurs after a few days' confinement to bed; and a limb confined in a splint speedily loses its healthy, rounded contour. The muscles of ladies' arms are usually badly developed; this is partly owing to their tight-sleeved dresses, but more to deficient muscular exercise of the arms. *Oxidation processes* are diminished; less carbonic acid is eliminated, and it tends to accumulate in the system, owing to the diminished activity of respiration. In consequence of the diminished oxidation, the temperature of the body is not well maintained, and the heat is not uniformly distributed. Cold feet are a common complaint of those who lead sedentary lives, though seldom complained of by others.

Along with the other muscles, the *heart* becomes enfeebled and the circulation less perfect. *Digestion* is enfeebled: the appetite is poor. The *nervous system* also suffers: nervous irritability is a common result, while sleeplessness—a thing almost unknown

among those who live by the sweat of their brow—is becoming much more common among the worried and ill-exercised inhabitants of our towns. As Maclaren has said, "Scholarships, examinations, speculations, excitements, stimulations, long hours of work, jaded frames, weary brains, jarring nerves, all intensified, seek in modern times for the antidote to be found alone in physical action."

There is no doubt that many diseases are favoured by deficient exercise, and can be averted by systematic exercises and the concomitant increased supply of pure air. It is often difficult to appraise the relative merits of exercise and pure air; but there can be no doubt that both are of extreme importance.

Consumption, even in those with a strong hereditary tendency, may be averted by systematic exercises, especially those directed to the expansion of the chest cavity. In most cases of consumption there is a history of deficient exercise or some constrained position, as well as of living in an impure air and on a damp soil.

Various deformities are induced by defective exercise of particular groups of muscles. Thus drooping shoulders result from shoulder-straps confining the action of the shoulder-muscles in the earlier years of life. Stooping is commonly due to sitting in cramped positions in school, and to the use of desks not inclined at the proper angle. Lateral curvature of the spine is also due to weakness of the muscles of the back, and is best treated in its earlier stages by gymnastic exercises specially directed to strengthening these muscles. The tendency to such curvatures is greatly increased in girls by the fact that their trunks are imprisoned in corsets as if in splints, and so exercise of the trunk muscles is reduced to a minimum.

Rules respecting Exercise.—1. *The clothing during exercise should not be excessive*, and should not interfere with the free play of the limbs, nor with full expansion of the chest. Flannel is the best material to wear next the skin, in case of perspiration.

2. *Avoid chill after any exercise.* Muscular rheumatism, or still

Inaction is one of life's chief debilit^{g} influences.

An Eastern monarch was v. ill f. intemp^{e} exercise & sought advice of his physic^{ns} was ord^{d} to eat a basilisk stewed in rose water. Slaves cd not find a basilisk, but Zadig supplied one saying 'it is not to be eaten: all its virtues must enter thro. the pores. I have therefore enclosed it in a little ball & cov^{d} w. a fine skin. Thou must strike this ball freq^{y} & take no other drink than rose water for sev^{l} d^{s}." Soon recov^{d} his strength

Abdominal waist dim? exc^{s} is a com^{n} cause of rupture.

graver evils, not uncommonly result from neglect of this rule. To prevent these, it is well, if there has been any perspiration during exercise, to strip and scrub the skin, particularly about the chest and arm-pits, with a rough towel.

3. *Exercise should be systematic and regular*, not by fits and spurts. It is very important to avoid sudden, violent, and competitive exercise. No severe exercise ought to be undertaken without a gradual training.

4. *The amount of exercise must be regulated by individual fitness.* A chain is no stronger than its weakest link. The muscles may be stronger than the heart or lungs, and the latter may be fatally injured by an amount of exercise which the muscles can well bear. Hence the importance of ascertaining the condition of the vital organs before entering on a course of training.

Another important bearing of this rule is in relation to the exercise of growing boys and girls. When we remember that a boy at school will sometimes grow six to eight inches in a year, it is evident that all the available force is being expended in this direction, and that *excessive* gymnastic exercise can only do harm. Between the ages of fifteen and seventeen there is usually the greatest amount of physical development, and if there is great muscular strain at this period, growth is interfered with, or the seeds of constitutional disease are laid.

5. *Every part of the body ought to be exercised.* This is done spontaneously by the infant. Every muscle of his body acts in sheer delight. His limbs are thrown about, and so he educates the muscles attached to them, while his crowing and crying serve to exercise the muscles of respiration and speech. The evils of exercise confined to particular groups of muscles have been already described. Many of our national games exercise chiefly the muscles of the trunk and legs, while the arms are comparatively little used. Lawn tennis is very valuable as affording exercise for both limb and trunk muscles, and still more so as it is a form of exercise which ladies adopt.

6. *Exercise should not be taken immediately after meals*, as thus digestion is interfered with.

7. *Exercise should be taken, as far as possible, in the open air.* A small amount of exercise out of doors is much more invigorating than a larger amount indoors. The benefit of gymnastics for girls is greatly diminished by their being commonly taken in closed rooms. This is a fact commonly lost sight of, though its importance is very great.

The Forms of Exercise taken may be divided into *recreative* and *educational*, though both of course may be recreative under many circumstances.

The primarily recreative exercises, such as rowing, cricket, foot-ball, etc., chiefly exercise the lower half of the body, with sometimes the addition of the muscles of the right arm. Educational gymnastics can be applied to exercise the muscles of any part of the body, and can be exactly graduated to individual requirements. Both forms of exercise are valuable, and should be encouraged.

Singing, speaking, and reading aloud, are forms of muscular exercise very much neglected, and they are particularly important, as the lungs and voice are by these means greatly strengthened, and rendered much less liable to the inroads of disease.

CHAPTER XXXIV.

PERSONAL HYGIENE (*continued*)—REST AND SLEEP.

The Physiology of Rest.—Partial and General Rest.—Sleep.—Practial Rules respecting Sleep.—Sleeplessness.

Physiological Considerations.—Life is made up of alternations of rest and action. The exercise of any organ is followed by a necessary period of repose, during which the oxidised materials produced by functional activity are removed by the blood, and carried to the excretory organs; while at the same time fresh

Dim^n of adipose tiss^e. Dur^g training
Antidexterity.

Alcoh. dim^s exer^n CO_2 ∴ to be avoid^d dur^g exer^e.

Exer sh^d be as vari^d as poss^e. Sports activ^s of chil^n more conducive to health than any formal gymnastics

"The outside of a horse is the best thing for the inside of a man" (Palmerston).

nutritive material is supplied by the blood to make good the losses thus sustained. Not only is there during rest a storing up of tissue-food brought by the blood, but if the rest be duly proportioned to the amount of exercise, a certain amount of reserve force is also stored up, ready for any extra emergency.

The only apparent exceptions to this rule of alternation of rest and exercise are the heart and lungs, and some less important organs acting out of the control of personal volition. But even these organs obey the universal law. The difference is that their rest is very frequent and momentary ; the heart having to contract sixty or seventy times per minute, rest $\frac{3}{11}$ of a second each second, or more than thirteen hours in the twenty-four. The lungs and respiratory muscles rest a shorter time than this, but probably about three hours per day.

The necessity for rest is well shown by the sense of taste. If salt is kept in the mouth for a considerable time, the power of tasting it disappears, and only returns in its original strength after several hours. The gustatory nerve has been exhausted.

The other sense-organs illustrate the same principle. Persons are not uncommonly made deaf by the deadening sounds of machinery. The same principle is illustrated by the advertisement of a well-known soap. After looking at a particular colour for some time, the nerves receiving impressions from this colour are exhausted, and only its complementary colour is visible. The importance of rest is even greater in the case of the brain and the muscles.

Rest may be either *partial* or *general*.

The principle of partial rest has very useful practical bearings. Such rest is illustrated by the student who takes a walk, or uses methodical gymnastic exercises : a concert may provide agreeable exercise for the auditory nerves and the part of the brain connected with them, while allowing the over-tired intellectual part of the brain to rest in peace ; similarly, light literature may prove a pleasing rest after severer studies.

Walking is more especially the exercise of the brain-worker.

By it a larger amount of blood is determined to the muscles, and in accordance with this one finds the difficulty of carrying on any discussion requiring serious thought during an active walk.

Partial rest is the same thing as *change of occupation*, and by a careful regulation of the relative amount of cerebral and muscular work, one can economise one's powers to a very great extent. The horse, which exercises chiefly his muscles, requires only five or six hours to recuperate his force; and our muscles require less sleep than our brain. It is evident from this that in order to economise the amount of sleep necessary for the maintenance of health, muscular ought to be in excess of cerebral work. The student requires much more sleep than the labourer; if he obtains a proper amount of sleep for his brain, this is too much for his muscles —indeed far too much, reckoning their comparative inactivity during his waking hours.

Sleep is the only form of complete and general rest. In attaining this condition, the muscles sleep first, then the eyes close (owing to muscular rest), and the thoughts wander; hearing is the last sense to lose cognizance of the surrounding world; dreaming succeeds wandering thoughts, and even dreaming may cease if the brain repose is complete.

During sleep the brain diminishes in size, and becomes paler; in other words, there is cerebral anæmia, or diminution in the amount of blood in the brain. That sleep and cerebral anæmia are closely related to each other is, to some extent, shown by the fact that pressure on the carotids will produce sleep; but that this is not the only factor is evident from the fact that if nitrite of amyl (a drug producing an extra flow of blood to the brain) be inhaled by a person asleep, he does not wake up in consequence. It is probable that the cerebral anæmia is rather a consequence of the functional inactivity of the brain during sleep than a cause of the sleep.

It was formerly thought that sleep is produced by cerebral congestion—that is an increased flow of blood to the brain. But

The old Bible men made much of sleep, & felt a cautⁿ against it on the part of good men. R. Baxter says "I am guilty for all the sleep I enjoy over 3 hrs in the 24"
Sir T. Browne says "Sleep is Death's younger brother, & so like him, that I never dare trust him with my prayers."
Jeremy Taylor only allows himself 3-4 hrs in Dec
In more waking hrs we think & feel, in our sleep we become
"If he sleeps he shl do well."
There shd be sleep but Sleepers, recreatⁿ but wasting.

Suggestns for sleeplessᵉ – 1. Think abt dream last dreamt, & thus lapse into it. This can only be done when you can begin to control ye mind bef. you are really awake.

Loss of air & exercise a grand contributing cause.

Live healthily. Avoid excesses, even of exercise. Avoid tea & coffee after dinner. A good night often follows a day's absolute rest. Get up steadily at end of say 8 hrs.

2. Fill lungs thoroughly with health till slight discomfort felt. Then another lung health hold again. Usually 3 times suffices.

cerebral congestion produces a stupified and unnatural sleep, the same sort of sleep as is produced by an excess of stimulants.

During sleep certain organs still continue to perform their functions. The heart and lungs continue their work; the blood is circulated and purified, the intestines continue their vermicular contractions, and absorb food from the alimentary canal, and the organs nourish themselves at leisure and reconstruct their tissues.

It is necessary to remember two facts in relation to sleep, which have important practical bearings. First, that during sleep *combustion is less active*, and so the temperature of the body tends to be somewhat lowered. Secondly, that *assimilation is more energetic;* this favours the absorption of noxious vapours, if any are present. There is less danger of remaining in a stuffy, impure atmosphere during the day than during the night—though, judging by the ordinary condition of bed-rooms, one would imagine that exactly the opposite was the case. One may remain in an ague district during the day without becoming infected, but sleeping in it is nearly certain to impart the disease. This is, doubtless, partly owing to the increased malarial emanations during the night, but, to a less extent, to the increased susceptibility while sleeping.

Practical Rules Concerning Sleep.—1. *Amount of sleep required.* It is impossible to lay down any fixed rule applicable to all persons and circumstances. The amount of sleep required, like the amount of food, varies greatly.

Habitual deficiency of sleep produces a condition of wretchedness and prostration, with great restlessness. Prolonged watching inevitably breaks down the constitution. Not the least evil consequence of irregular and deficient sleep is, that sleep, when desired, is often courted in vain.

Habitual excess of sleep produces a condition of brain less active than usual, and less favourable for thought and action. Impressions are received less readily, and the power of will is correspondingly diminished.

The amount of sleep required varies with—

(1) *Age.*—The infant, if healthy, spends the larger part of his existence in sleep; gradually the amount required diminishes until, for the adult, seven or eight hours suffice. Children over two or three years old require sleep only during the night; and this is to be encouraged, as sleep during the day prevents fresh air and exercise. In advanced life there is a tendency to revert to infantile habits, sleep occurring in frequent short snatches.

(2) *Sex.*—Women seem to require rather more sleep than men, probably owing to the greater impressibility of their nervous systems. The hours of sleep required have in accordance with this view been stated to be, "Six for a man, seven for a woman, and eight for a fool."

(3) *Temperament.*—Those of a cold lymphatic temperament require more sleep than sanguine or nervous people, though the latter sleep more deeply. Frederick the Great, John Hunter, and Napoleon I. are said to have required only five hours' sleep per day; but the last of these had the faculty of taking short naps at a few moments' notice.

(4) *The sick and convalescent* require much more sleep than those who are healthy.

(5) *Habit* has a very important influence. There can be little doubt that many people sleep too much, and thus dull to some extent their mental faculties; but on the other hand, modern life, with its nervous strain, keen competition, and constant hurry and worry, makes it necessary to have a larger amount of sleep than our forefathers required.

(6) *Occupation.*—Mental work requires more repose than physical.

2. *Relation of sleep to food.*—The molecular life of the tissues—that is, the processes of nutrition—ought to be undisturbed. These go on most perfectly when no active function, such as that of digestion, is being performed. In fact, it is as difficult for them to build up their tissues during the performance of an active function,

Dur.n of sleep should be inversely as its depth.
Light sleep corresp.s to lang.d exercise, sound sleep to vigorous exertion. But here bad habits come in. Sleep often broken & unsatisf.y because excess.

The late Lord Mansfield made a practice of enquiring of aged witnesses to what they attrib[uted] their long life, & almost invariably found that whatever other diffce they had all been early risers

as it is for us to sleep while driving over a rough road. But while the stomach carries on the digestive functions to only a small extent during sleep, the intestines continue still to digest and absorb food. In accordance with these facts, it is advisable to allow at least two hours between the last meal of the day and sleep, especially if animal food has been taken.

3. Remembering the facts that absorption is increased and the temperature is lowered during sleep, it is important to *sleep in pure air*, and to have *warm coverings*, especially about the shoulders and arms. There is a common tendency, especially with children, to throw all coverings off the arms and shoulders; and many an obstinate cough might be cured by the simple expedient of wearing a flannel jacket at night.

4. *Sleep during the night and not during the day.* It would hardly be necessary to say this, as the universal instinct of animals shows its advisability; but, unfortunately, the habits of mankind have commonly led to a partial reversal of the natural arrangement.

Watchmen and night policemen not uncommonly suffer from their forced night occupations. They miss the sunlight, and have to endure a lower temperature, and the depressing influences of a more solitary life.

An after-dinner nap is an enervating luxury, except in hot climates, and under special circumstances.

5. The room should be dark; light, like sound, is inimical to sleep. The head should be moderately raised. The temperature of the room for robust persons need not be artificially raised.

Sleeplessness, as a rule, occurs only when some physiological law has been broken. To relieve it, it is essential to equilibrate muscular and mental functions. Increase of muscular exercise is an important element in its treatment. In addition it is advisable not to have any severe mental work during the evening, nor to indulge in late suppers. Sleeplessness is the bane of many men of a nervous temperament, and chiefly attacks those of sedentary habits. It is apt to recur, and for this reason, if for no other, narcotics

ought to be scrupulously avoided. The habit of taking such soporifics is unfortunately becoming much more common, and is productive of many evils. Death from accidental overdose is a frequent calamity, and the dose in all cases requires to be gradually increased, until most injurious quantities are necessary to induce sleep. The consequence is that the poor invalid's nervous system is completely ruined, his power of will is annihilated, and he becomes the miserable slave of an evil habit, whose end is death.

CHAPTER XXXV.

PERSONAL HYGIENE *(continued)*—CLEANLINESS.

The Structure of the Skin.—Effects of Uncleanliness.—The Uses of Soap.—The Uses of Baths.—Varieties of Baths.—Swimming.—Cleanliness of the Person, Apparel, House, and Street.

Physiological Considerations.—The skin consists of a superficial part or epidermis, and a deeper part called the dermis or cutis. The epidermis is composed of a number of layers of minute cells, which when they reach the surface become dry, and are cast off as flakes or scales, commonly known as "scurf." Nails and hairs are composed of modified and hardened epidermal cells. Singeing the ends of hairs is now commonly recommended, with some idea that the nourishment is thus retained, but this is altogether fallacious, as there is no central cavity in the shaft of hairs, and no fluid in the hair which could escape.

Certain tubes open on the surface of the skin, penetrating at their deeper ends into the cutis. These are of two kinds, sweat or *sudoriparous glands*, and *sebaceous glands*. The sudoriparous glands are simple tubes, the lower ends of which lie coiled up in the dermis.

Each tube when straightened out is about a quarter of an inch long; it contains a central canal, into which the perspiration is poured. It has been estimated by Sir Erasmus Wilson that in the

palm of the hand there are 3,528 orifices of sudoriparous and sebaceous glands on a square inch of surface; reckoning each gland as $\frac{1}{4}$ inch long, this means 73½ feet of tubes in this small space. Assuming that there are 2,800 tubes to every square inch, and that the amount of surface in a man of ordinary height and bulk is 2,500 square inches, it follows that there are seven million pores in a man—that is, 1,750,000 inches, or nearly twenty-eight miles.

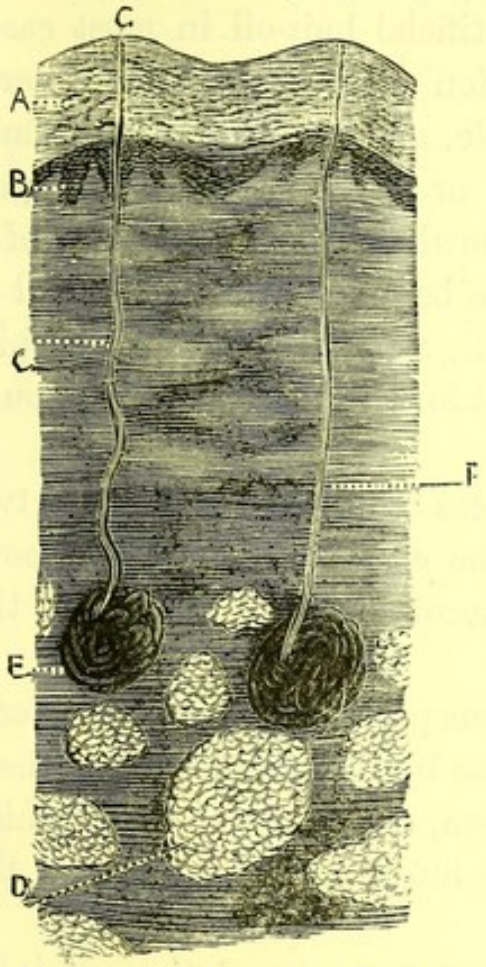


FIG. 35.—VERTICAL SECTION OF THE SKIN. Highly magnified.

A—Cuticle or Epidermis.
B—Rete Mucosum.
C—True Skin or Dermis.
D—Fat Cells.
E—Coiled extremity of Sudoriparous gland.
F—Sudoriparous gland running spirally to
G—Its Orifice on the Surface of Epithelium.

The sudoriparous glands secrete the perspiration. This is constantly evaporating from the surface of the body, though to a much greater extent in hot weather and during severe exertion. It is very important that the orifices of these glands should be kept open in order that the secretion may not be interfered with. Animals have been speedily killed by covering their skin with gelatine, and so preventing the escape of perspiration. Some idea of the amount of perspiration may be gained from a remark of Boërhave, that if the piercing chill of winter could be introduced into a summer assembly, the insensible perspiration (that is, the perspiration

slowly evaporating, and never appearing on the skin as beads of sweat) being suddenly condensed, would give to each person in the assembly the appearance of a heathen deity wrapt in his separate cloud.

The sebaceous glands are shorter than the sudoriparous, and commonly end alongside the hairs before the latter issue from the skin. They secrete an oily material which serves the purpose of a natural pomade, and renders any artificial hair-oil in most cases unnecessary. The sebaceous secretion also keeps the general surface of the skin unctuous and supple, and prevents dryness and harshness, if perspiration is deficient; or if the latter is great, prevents the macerated condition—somewhat like the hands of a washerwoman—which would otherwise be produced. The smell of the sebaceous secretion is not pleasant, especially in the arm-pits and some other parts. It is important for this reason that it should not be allowed to accumulate.

The **Conditions Due to Uncleanliness** may be classed under two heads; those due to obstruction of the excretory ducts, sebaceous and sudoriparous; and those due to accumulation of *débris* on the general surface of the skin.

1. The *obstruction* of the sudoriparous pores of the skin interferes with the elimination of waste products by the perspiration; these are re-absorbed or retained in the system, the consequence of which is that more work is thrown on the lungs and kidneys, and the equilibrium of health is destroyed.

The sebaceous obstruction causes an accumulation of oily secretion in the ducts. The black spots so commonly seen about the nose, are the blocked up orifices of sebaceous glands, and by squeezing the nose tiny threads of fatty matter are forced out from the interior of these glands. Pimples on the face are usually due to obstruction of the sebaceous glands; sometimes the obstruction leads to inflammation around the sebaceous gland, a condition known as Acne, which often permanently injures the skin.

5½ times as much heat req^d to conv^t boil^g H_2O into steam as raise same am^t H_2O from freez^g to boil^g point.

Gt advance in cleanliness as shewn by entry in Pepys' diary (Chas II time), that his wife had gone to take a bath. He also notes he has had his ears washed by maid-servt, & caught cold in consequ.

For 1000 yrs not a man a woman in Europe, even took a bath - no wonder then at spotd plague, black dth, sweating sickness, dancing & biting mania &c

St Jerome [illegible] commends an Egyptian hermit, who only combed his hair on Easter Sunday, never washed his clothes, but let them fall to pieces by rotting

Macaulay descd the time bef. the reform as a time "when men died faster in purest country air than they now die in most pestilential lanes of our towns, & faster in lanes of our towns than they now die on the coast of Guiana"

In autobiography of Geo. Combe, he tells how he forgot to give his rabbits new straw to clean out the dwelling properly & take away the old straw. To his horror the rabbits got into bad habits & exhibited bad moral qualities. The mother committed infanticide, the father became savage. "I held up the young to the mother & heathen: but soon discovered that if I cleaned out the habitation gave clean straw, & attended to her necessities she became a changed creature & attended to all her duties".

— See Gibbon's Decline & Fall III. CXXIX p 108 for instance of uncleanliness. A studious virgin could boast that at 60 yrs old, she had never washed exc. tips of fingers to receive the communion.

2. *Accumulation* of effete matter on the skin occurs, unless frequent ablutions are performed. The epidermis is constantly shedding its older and more superficial parts, in the form of minute scales or "scurf." In the absence of frequent washing, the scales of epithelium tend to accumulate unduly, owing partly to the clothing preventing free exposure to air and escape of the scales; and partly to the sebaceous secretion matting the scales together, and rendering them more adhesive. The saline matters of the perspiration also accumulate along with the scales and sebaceous secretion, and in virtue of their hygroscopic properties tend to keep the skin clammy and cold.

The obstruction of excretions and the accumulation of *débris* lead to other consequences. Thus:—3. The *sensibility of the skin* is dulled when the sensory papillæ are covered with dirt. The sensations received by the skin are important in regulating the temperature of the body. A cold external temperature should cause a reflex contraction of the small arteries bringing blood to the skin, thus diminishing the flow of blood and preventing undue loss of heat. Similarly, if the external temperature is high, or the internal development of heat is too great, these arteries dilate, and sending more blood to the skin, cause a greater loss of heat by radiation and conduction. Impaired sensibility of the skin leads to a deficient reaction of the reflex nervous mechanism to which the above effects are due, and consequently the dangers resulting from sudden alterations of temperature are greatly increased.

4. The *tendency to chills* is increased, not only by deficiency of the nervous tone of the skin, but also by obstruction of the pores of the skin, and by the hygrometric action of the saline matter collected on it.

5. *Cutaneous diseases* are due to, or favoured by, uncleanliness. These are of two kinds—*parasitic* and *non-parasitic*. Acne, which is the chief non-parasitic disease favoured by uncleanliness, has been already mentioned.

Parasitic skin diseases are greatly favoured by the presence of

a dirty skin, which affords a suitable soil for the development of the parasites. *(See also Chapter XXXVI.)*

Uses of Soap.—Soap is produced by the action of an alkali on an oil. The alkali displaces glycerine from the oil, and forms an alkaline stearate, which is soap. Soft soap is stearate of potassium; hard soap is stearate of sodium. The former is not used for washing the skin, as it is too irritating. The differences between the various kinds of hard soap are insignificant. All contain a slight excess of soda; the greater this excess, the more irritating is the soap to delicate skins. If any irritation is produced by the use of soap for washing the face, a solution of a teaspoonful of sal-volatile in a quart or more of water may be used instead, or the unpleasant effects may be subsequently removed by rinsing the surface with water slightly acidulated with lemon juice. Hard soaps may be also made with potash, if the fat employed be a solid one; but such soaps are rather softer than ordinary hard soaps, and more caustic. Cocoa-nut oil is used in making marine soaps, because, unlike all other kinds, it is not rendered insoluble by brine, and so will form a lather with sea-water.

In washing the skin, the water washes away a considerable amount of epidermis, and the saline matters which have collected. But between water and the sebaceous oily secretion there is a natural antipathy; and as this is the most ill-smelling part about the skin, something more than water is required for cleanliness. This is provided by soap. The alkali in soap combines with the oily matter, forming an emulsion which carries away with it a quantity of the dirt, which usually blocks up the orifices of the sebaceous ducts. At the same time the orifices of the sweat glands are cleared out, and any remaining dead epithelium is carried away in the alkaline lather. When the skin is rubbed by the towel after washing, the softened epithelium, and with it any remaining dirt, is rubbed off, leaving the skin clean, and much more capable of performing its normal functions.

Substitutes for soap, such as the various "wash-powders" for the

acc. to Liebig amt. of soap used, no inaccurate measure of
station of the wealth & civilt. of a nation.

In normal soaps 16-35 p c of H_2O present acc^g. to their
kind. Sometimes as much as 70% addd.

Sod. Silicate sometimes addd - imps detergent propts to sod. Stearate, but
if sold at lower price might be useful in millen^{ia} wd not
suffer postponemt.

Cold water soaps contain alge propts of free alkali - necessd
are wasteful.

A soap wh. does the tongue applied to a fresh section no
harm may be used for any purposes.

Lime soap is insoluble, as seen in effect of hard water on soap



Artificially col^d soaps often poisonous, esp^y the red, blue, & green varieties
Nearly all toilet soaps contain an excess of soda.

Operation of Adulteration Acts limited to foods & drugs. In soap "liquoring"
is effected, addn of 5 to 25 % sol^e silicate. Such soaps have
on section a tallowy white appearance, with the ~~crystal~~ waxy look due
to crystalln of fatty acids, as in pure soaps.

Walters prefers cold below 70° F, tepid up to 85°, warm up to 97°. hot above this.

toilet, are of little use. They only half do their work, as they do not enter the crevices of the skin, nor remove the obstructions in the glandular orifices. The common excuse for their use is that soap produces irritation of the skin; but good soap never irritates the delicate skin of infants. Irritation denotes neglect of soap, or a condition of the skin approaching disease.

The Use of Baths.—The primary object of bathing is cleanliness; inasmuch as cleanliness is necessary for health, the maintenance of health is involved in the use of baths. A secondary consideration is the pleasure derived from bathing. Baths are especially necessary for those persons who lead sedentary lives. When the skin is kept in an active condition by exercise, it to some extent cleanses itself. Thus, a farm labourer who has a weekly bath, may be really cleaner than a person of sedentary habits, who has two baths per week.

Baths are classified according to temperature as follows:—Below 85° Fahrenheit they are described as *cold*, though it is obvious that there are many gradations of temperature between 32° and 85° F.; between 85° and 95° they are called *tepid; warm* between 95° and 98°; and *hot* between 98° and 105°. It is very important in deciding the temperature of a bath not to trust to one's sensations; the only accurate measure is by the thermometer. A cold morning tub in the summer will commonly contain water at 55° to 60°; while the same in winter will be down to 40°, or occasionally to 32°. It may be desirable for weakly persons, in winter, to bring the temperature of the morning bath up to 50°.

For purposes of cleanliness the *warm bath* is the most efficient, combined with the free use of soap. It is most effective in thoroughly cleansing the skin, and increasing the rapidity of its functions. The chief objection to it is that it produces an increased flow of blood to the skin, by relaxing the cutaneous blood-vessels; in consequence of this the danger of chills is greatly increased. A severe catarrh or a quinsy is no uncommon result of warm baths taken at public bath-houses. Warm baths ought not to be taken

by healthy individuals oftener then once a week, and then at night, so that any exposure to subsequent cold is unnecessary. The increased sensibility to cold resulting from a warm bath may at any time be obviated by afterwards rapidly sponging the body all over with cold water, and then drying the body quickly, and using the friction of a moderately rough towel. It is desirable for both cold and warm baths to have a "bath-sheet," in which the person may be completely enclosed on coming out of the bath. Drying is thus much more quickly accomplished, and the danger of chill is minimised.

A daily morning *cold bath* is a most important agent in the maintenance of robust health. The first sensation on entering a cold bath is of shock, due to the cooling of the surface of the body. This is followed in a few seconds by a glow, due to the blood returning with considerable force to the skin. A cold bath ought not to be slowly taken, but as rapidly as possible. If soaping the body is desired, it should be done before entering the bath, and the stay in the latter should be little more than momentary. In this way the best reaction, or in other words, the best glow is obtained.

If a feeling of cold and chilliness remains after a cold bath, it has done more harm than good. This condition may often be avoided by drying quickly and brisk friction; if after this a good reaction is not obtained, the temperature of the water should be increased. For those who are not very robust, the "cold tub" in winter is to be deprecated. Water at 45° F., or even lower, produces chilling without any reaction; whereas, if the water be raised to 60° by the addition of warm water, or in some cases even to 70°, a good reaction will be obtained. In other cases, in which a reaction is not experienced even after a bath of the latter temperature, a tepid bath may be taken, and then the body rapidly sponged with colder water.

It is important, in relation to cold baths, to gradually accustom oneself to them, preferably beginning them in summer, and, unless

robust, to avoid very cold water. If a chill follows a bath, a cup of hot drink, such as tea, will obviate its effects.

Cold baths increase the tone of the skin, rendering it less susceptible to changes of temperature. The tendency to "catch cold" is greatly diminished, the blood-vessels and nerves of the skin both responding more readily to any stimuli. The cutaneous nerves become "hardened" by the sudden shock of cold water, and so morbid reflex actions, resulting in catarrhs, are much less prone to occur.

Swimming is a very valuable combination of bathing and exercise. A sudden plunge into cold water for swimming purposes is dangerous to those who are not hardened to it, and especially so in the case of running water, as in rivers, or the sea. Here the water around the swimmer is constantly being changed, and each layer of water coming in contact with him abstracts a considerable amount of heat. Many of the cases of so-called death from "cramp" are really due to the benumbing and depressing influence of continued cold on the vital organs.

Swimming, under proper superintendence, ought to be universally enforced. The exercise accompanying it serves in most cases to counteract the depressing action of the cold water; but it is important in all cases to attend to certain rules. The immersion should not be prolonged; the body should be warm at the time of entering the water; and the bath should not be taken until about two hours after a meal; nor after prolonged fasting, as before breakfast.

Personal Cleanliness.—Personal cleanliness involves not only attention to the skin, which we have already considered, but to the hair, nails, mouth, and other parts of the body.

The *hair* ought to be carefully brushed and combed, but it is not desirable to use soap to it as often as to the skin. Soap takes away the sebaceous secretion from the hairs, and renders them dry and brittle. Artificial pomades are, as a rule, undesirable and unnecessary, the sebaceous secretion furnishing the necessary oily

material. Where this is deficient, it is preferable to cut the hair short, thus diminishing the length of hair requiring lubrication; if this fails, then the aid of pomades may be invoked.

The *nails* should be cut square, and not down at the sides. It is hardly necessary to say that they should be kept clean: the finger-nails of medical men have been known to carry about infection of a serious character.

The *mouth* and all mucous orifices should be kept scrupulously clean. A fœtid breath is not uncommonly due to the discharges from carious teeth, or to the decomposition of food which has been allowed to accumulate in the cavities of teeth. Such decomposing matters when swallowed, are apt to lead to indigestion; and this also occurs from imperfect mastication of food by the bad teeth. It is important that the *teeth* should be frequently cleansed, and that all carious teeth should be "stopped" at an early period, and tartar and other accumulations removed. Whether bad teeth, which are so extremely common, are due to the drinking of very hot liquids, or to deficient calcareous matter in the food, or (which is more probable) to hereditary weakening, owing to more perfect cooking of food rendering mastication less necessary, there can be no doubt that by keeping the mouth thoroughly sweet and clean, and by stopping carious teeth as soon as discovered, their vitality may be greatly prolonged.

General Cleanliness.—Next to cleanliness of the skin, that of the *apparel* is most important. It is rather absurd to think that, as a matter of fact, the only covering a man is born with is commonly less clean than the apparel he clothes himself with; and that if any article of clothing is less clean than another, it is the one he wears next his skin. He has a clean vest less often than a clean shirt, and a clean skin less often than either.

The same tendency to disregard cleanliness is shown by the general preference for colours "that do not show the dirt;" the fact that it is still there, though not seen, being ignored. It would be much better for the health of the community if every one were

Microbes -(H. Power Lancet Dec. 11. 86)

1. Zymogenic - see p. 77.

2. Chromogenic - alw. aerobic. The most remarkᵇˡ. of microᶜ. is B. prodigiosus or red-sand. - of bactᵍ. is the Bacterium rubescens, appear ᵍ in ves.ˡ cult.ᵍ decomp.ᵍ astaci ; & B. cyanogenus wh. is the ˆ cause of blue milk.

3. Pathogenic - must prove 1/. that microbe constᵗ. present in the ~~blood~~ tissues or bld - 2/. that when isolᵈ. & cultivᵈ. it can when introᵈ. into body of a healthy anim. produc. the orgˡ. disᵉ. & again be fd in qty in the body.

obliged to dress in white or light-coloured clothes; there would then be some hope of cleanliness being maintained. Changing of apparel is commonly confined to underclothing. It is forgotten that vests, trousers, dresses, etc., acquire a large amount of dirt and organic matter, and ought to be changed and well aired at frequent intervals. It is well to spread out one's clothes in a dressing-room at night, in order to have them well ventilated and purified by the oxygen of the air.

Cleanliness in respect to *bed-clothes* is very important. Organic matters evolved from the skin, lungs, etc., hang about the bed-linen, and give the bed-room the "close smell" which can nearly always be appreciated on entering it in the morning straight from the fresh air. The beds should not be made directly after being evacuated, but the clothes should be thrown over the bottom of the bed, the bolsters and mattress well shaken, and every part exposed to a free current of air during the greater part of the morning, before re-arranging the clothes. Restless nights are not uncommonly due, in part, to impure bed-linen poisoning the skin. Eider-down quilts, unless frequently ventilated by exposure to outside air, act as receptacles of dirt and organic effluvia. Superfluous bed-room furniture should be avoided, as it all takes away from the breathing-space. Bed-hangings should be reduced to a minimum, and all excretory matters covered up during their stay in the room, and removed as early as possible.

Cleanliness of *the house* is also very important as a means of health. Dust, in however obscure a corner it rests, attracts to itself organic matters, and forms a soil in which disease germs are propagated. Besides this, it devitalises the air, that is, deprives it of its active oxygen.

Dust in *the streets* serves to carry about various diseases. There can be little doubt that infection is sometimes spread in this way. In addition to this, dust mechanically irritates any part it comes in contact with, producing bronchitis, etc.

CHAPTER XXXVI.

PARASITES.

Vegetable Parasites.— Schizomycetes.— Saccharomycetes.— Thrush.— Ring-Worm.— Favus.— Tinea Versicolor.— Scabies.— Fleas, &c.— Trematodes.— Nematodes.— Filariæ.— Tape-Worms.— Preventive Measures.

Parasites (Greek, *para*, upon, and *siteo*, I feed), in the broadest sense of the word, are living organisms, which derive their nourishment from other living organisms. They may belong to the vegetable or animal kingdoms, and may live on the skin, in the alimentary canal, or in some one of the internal organs. In some instances, as in ringworm, the organism feeds on the living tissues of the animal infested; in others on the partly digested food, as in the case of tape-worms; while other parasites only pay temporary visits to the surface of the body, for the purpose of obtaining food, as in the case of fleas and gnats.

The importance of the different parasites varies greatly; some being the cause of active disease, while others are comparatively harmless. Only the commoner and more hurtful varieties will be here described, the rarer ones being simply named.

Vegetable Parasites.—Vegetable parasites all belong to the class of fungi, and more accurately to the two lowest divisions of this class which have been provisionally formed, viz.—Schizophyta, and Zygophyta. The Schizophyta include two orders, Schizomycetes and Saccharomycetes.

The *Schizomycetes* are minute cellular growths; the cells of which may be isolated, in which cases they are spherical (Micrococcus), or rod like (Bacterium); or united into filaments which are straight (Bacillus), or spirally wound (Spirillum). None of these contain chlorophyl; they multiply by fission, occasionally by the development of spores, and occurring in swarms, they may in a certain stage be imbedded in a gelatinous matrix (the zoogloœa stage). They are all extremely minute, the Bacterium being about $\frac{1}{10000}$ of an inch in length, and the Micrococcus rarely more than $\frac{1}{25000}$ of an

Truth is more easily educed from Error than from confusion (L. Bacon) hence importance of even tentative classific^{n}

Micrococcus (Sphero-bact.) - do not pass into rods or fil.ts & thus disting.d f. Bact.a proper or Bac.i. Acc.to Cohn have no power of indepl loc.on.s, thus diff.t f. Bact.a wh. have per.ds of rest & mot.n Rarely over $\frac{1}{25000}$" diam.r - Multip.n by transv. fiss.n some seen in dumb-bell shape. Are anaerobic. Much infl.d by temp. Appear to resist antis.cs much more than Bact.a.

Known that rod-Bact.a when cultiv.d may present spores, wh. can div.e & subdiv.e & wh. phys.ly indisting.e f. Micr.i. Quest.d whether Micr.i are not an abortive stable form of Bact.a. Numer.s attempts to prod.e Bact.a f. them unsuccessf.

Cohn div.s Micros.i into 1). chromogenic, 2). zymogenic, 3). pathog.c - "ferm.ts of contag.m".

Quest.n of relationship of Bact.a to septic.a & Pyæ.a v. diff.t f. that of their rel.n to specif. dis.s.

Rel.n to blood pois.g - if micr.i excl.d no putref.n. Also pres.t where it occurs much end.s to shew that infect.s prop.y of pus dep.t on or coexist.t w. presence of micr.i. Their prop.y of caus.g suppur.n may be lost when cultiv.d in nutrient flds, but A. Ogston has cultiv.d them in eggs, & then caus.d suppur.n. Zooglœa masses in aff.d pts in Pyæ.a. In Puerp.l F., Hosp. gangr., ulcer.e endoc.s, Diphth.e endoc.s, have been fd both in prim.y les.n & in sec.y abs.s.

Healthy organism has agt power of resist.g their entr.e & of destroy.g if admitted into blds. Recent exp.ts as to whether Bact.a exist normally in blds, held in abeyance by intact.y of tiss.s, so that after death they germinate, have led to v. diff.t results.

Rel.n to specif. fevers — Micros. diphtheriticus descr.d by Loeffler obs.r who. others have fail.d to discov. it. Micros. vaccinæ - exists in lymph, but imperf.t evid.ce as to whether it constit.s the contag.m is negat.e.

In Horse-pox, glanders, foun.a & micr.i fd - but true rel.n uncert.n

Micros.i, Bact.a Bac.i & Spirilla can each be div.d into those that are septic, zymogenic, chromogenic, & halliogenic.

Comma bacillus not yet capt. of transfer to animls.
Leprosy simil. cant be transfer. Rinderpest & Pn. of
anims cant be transfer. to man.

Multipl. infect. mat. of chol. outside body behav. in Koch.
Bac. can grow on linen, meat broth, a potat. The whole mass of
H_2O prob. does not cont. nutrit. mat. in a suffic. concent. cond.;
but gutters cesspools &c may.

Spore bear. cond. of Com. bac. not yet discov., unless Fenan's
obsern. to be trust.

Bacil. Anthracis - cause of 1). loc. or ext. form of malig. pust. & 2).
gen. or int. anthrax (woolsorter's dis., Siber. plague)
In man alw. derived f. anims. Direct contag. rare if ever f. liv. anim., gen.
f. carcase (butchers, tanners &c) Rare arises f. cat., as pois. destroy. by cook.
Is commun. by butter or milk or by flies' bites. Indirect contag. chiefly in those deal.
w. hair or wool of anims dy. of the dis. Dec. diffused by H_2O, or by means of wool-
waste & bone-dust used as manure. Pasteur's researches seem to shew that it can
be cultiv. in earth round buried carcases, can. to surf. by earth-worms & distrib. on veg.
Is $\frac{1}{2500} - \frac{1}{1250}$" in length. Fil. are straight, curved, or bent at ∠s. Reprod. by fiss. & spores.
Is aerob. vital. destroy. by 60°C (or 140°F) Spores not destroy. by short expos. to 100°C moist,
& prob. still higher dry.
String. reigns for destr. of hides & carcases of affd. anims and do more than anything else.
Wool, hair & rets. infect. for long per. by system. disinfn. of them.

1. Schizomycetes { Micrococcus, Bacterium, Bacillus, Spirillum
Schizophyta
2. Saccharomycetes — Saccha. rectae
Hyphophyta { oidium albicans (thrush), tricophyton tonsurans (ringworm), Achorion Schönleinii (favus), microsporon furfur (tinea versic.), Aspergillus, Mycetoma Carteri

Spirilla (Spirobacteria of Cohn) div. into 1). Vibrios - fil. short,
sinuous, slight. 2). Spirillum, fil. short, spiral, rigid. 3). Spirochate -
fil. long, spiral & flexible. Spiril. Obermeieri sometimes called Spirochate O
Is indistinguishable in form & movements f. Sp. plicatilis of Ehrenberg, found in stagnant H_2O
Dr V. Carter reprod. Rel. F. by inocn. in certain sea-monkeys - 6 failures out of 21 trials.
He says "Doubtful if the Spiril. itself proper to the contagium proper, & not rather some other
agency with which is associated."

inch in diameter. Certain organisms belonging to these divisions have lately assumed much greater importance, owing to their intimate relation to the causation of disease. Micrococci have been found in the blood in various septic (blood-poisoning) diseases, such as pyæmia, septicæmia, and puerperal fever, but whether they constitute the active cause of these diseases or are simply associated with it, is still somewhat doubtful. They have also been found in the system in various specific contagious diseases, such as diphtheria and vaccinia (vaccination), but their exact relation to these diseases is still unknown.

Bacteria of various forms are found everywhere. The *Bacterium termo* is apparently the cause of putrefaction, as, in its absence, freedom from decomposition can be ensured.

Another form of Bacterium seems to be the cause of pebrine—a disease of silk-worms—which has caused great loss in France, and has recently been thoroughly investigated by Pasteur.

To avoid confusion, it may be stated that the term Bacterium has been applied to all the organisms belonging to the Schizomycetes, though strictly it applies only to the rod-shaped isolated organisms.

A form of Bacillus, called the *Bacillus Anthracis*, has been proved to be the cause of malignant pustule of man, the splenic fever of animals. The close association of the *Bacillus tuberculosis* (Koch) with the origin of tubercular consumption, is discussed in Chapter XXXVII.

A form of Spirillum has been found in relapsing fever, which appears with each paroxysm of the fever, and disappears in the intervals. It is called *Spirochæte Obermeieri*, from Obermeier, who first described it.

Saccharomycetes occur in fermenting substances, as in the fermentation of saccharine solutions. The only organism belonging to this order, which is associated with diseased conditions, is the *Sarcina Ventriculi*. This is found occasionally in the vomit or even in the urine of some persons.

The *Zygophyta* occur as thread-like growths, forming a mycelium.

This is composed of jointed branching tubular cells, in which minute spores are produced. Each spore, when liberated from its tube, is capable of producing another mycelium, and thus the growth spreads. The spores may be carried through the atmosphere, thus producing infection at a distance. They are extremely minute, having an average diameter of ·006 m. m. (about $\frac{1}{4000}$ of an inch.)

The following are the chief Zygophytous parasitic diseases:—

Thrush is associated with the growth of a minute filamentous fungus, the *oidium albicans*. It is common in babies, who are improperly fed, and in old people, or in persons exhausted by any chronic disease. Small white patches collect on the tongue and neighbouring parts, and these are often followed by the formation of minute ulcers. When it occurs in children, the food must be carefully attended to, and feeding bottles frequently scalded, etc. Glycerine of borax is generally applied to the interior of the mouth, but sometimes a weak solution of sulphurous acid is more efficacious. In all cases, it is important to treat the general health as well as the local condition, as thrush only comes on in weakly states of health.

Ringworm is due to the growth of a fungus, the *tricophyton tonsurans*, which may attack the skin of the body, or the scalp, or the beard. It is much more difficult to eradicate when it occurs in hairy parts, as the fungus growth penetrates to the roots of the hairs, and continues to live here long after it has been destroyed on the general surface of the skin; it is also very difficult to cure in the rare cases in which the nails are attacked. The fungus spreads on the skin in gradually enlarging circles. When seen on non-hairy parts, it forms patches of varying size, having a slightly raised and inflamed margin. In all its stages, and wherever found, it is extremely contagious, being especially apt to spread in schools. The spores may be carried about by means of hats or bonnets, by gloves, towels, razors, and other means. Children not uncommonly get ringworm by playing with kittens or pups suffering from it. The disease often remains undetected for some time; and many

In Oidium tubular filts, branching stems + minute spores.
Don't use honey of borax as the honey favours growth.
Thrush does not pass thro. al. canal.

Aspergillus - a fungus of this species attacks nails, caus? discol.n & distort.n Asmen var? has been fd in ext. aud? meatus; a long stem w. a sm. cup, on wh. numerous sm. spores ris.e (see fig.)

Mycetoma Carteri - (foot fungus of India) - bones of ft perfor.d w. canals f. size of pea & that of nut. Cavities are fill.d w. a mass of fungus, red int.ly & w. an ext.l coat.g of black. In the mature form the fung. consists of minute articul.d threads branch.g & fill.g w. grumous mat.l Spores cont.n an oil-globule at ea. end & germinate rapidly.

cases, after they have been apparently cured, remain contagious, and thus the disease is spread, while its presence is unrecognized.

The removal of ringworm, as of all other skin parasites, is effected by some local parasiticide. Iodine, sulphurous acid, carbolic acid, are usually effectual when the parasite attacks non-hairy parts: for the scalp and beard more penetrating remedies are required, and a longer perseverance in treatment. In addition to these remedies extreme cleanliness is essential in the treatment.

Favus is due to the growth in the skin of a minute fungus called the *Achorion Schönleinii*, which invades the same parts as those affected by ringworm, but differs remarkably in its mode of formation of spores; yellow cupped discs from $\frac{1}{4}$ to $\frac{1}{3}$ inch in diameter being produced. It is very rare in England, and almost confined to persons (especially children) who are kept in a filthy condition. It is a common and fatal disease in mice. The treatment is similar to that of ringworm.

Tinea versicolor is caused by the growth in the epithelial cells of the skin, of a fungus called the *microsporon furfur*, which unlike two last, does not invade the hair or nails. It forms light brown patches covered with a horny scurf, which gradually spread, until nearly the whole trunk may be covered. It does not attack children, and never affects uncovered parts of the body. It chiefly occurs in those who do not take frequent baths, and who perspire freely. It can be removed by daily washing with soap and water and rubbing with a rough towel, followed by the application of a weak carbolic lotion.

Animal Parasites.—Animal parasites are found on the skin or in internal organs. In the latter case, they may have gained access through food or drink taken, or by penetrating the skin. All the animal parasites belong to the Invertebrate class. The following is a fairly complete list:—

The *Acarus Scabiei* is a minute animal not unlike a cheese mite, which causes the disease known as *scabies* or the itch. It is probably never more than $\frac{1}{77}$ of an inch in length. The female has

eight legs, with terminal suckers on the four front legs and hairs on the hind legs. The male is smaller than the female, and in the adult condition the two hindmost legs have suckers, as well as the four anterior. It remains on the surface of the skin, while the female burrows deeply in the substance of the epidermis. At the bottom of the oblique burrow it deposits ten to fifteen or more eggs, which hatch in a fortnight and then commence similar operations on their own account. Scabies generally starts between the fingers, whence it rapidly spreads. It is almost entirely confined to those whose skins are uncleanly, and whose linen is seldom changed. Others, however, may catch the disease accidentally, and it may become very severe before its real nature is detected, the treatment being misdirected towards remedying some supposed disorder of general health, instead of towards killing the parasites. Occasionally whole families are infected by a nurse, or from some accidental source. Formerly it was called "the seven years' itch," from the great difficulty in curing it before its true cause was discovered.

The irritation caused by the insect produces various rashes which closely resemble the rashes due to constitutional causes, such as eczema. In some cases, the only certain means of diagnosis is by the microscope.

The removal of this parasite is effected by two measures. First the skin is softened, the superficial epidermis is removed, and the burrows are laid bare, by the daily use of hot baths with soft soap, and subsequent rubbing with flesh towels. Then some parasiticide, such as the well known sulphur ointment, is rubbed into all the affected parts of the skin. A few days' perseverance in this treatment usually suffices for a cure. The patient's clothes and bed clothes ought also to be thoroughly purified by boiling or dry heat; otherwise he may become re-infected.

The *Acarus folliculorum* is a minute insect, which is commonly found in the sebaceous follicles of apparently healthy people. It does not give rise to any disorder.

Psorosperms - appar some cond^ns of oviform psorosperms or coccidia w. dis^d cond^ns of human body - recog^d in cases of Paget's dis^e of breast (malig^t papil^r dermat^s) & in the skin dis^es called Psorospermose folliculaire végétante. Are protozoa. Kid^d & meta shown stud^d w. psorosp^l cysts. Habitat said to be intracellular. Superf^l resembl^e to tubercul^r in symp^s? Possibly mollusc. Contag^m due to these.

Psorosp^l coccidia are real caps^s .037 mm long by .02 mm in diam^r. Very freq^t fd in liver of rab^ts 60-66 % affect^d Source of infect^n & stage in wh. coccid^m introd^d is unknown; prob^y the dis^e is not acq^d by rab^ts

D^r Delepine fd 92 % of rab^ts affd. agrees that coccidia erupt along biliary canals Diagram p. 305 Ill. med news 1889.

The nits are best removed by methyl^{d}. spirit.

The *Larvæ* of several insects have been found embedded in the skin. In the ox, the larva or bot of the gadfly produces a troublesome disease, a large boil being formed under the skin as the larva grows. This larva has, on rare occasions, attacked human beings. Rare cases are recorded where other larvæ have become developed in men, in all upwards of twenty separate genera of insects having been recognised. The treatment consists in removing the parasite where possible, and where not possible killing it *in situ*.

The *Chigoe*, commonly known as the jigger or sand-flea, is a minute parasitic insect, found in the West Indies and northern parts of South America. It was formerly regarded as an acarus or mite, but is really a flea (*Pulex penetrans*). It is so small as to be scarcely visible; but the impregnated female possesses a proboscis, by which it penetrates the skin—generally near the nails—and there develops a bladder the size of a pea, which sets up severe inflammation.

To get rid of the intruder, the orifice by which it entered must be dilated with a needle, until large enough to admit of its extraction, without rupturing the cyst.

The *Leptus Autumnalis* or harvest bug, is apt to imbed itself in the skin, and cause great irritation.

Several species of *Fleas* infest the human frame. They are propagated by means of eggs, the worms from which enclose themselves in a tiny cocoon before assuming the adult form.

Three varieties of *Lice* occur on the human skin. The first (*pediculus capitis*) infests the head, especially of children, and multiplies with astonishing rapidity, the female laying altogether about fifty eggs. The other two varieties are the body louse (*pediculus corporis*) and the crab louse (*pediculus pubis*).

Strict attention to cleanliness is the best means of getting rid of fleas and bugs. A wash made of carbolic acid and vinegar painted over bed crevices is very efficient. Lice may be removed from the head by cutting the hair short, and rubbing into it a weak carbolic lotion, or white precipitate ointment.

The *Trematoda* or Flukes furnish two human parasites, viz. the liver-fluke *(Distoma hepatis)*, and the Bilharzia hœmatobia. The liver-fluke occasionally produces jaundice in man. In sheep it is the cause of the disease known as the "rot." The *Bilharzia hœmatobia* is chiefly found in Egypt, and the Cape Colony. It is about a quarter of an inch long, and infests the blood vessels, more particularly of the kidneys; setting up severe irritation and the discharge of blood. It is probable that the eggs of this parasite are received in drinking water or on salads, though occasionally inoculation may occur through the skin when bathing.

The family of *Nematoda* possesses numerous parasitic members. The common thread worm *(Oxyuris Vermicularis)* is one of the most common of these. The female is $\frac{1}{3}$ to $\frac{1}{2}$ inch in length, and inhabits chiefly the lower bowel. The ova, which are from $\frac{1}{490}$ to $\frac{1}{1100}$ inch in diameter, often gain access to drinking water, or are carried by flies, or received on salads, etc. The injection of salt and water into the bowel, and remedies tending to improve the general health, are the proper remedies.

The round worm *(Ascaris Lumbricoides)* inhabits chiefly the small intestine; hence medicines for its removal require to be given by the mouth. The female is from 10 to 14 inches long; the ova, of which each female discharges on an average 160,000 daily, from $\frac{1}{340}$ to $\frac{1}{440}$ inch in diameter.

The whip-worm *(Tricocephalus Dispar)* is a smaller trematode, which is rarely met with in this country. The *Dochmius Duodenalis* is met with chiefly in Italy and Egypt. It sucks the blood in the intestine, causing dangerous hæmorrhage. The *Strongylus Gigas* is chiefly found in the kidneys of the ox, dog, etc., and is very rare in man. It resembles a very large round worm. In the kidney it produces severe disorders, but how it gets there is not known.

The *Trichina Spiralis* has been already described (*page 35*).

The *Filaria Dracunculus* (Guinea Worm) seems to gain access into the stomach along with water, or possibly in some cases, by

Mature eggs of liver-fluke do not undergo further devel^{t} until expel^{d} fr. host: but when they fall on moist places, embryo is liber^{d} & moves free by its cilia. From Asen^{cy} or other dis^{e}, passes into mollusc^{d} animal, assumes larval cond^{n} & devel^{s} other larvae in its int^{s}: these again when free prod^{e} still higher larval forms known as Cercariæ, wh. pass thro a pupa state & emerge fr. their cysts as flukes. Entr^{e} of Distoma into man & sheep by small molluscs on herbage & veget^{n}. Mature eggs are expel^{d} by thos^{s} & may be discov^{d} in bile &c.

Male abt $\frac{1}{2}$ this size

Male of Ascar. distin^{d} by smaller size & double penis: In female the very long & tortuous coats of ovarium may be seen thro. transpart parietes. Genital open^{g} is near centre of worm.

Ascaris mystax wh. comm^{s} in cat, occas^{y} in man.

Ascaris megalocephale in horse, Ger than human. Utric^{s} coils free (postmortem thro. intest)

Whip worm chiefly in human coecum. $1\frac{1}{2}$–2" long neck is double length of body & very thin.

Guinea worm only in tropics. In legs as a rule (in Hindoos abt arms or breast after defac^{n}); abt the shoulds of water bearers who carry skins on backs. Nearly entire worm is occup^{d} by uterus, wh. is gen^{y} fill^{d} w. young ones, distin^{d} by their taper^{g} tails. Young gain entry to body by boring thro. skin. They then attain full length in females 3' 1" in males 1–1½' Diam. abt ⅛" ⅕"
5–10 mos. Fd in waters of ports & marshes.

Sclerostoma syngamus a sm. worm infest? trachea of birds & caus? 'the gapes'. Fem. under $\frac{3}{4}$" long, male ab^t $\frac{1}{8}$".

Parent worm (Fil. Sang. Hom.) lives in lg^{es}, embryos born in lymph stream & can? into bld. No. in bld grad^y incr? up to midnt, when may be seen 200 in one drop of bld. This an adapt^n of paras^c habits to those of fem^e of a partic^r species of mosquito – the interm^d host. In its stom. the fil^a bec^s fert? gen mne active & possess^d of anal? canal & boring appar^s, by wh. it leaves the msq. after its 1st blood meal. P.S.V.S. swall? in H$_2$O.

10 % of adult pop^n in some countries have fil^a – so dis? as result are accid? Obstn of lg^{es} by ova being disch? prem^y into lg stream & act? as emb^{ic} Boil all H$_2$O drunk. Prev^t access of msq. to H$_2$O. Pers? had? fil^a shd sleep under msq. curtain

Taenia mediocan^a distinq? from T. solium by –
1. uter. has? a less no. of lat^l branches.
2. genital pores in alat^l post^r below centre-line of 2a. mature segm^t.
3. head has neither hooks nor rostellum.
4. The four sucking discs have abund^t pigm^t gran? giv? them a v. char^c appear^a

Taenia Echinococcus distinq? by its extreme minute^s: consists of head w. suckers hooks & rostellum, & 3 segm^{ts}. of wh. the mid. one is the longest & cont^s the sex^l organs. May have (1000's eggs.

The food? of dogs on int^l pts of sheep (as omentum &c) who hang loose in butcher's shop, with^t prev^s cook?, a pref^t means of infect^n. The Coenurus cerebralis prod^s 'staggers' in sheep. Hydatid inst? one of one head has several hundreds, attach^d to the caudal vesic^r

Bothriocephal^s latus – cystic. prod^s in fish.
1. head has no hooklets. 2. Four suck^g are repl? by 2 lat^l fissures. 3. worm may be 25^{ft} long & at widest pt nearly 1" wide. 4. genit. pores in centre inst^d of margin of 2a. segm^t & preg^t 2 open^s on same joint near 2a. other

perforating the skin. It burrows among the tissues, especially of the legs, and attains a length of several feet.

The *Filaria Sanguinis Hominis* is a minute worm, about $\frac{1}{75}$ inch long, which infests the blood of man, chiefly in the tropics. Its mode of entry into the system is doubtful, but it is probable that the ova of this worm may be introduced by mosquito bites, as well as by the drinking-water. Vast colonies of these worms circulate in the blood, and may produce various diseases. Commonly, if a drop of blood is examined during the day, no filariæ are detected, while at night they are present in abundance. It seems that they remain quiescent during the day, only migrating into the blood-vessels at night. The filariæ sometimes accumulate in the lymphatic vessels and glands, and produce obstruction of the flow of lymph or chyle. In some cases, as a result, *chyluria* (chyle in the urine) is produced; while in others *Elephantiasis*, characterised by enormous enlargement of the legs and other parts, ensues.

Tape-worms are found infesting the alimentary canal of man. Each has a double phase of existence. In the first, the characteristic head or *scolex*, along with a bladder-like body, lies imbedded in the solid tissues of an animal; in the second, the *strobilus* or tape worm, forming really a colony of animals, occupies the alimentary canal of another animal. The tape-worm consists of a number of flat segments, each of which is capable of producing eggs, from which a six-hooked embryo is developed. The segments escape from the alimentary canal, and their ova are discharged and scattered broadcast. These subsequently find their way into the alimentary canal of another animal, the hooked embryo escapes from its cell, migrates into the solid tissues, and there produces a scolex. The scolex remains *in situ* until its host perishes, or becomes the prey of another amimal. When the latter happens, the scolex enters the alimentary canal, loses its bladder-like body, and develops a chain of segments. It follows from the above that two distinct hosts are usually necessary to complete the cycle of

existence of these creatures, one being commonly a herbivorous, and the other a carnivorous animal. Thus :—

Cystic Form.		Tape-worm Form.
Cysticercus Cellulosæ in the muscles of the Pig ...	*becomes*	*Tænia Solium in the alimentary canal of Man.*
Cysticercus ———? in the muscles of the Ox ...	,,	*Tænia Mediocanellata, in the alimentary canal of Man.*
Cysticercus Pisiformis in the muscles of the Rabbit ...	,,	*Tænia Serrata in the alimentary canal of the Dog & Fox.*
Cysticercus Fasciolaris in the muscles of Rats and Mice	,,	*Tænia Crassicollis, in the alimentary canal of the cat.*
Cœnurus Cerebralis of the Sheep's Brain	,,	*Tænia Cœnurus, in the alimentary canal of the Dog.*
Echinococcus Veterinorum of the Liver of Man, etc....	,,	*Tænia Echinococcus in the alimentary canal of the Dog.*

The *cysticercus cellulosæ* has been already described (*page 35*). The cystic form of the dog's tape-worm (*echinococcus veterinorum*) is one of the most dangerous parasites to life in man. It forms large cysts, chiefly in the liver, but occasionally in the lungs, brain, and other organs. For the removal of these, surgical interference is required. This form of cyst is commonly known as a *hydatid.* It is most frequently seen in Iceland and Australia, though not uncommon in this country. Its frequency depends largely on the number of dogs, and on the facility with which the ova of their tape-worms can gain access to water.

The adult *Tape-worms* are usually derived in man from eating meat containing the cystic form. The *cysticercus* of the pig produces *Tænia Solium ;* that of the ox, the *Tænia Mediocanellata.*

Preventive Measures.—In avoiding the various Entozoa described, it is important (1) to *carefully avoid all underdone meat.* The eating of smoked sausages, or of meat which is not cooked throughout, is a common source of tape-worm and of trichinosis.

(2) *All vegetables should be thoroughly washed :* this is especially important in the case of water-cress, lettuce, etc., which are eaten raw.

The head of tape-worm is not the true head – is a hold fast – no mouth or eggs.

May be over 1000 zooid in Ea. tapeworm. In centre of 2 mos entire colony is formed. Ea. zooid cont? when perfect fully 30000 eggs (Cobbold). The 1250 are reformed abt every 2 mos, so that the owner of tape worm discharges per annum abt 180 mill? eggs. Each egg is abt $\frac{1}{800}$" in diam? – shell diss? by gast? juice & embryo 6 hooked escapes.

Acc? to Cobbold in many hundred cases only 3 p.c. of T. Solium & 97 p.c. of T. mediocan – this applies chiefly to the wealthier classes. But take? all together prob? only 25% T. Solium Larva of T. med. not known to migrate, but Cystic. cell? does. Prob? Mosaic prohibn of pork had to do w. paras? infect?

Echinococcus – head something like head of ord? tape worm – double row of hooklets & 4 suckers. May be 10000 heads to one hydatid. Each one of these capable of prod? T. Echinoc.

Egg of a hen prod? one indiv? but same of Echinoc. may prod? 10000 indivs

In Iceland $\frac{1}{6}$ of inhabts die of Echinoc.

Measles in pork & beef perish at 115°F. – at any rate cannot survive 122°. for one min.

Tapeworms should be burnt

Leprosy for 13 centuries was endemic in S. Brit^{n}, now annihilᵍ^{d} example not to be fᵍ. The cause is endᵗ & yet capᵉ of abidᵍ in N. regⁿˢ & tropics Case of E. tuberosa recently origᵈ in N. Zealᵈ – before that unknown. Had been engaged in drainᵍ & lived on margin of marshes.

Has been ascᵈ to bad food & fish-diet. Now believᵈ to be hereditᵗ, non-contagᵗ Yet curious instᵉ of 1ˢᵗ appearᵉ after immigⁿ of foreigners f. a leprous country, as in Sandwich Islᵈˢ f. Chinese. A peculʳ form of Basil. fᵍ

1. Endemic diseases – not communᵉ but due to locᵗ condⁿˢ as damp, occupn &c.
2. Miasmata – rootᵈ to the soil.
3. Infectious disᵉˢ – belong to people not place – are
   1). infectious proper, & 2). infective, wh. also communᵉ
   but may be developᵈ in indivˡ e.g. Erysipl., Pyæm. & Septicᵉ
   3). communᵉ or transportable miasms, as Typᵈ, Cholᵃ, Y. Fev
4. Enthetic disᵉˢ – only by inoculⁿ, as Hydrophob. Glandˢ

(3) If the purity of the *water* is not ensured, it *should be boiled* before drinking, especially in tropical climates, and where many dogs are kept. Dogs should be kept out of the kitchen, lest ova accidentally gain access to articles of food.

(4) The possibility of *flies* and *mosquitoes* acting as carriers of parasitic disease must be remembered.

(5) Intestinal parasites, as a rule, occur in debilitated persons, and especially in those suffering from some abnormal condition of the mucous membrane. It is essential, therefore, that this should be treated, and that the general health should be improved by medicinal and other measures.

CHAPTER XXXVII.

THE PREVENTION OF ENDEMIC DISEASES.

Endemic and Epidemic Diseases. — Consumption. — Influence of Heredity, Sub-soil Drainage, Overcrowding, and Infection.—Scrofula.—Rheumatic Fever.—Marsh Diseases.—Rickets.

The prevention of disease depends largely on a knowledge of its causes. Disease may be due to a personal life not in accordance with physiological laws; or to some other cause acting *ab extra*, whether it be conditions of atmosphere or soil, or some contagion received into the system.

We have already discussed the influence of habits, of clothing, exercise, sleep, and food on health, and have shown how errors in these respects may lead to disease. It now remains to consider more particularly the prevention of diseases, which are to a large extent independent of personal habits of life. Many such diseases are unfortunately not preventible; but there can be no doubt that with increased attention to the condition of air and water, of drainage of the soil and allied matters, the number of inevitable diseases will be greatly diminished.

The chief preventible diseases come under one of two heads:—

those which are constantly present in a smaller or larger degree, and those which only appear periodically. The former are called *endemic diseases*, the latter *epidemic diseases*. It must be remembered, however, that many epidemic diseases, like typhoid fever, are prevalent in a less degree constantly, and are therefore endemic; while certain endemic diseases, like leprosy, plague, and yellow fever, become epidemic under certain ill-understood conditions. The chief endemic diseases we shall consider are—consumption, scrofula, rickets, rheumatic fever, and ague; the chief epidemic diseases—small-pox, scarlet fever, diphtheria, measles, whooping cough, typhus and typhoid fevers, cholera, and dysentery.

The Prevention of Consumption.—There can be no doubt that this is a disease which is entirely preventible. There are four main factors in its causation—1st, its marked hereditary character; 2nd, the influence of sub-soil drainage; 3rd, the influence of overcrowding: and 4th, its possible contagiousness. When we remember that phthisis (consumption) kills more than 80,000 persons per annum in the United Kingdom, or 11 out of every 100 persons, and that other phthisical and scrofulous diseases kill a large additional number, the importance of studying the conditions on which it depends is evident.

Its *hereditary character* is well known; too much stress must not however be laid on this point, as there are few families in which some relatives have not died of consumption. On the other hand, if several members of the same family have successively died of consumption, the project of an alliance by marriage with any remaining member of the family should on no account be entertained.

The influence of sub-soil drainage on the prevalence of phthisis has been clearly shewn by Dr. Buchanan (9th and 10th Reports of the Medical Officer to the Privy Council, 1866-7). He found that as the sub-soil water was diminished by means of drainage, the mortality from phthisis diminished. It was also found that the mortality from phthisis was reduced more in the early years after

In this country a dimn. in d.r. f. Phthisis from 2567 per mill. in 1858-60 to 1846 per mill. in 1881-3, & in Massachusetts from 39.50 per 1000 to 29.90. 5th dimn. in army d.r. f. Phth. (Ransome). Phth. ubiquitous & influ. of climate on its prod. & limitg. agt. exag. Its chief effect was in fav. a discontinuous open-air life. Dust only needed a cause of Ph. by prod. a degen. cond. of lungs on wh. tubercle might easily be graft. Infl. of hered. also exag. acc. to Ransome

D. Drysdale fd that tubercl. dis. caused 65 p. 1000 of total deths among rich & 250 p. 1000 among poor. Dr E. Smith at Brompt. Hosp. fd that parents of phthl. parents att. it had on an aver. 7.5 children. Acc. to J.S. Mill "little advance can be expected in morality until prod. & pop. fam. is regd in same light as drunkenness or any other physical excess". Pop. fam. is regd in same light as drunkenness or any other physical excess".

At Brompton Hosp. hered. traced in 25% - in Dr C.J. Wms's priv. pat. in 12% direct hered. predisp., & in 48% fam. predisp.
Transmiss. comm. thro. mother; if one par. only affd. father trans. more readily to son & m. to daughter. Infl. of hered. seen in earlier (date of) attack than in any peculr. of symps.

After sewerage, deaths f. Phthisis fell 49% in Salisbury, 47 p.c in Ely, & 43 p.c in Rugby, & 41 p.c in Banbury

Overcrowd.g pred.s by foul air. Facts shew.g that incr.d density of pop.n meant incr.d mort.y fr. lung-dis.es. Dr. Greenhow's researches shew influ.ce of in-door occup.ns in badly-vent.d rooms. Haviland's compar.e mort.y of d.r. of two sexes, shew.g that highest d.r. alw.s fell on set work.g most in-doors assum.g that facil.s the most important constit.t of foul air, Dr Ransome points out that direct transfer.e by breath.n thus. died of phthisis, does not fit into all facts, esp.lly influ.ce of dry soil in dim.g Phth.s & ventures to say that absorption of bac.-outside body may incr.e its mort.y. Prof.r Brown's excess CO2 fav.s bacteria, & org.c matter

Of 6000 cases adm.d at Brompt. Hosp.l 2/3 had in-door occup.ns, esp.lly millin.s, sempstresses, & tailors.

Zeimssen says that imprison.t for 15 yrs is equiv.t to sentence of death by Phth.s

One contrib.g cause of mort.y of guards was prob.y the pipe-clay inhaled in clean.g their white cloth fatigue jackets

Army d.r. fr. Phthisis 11.9 p. 1000 form.ly, now 2.5 (Dr Ch.)

drainage works were completed, than in later years, because the sewer-trunks tended to become consolidated and impervious. The obvious inference from this is that inasmuch as sewer-pipes carrying off excretal products are required to be impervious, a separate system of sub-soil drainage is desirable. *(See page 298.)*

Overcrowding has a very important influence in producing phthisis. Dogs in badly ventilated kennels, horses or monkeys under similar conditions, not uncommonly die with all the symptoms of galloping consumption.

Dr. Parkes gives statistics from a badly ventilated prison in Vienna (the Leopoldstadt) which illustrate the same point. In the years 1836-47 the deaths were 86 per 1,000, of which 51·4 per 1,000 were due to phthisis. At the same period in the well-ventilated House of Correction in Vienna, under similar diet and modes of life, the deaths were 14 per 1,000, of which 7·9 were due to phthisis. Apparently then 43·5 per 1,000 of the deaths from phthisis in the former case were attributable to foul air (and possibly infection from one patient to another).

Examination of army statistics gives similar results. The Sanitary Commissioners for the Army, in a now celebrated report, found that before the Crimean War at least two soldiers died for one policeman. They eliminated from their statistics all foreign regiments; and,—spite of the fact that unsatisfactory recruits are rejected, and that soldiers are not more heavily worked and are better clothed than policemen,—they found that while in the Foot-Guards the mortality was 20·4 per 1,000, and in the Infantry of Line 17·8 per 1,000, in the Metropolitan Police it was only 8·9 per 1,000; more than half the high mortality in the first two being due to lung diseases, and especially phthisis. It was found that the air of the barracks was disgustingly foul, and that the men were crowded together in a very insufficient space. The ventilation and drainage of the barracks were improved, and a speedy improvement resulted. While thirty years ago phthisis killed eight soldiers per 1,000 every year, now barely three per 1,000 die; while formerly two

soldiers died of phthisis for every civilian, now four civilians die for every three soldiers.

As still further confirming the view that vitiated air was the chief cause of the excessive prevalence of phthisis in the Army, before and about the time of the Crimean War, we may note that during the twenty-two weeks in which part of the British Army was before Sebastopol, the mortality from every cause, including violence and accident, was only $12\frac{1}{2}$ per 1,000, or nearly $\frac{1}{3}$ less than that of the Infantry of Line, and $\frac{2}{5}$ less than that of the Foot-Guards in England.

The *possible contagiousness* of phthisis, under certain conditions, has been surmised in former times; but the facts bearing out this view have been so few, that it has not found general favour. But some recent researches go far towards disproving the ordinary views of the cause of phthisis. In starting, we must remember that consumption is a wide name, under which several different diseases have been included; the only true phthisis, however, being that characterised by the formation of small-celled growths, called *tubercles*. This is the form of consumption which is now asserted, under certain conditions, to be contagious. The facts on which this assertion is founded are two-fold.

1. It has been found that when tubercle is inoculated locally in any animal, it leads to the formation of a local tubercle, and after a variable time a large number of tubercles scattered throughout the body (general tuberculosis); and the virus increases in activity by inoculation in a series of animals. On the other hand it has been found that the tubercles produced by the injection of non-tubercular foreign matters never lead to general tuberculosis, and after several injections become quite inoffensive.

2. Koch has found in the true tubercular growths (and even in the expectoration of phthisical patients) microscopic organisms, which he calls *tubercle-bacilli;* these appear as delicate rods from a quarter to half the size of a blood-corpuscle in length, some of the rods possessing oval spores. These bacilli, which are really

Tubere. by inocul^{n} – many P.M. warts have been proved to cont^{n} tubere. bacilli. Case of porter securing body of pat^{t} who had died of Phth. tubere. nodules appeared on porter's arm & the event^{ly} died of mil^{y} tubere^{s}. Deutsche Med. Wochenschrift Mar 27. 90 gives case of chd æt 7 mos who accid^{ly} fell, head breaking a chamber utensil into wh. mother accust^{d} to expect^{te}. M. æt 25 had phth. & tubere bac^{i} in her sputa. Three suppurants on chd's head carefl^{y} dress^{d} w Hg Cl$_2$ sol^{n}. heal^{d} in 1 wk – 6 wks after two of scars swollen & a painful swelling in reg^{n} l. parotid Sm. ulcers found & absc. behind l ear, in wh. tub. bac^{i} fd. Chd died 4 mos after. Caseous glds fd in neck. A few tubere. nodules fd elsewhere. (Lanc. Apr. 90)

D^{r} B. Sanderson prod^{d} tubere. inf^{n} by inject^{g} cott^{n} thread under skin, but if sets are insert^{d} in Ac. Carbol. no tubere. prod^{d} Mat^{ls} susp^{d} of septic char^{r} prod^{d} tubere. even more read^{ly} than tubere^{s} mat^{l}. Wd appear that tubere. v. closely allied to Pyæ & among anim^{ls} diff^{ce} is simply one of degree. D^{r} Sanderson fd that inj^{n} of pus into rab^{ts} prod^{d} Pth f. & Pyæ abs^{t} in some, & in others tuberculosis. axis^{g} f. seat of inoc^{n}.

Chauveau fd that heifers might be infect^{d} by mix^{g} tubere^{s} mat^{l} f. their own species w. their food. Bollinger confirm^{d} this, but fd that Carniv^{a} cd be fed w. impun^{y} on fresh tubere^{s} mat^{l} taken f. anim^{ls} of bovine species

Tubere. in man freq^{y} a local dis^{e} – e.g. in joints. Lupus, shewn by Koch to be a tubere^{r} affn. of skin, but never prod^{s} gen^{l} tubere^{r} dis^{e}.

Close conn^{n}. of Koch's bacil. w. tubercle shewn by (1) its almost const^{t} presence in tubere^{r} cases: (2) its absence in all other dis^{s}: (3) the prod^{n} of the dis^{e} by inoc^{n} w. pure cultiv^{ns} of its colonies.

At Bromp^{t}. Hosp^{l}. p.c. of acq^{d} phthi in resid^{t} staff less than of most gen^{l} hosp^{ls}. Communic^{n} p. host^{d}. to wife maint^{d} by Virchow-D^{r} H Weber's cases. Weigert says meningi^{s} has been caus^{d}. by infect^{n} thro. upr^{r} nasal passages. Infect^{n} al^{y} canal by swall^{d} sputum.

Has been exper^{ly} proved that a tubere^{r} cow infects the sucking calf, & every reason to think the same true of human mother.

To prev^{t} Phthi. D^{r} Ransome (B.M.J. '87) recom^{ds} (1) disinfn. & dest^{n} of phthi^{l} sputum. (2) Discouragt. of marr^{e} betw. phthi^{l} subjects. (3) prev^{t}. of irrit^{g} dusts in workshops. (4) Discouragt. of stoop & confined posn in work. (5) betr. drainge of imperv^{s} soils. (6) provn of spēc^{l} vent^{n} in workshops offices, dwell^{gs} streets & crowd^{d} alleys.

minute vegetable growths, belonging to the class Schizomycetes, Koch was able to cultivate in a suitable medium outside the body; and after growing them for as long as fifty-four days, he inoculated various animals, producing tuberculosis in every case; while in similar check experiments in which all the conditions were the same, barring the absence of bacilli, no tuberculosis resulted.

That the tubercle-bacillus is the essential cause of tuberculosis seems fairly certain; and this fact does not in any measure contravene what has been said concerning the influence of a damp sub-soil or over-crowding in its causation. We may rather infer that the damp soil furnishes conditions favourable to the growth of the tubercle-bacilli; while over-crowding probably acts in the same way, and also by ~~actually~~ carrying the bacilli from the breath of one person to another. If it be true that phthisis may possibly be "caught" by breathing infected air, the importance of isolating consumptive patients and not allowing the healthy and diseased to sleep together becomes apparent. This has been already acted upon by the German Minister of the Interior as regards the state prisons. On the same principle the use of antiseptic inhalations has been found very valuable.

It was found by Koch that a minimum temperature of 84° Fahr. was required for the development and multiplication of the tubercle-bacillus. This may possibly account for the comparatively slight contagiousness of tubercle in this country, and also for the fact that in the south of Europe it is commonly regarded as a contagious disease. It will also explain the value of a dry and moderately cold climate in phthisis.

Prevention of Scrofula.—Scrofula is an affection of the lymphatic glands, most commonly of the neck, in which they become enlarged and inflamed, and commonly undergo chronic suppuration. The cheesy matter, which is usually found in the scrofulous glands, has been found to contain tubercle-bacilli, and we may regard scrofula therefore as a tuberculous disease, closely allied to phthisis.

But these bacilli do not appear to be always present, and it would seem that in many cases there is a preliminary condition before the formation of tubercle, in which cheesy matter may be present without tubercle. Similarly there may be a scrofulous condition of the lungs, having the symptoms of consumption, in the absence of bacilli.

Enlargement of glands is most commonly due to irritation of some neighbouring surface. Thus, the glands in the neck become enlarged in children from the irritation of sores or lice in the head, or in consequence of a discharge from the ears or a chronic sore-throat or the eruption of teeth. Usually these glandular enlargements subside when the irritation is removed, but in persons suffering from debilitated health or possessing an hereditary tendency to scrofula or consumption, the enlargement persists, and produces a cheesy degeneration of the glands.

The indications then in preventing scrofula are (1) to remove any skin or mucous irritation that may occur; and (2) to improve the general health by abundant fresh air, exercise, and food; thus removing the constitutional tendency. We may allude at this point to the fallacy of the popular notion that a discharge from the ear or a sore head must not be cured, lest a worse thing come to the child. Such a notion is productive of great evil, and many children's lives have been lost in consequence of it.

Prevention of Rheumatic Fever.—The occurrence of rheumatism is closely connected with a damp condition of the atmosphere and soil. In accordance with this, it has been found that the frequency of rheumatism (as of phthisis), diminishes when a good sub-soil drainage is established.

A serious chill, such as that from sitting in damp clothes, is the most common cause of rheumatic fever in predisposed persons.

The tendency to rheumatism shews a markedly hereditary character; in other words it "runs in families," the members of some families getting an attack on the slightest provocation, while others in the same circumstances escape. Not only is it hereditary,

Path? of Rhsm — 1. lactic acid theory
2. nervous theory.
3. germ theory.
4. malar. theory — a miasm generically allied to, but specifically distinct fr. the miasm of malª (Maclagan).

In Remit.t T. fois.n more severe than in intermit.
If Intermit.t T. severe than quotid.n, next tert.n, next quartan.
In many pts of Glos $\frac{2}{3}$ of mal.a is due to mal. fev.s & sequelæ. When a clim.e called 'unhealthy' simply means it is malar.s (Parkes)

Malar. in time of L. Mary when for potill purp.s lands allow.d to lie fallow.
Epid.cs die out at height of rainy season, but the dis.e is com.n ab.t in wet yrs. Dies out at height of rains.
Break.g up of virgin land, cut.g down woods, neglect to cultiv.e prev.s tilled lands, all favour mal.a
Malar.s distr.s occ.s dry, Eg. Roman Campagna, table land of Deccan. Marshy distr.s occ.s not malar.s
Ship malaria curious. capt.d 1/4 by neighb.g mal.s bef. Embarks.n 2/. use of H2O on board 3/. mingle ship p. might of Decay.g veg.e matt.r w. bilge H2O. 4/. derived fr. malar.s mud.
Rod-shaped bacilli w. Elong.d oval Spores. Some of these fd by Klebs in H2O of Campagna. This expl.s by fact that H2O prev.s devel.t of mal. poison. Bac.i fd in human fatal cases. After isol.n & cultiv.n they prod.d mal.a in animals
Dist.s of marshy distr.s E.g. Pampas of R. Plate states, & no mal.a
Also of mal.a in dry places, as hill fever in Deccan
Heine lays stress on am.t of Fe in calcite soils of hill fevers of Deccan.

Trop.l Dysent.y prevails in worst forms in mal.s locals. Exactly in same prop.n as mal.a banish.d fr. soil of St Bl.cs, typ.d has disap.d as an end.c (dis.e

but a previous attack renders one much more susceptible; as does likewise the occurrence of scarlet fever or child-birth.

The indications then in the prevention of rheumatism are to live in a dry place, to maintain the general health above par, and to avoid chills, particularly if one has had a previous attack of rheumatism or scarlet fever.

Gout is frequently mistaken for rheumatism, and the mistake is rendered greater by the frequent use of the hybrid term, rheumatic gout. Gout points as a rule to errors in diet, rheumatism to atmospheric conditions.

Prevention of Marsh Diseases.—Ague may be taken as the common name for the two chief varieties of marsh disease—intermittent and remittent fever. It occurs in low-lying marshy ground, which usually posseses a luxuriant vegetation, and a porous soil containing a large amount of decaying vegetable matter. In temperate climates it is most common in spring and autumn, and in the tropics occurs chiefly in the season of heat and drought following on the periodical rains. The upturning of soil which has been long untouched, has given rise to it in many cases. Damp, or a high temperature, or decomposing vegetation are not alone competent to produce it; but it is requisite that the soil should be porous and impregnated with water, and that the surface should then be quickly dried by a certain elevation of temperature (Bristowe). There can be no doubt that the malarious poison is exhaled from the soil along with the moisture, and more abundantly at night-time than in the day. In accordance with this, ground-floors of houses in ague districts are more dangerous to sleep in than are the higher storeys. In temperate climates the miasm is said not to mount above 500 feet, in tropical climates from 1,000 to 1,500 feet (Parkes). It is especially dangerous to sleep under trees in malarious places, as these form a kind of filter obstructing the poison.† The water of malarious districts should carefully be avoided, or only drunk after boiling.× The settled inhabitants of ague districts do not contract the disease so easily as persons newly arrived; negroes

× Bet. drink rain H₂O.

† A belt of trees betw. mal. place & house affords consid. protect. & a sheet of tar simil. exerc. an absorb. power.

for instance hardly suffering where Europeans rapidly die. It is important to remember also that when suffering from privation or fatigue, one is much more liable to an attack than when robust and well fed; and that one attack, unlike most fevers, renders the sufferer even more liable to subsequent attacks when fresh exposure occurs.

Ague districts may be rendered perfectly healthy by thorough drainage, as is shewn in the case of London, which was formerly marshy and aguish. The other points to be observed in the prevention of ague may be gathered from the above details.

Prevention of Rickets.—Rickets most commonly begins between the twelfth and eighteenth month of life. It is especially a disease of childhood, although occasionally developed as late as eighteen years of age; and is characterised by a softening and bending of the bones and an enlargement of them at their joint-ends. It is not hereditary; but is most common in children who are badly fed and live in the midst of unhygienic surroundings. Thus it occurs chiefly in poorer children, and among richer children in those who have been artificially fed, and have had amylaceous food too soon, and a deficient amount of milk. The influence of premature weaning on its production has been already described (*page 39.*)

For its prevention, the child must have abundant fresh air and warm clothing, and his diet must be carefully regulated, both as to quantity and quality. After its onset the same measures are required, together with others suitable for the prevention of deformities.

Fol.g soils have best veg.e manures (Pastures) – 1/. alluv.l soils, old estuaries, deltas
Marshes overflowd. by sea regul.ly are often healthy.
2/. sands, if imperm.e clay or marly subsoil
3/. lowest pts of chalk, where subsoil of gault or clay.
4/. weath.d granitic or trap rocks, if veg.e mat.r intermixed.
5/. rich veg.e soils at foot of hills.

Rickets not due to defic.y of Ca salts in food. No remedy so useful as Ol. Morrh. altho. cont.g no Ca.
Best substitute milk (milkmaid's hand) is more easily dig.d than cow's milk for young infants

Infect. Dis. 1. remark. uniformity in phen. manif. by each.

2. With exceptn of 1 or 2 sm. groups are communicable fr. one to another med. or immed.

3. Cause is sid. something mat. & ferm. to the body

4. Virus undergoes self-multiplcn.

5. Never arise de novo, or more accurately de nihilo.

6. In a cert. no. of cases cause has been proved to be a microbe.

Mortality of Typhoid fever – 17.4 % (Murchison) Aver. in chief hyg towns just now 11–12 %. Over 50 means ½ die.

Typhus F. – var. in diff. epids. – above or below Ty?

Measles – often 2–3 % – has risen to 30 % when crowding &c.

By far most in 2nd yr, after 10 is trifling.

Scarlet F. – a mort under 10 % moder. Max. 2–4th yr, contin great up to 10 or 12: by 15 has reach. minim.; then unlike Measles continues formid. thro. life, esp. to puerperium

Sm. Pox – among unvacc. pop. destroys ab. 10 % of pop.

Of unprotect. pers. attack. often 40 % die

Wh. Cgh – d. v. high in 1st yr, then dim. quicker than Measles.

Insignif. by 10th yr.

CHAPTER XXXVIII.

THE PREVENTION OF EPIDEMIC DISEASES.

Modes of Propagation of Epidemic Diseases.—Specificity of Contagia.—Germ Theory of Disease.—Modification of Bacteria by Alterations in Food, etc.—Two classes of Epidemic Diseases.—Small Pox.—History of Vaccination.—Theory of Vaccination.—Objections to Vaccination.—Scarlet Fever.—Measles.—Whooping Cough.—Diphtheria.—Typhus Fever.—Relapsing Fever.—Typhoid Fever.—Cholera.—Summer Diarrhœa.

Nature and Origin of Epidemic Diseases.—Epidemic diseases have also been called Specific Febrile Diseases, and Zymotic Diseases. The latter name has been given them on account of the resemblance to fermentation (zymosis) in their progress, but as this name involves a theory, the former name is preferable.

These diseases are characterised by certain definite characters.

1.—*They are usually infectious or contagious.* It is preferable to use these two terms as interchangeable, *contagium* signifying the specific poison (probably an organism) to which a fever is due. The modes in which infection is received vary greatly with the different fevers.

(1) Some can only be propagated by *inoculation*,—the introduction through an abraded surface of a minute quantity of the poison; such are glanders and hydrophobia. Others again *may* be introduced in this way, which are usually acquired in another manner, as scarlet fever, small-pox.

(2) Some are carried through the *atmosphere*. Small-pox can be carried as far as any poison, while the poison of typhus fever only traverses a few feet. The state of ventilation will greatly influence the contagiousness of fevers, and in all cases a stagnant air containing the poison is much more infectious than one frequently changed. The atmosphere may be loaded with sewer gases, which contain products from previous cases of typhoid fever, cholera, etc. The long-lived character of the contagia of these diseases is very remarkable.

(3) *Clothes*, books, and furniture are not uncommonly carriers of infection. An old letter, or a lock of hair, has even after many years' concealment in an enclosed space, produced infection on being brought to light. Woollen articles convey infection better than calico, and dark clothes better than light coloured. A fever nurse's clothes should never be woollen, but some other washing material.

(4) *Drinking water or food* are not uncommonly the source of epidemic diseases, usually from accidental poisoning of these by mixture with the contents of sewers, or by the absorption of sewer-gas. Milk and water are the two usual sources of infection. Cholera, typhoid fever, dysentery, and summer diarrhœa are the chief diseases from this source; but scarlet fever, and probably diphtheria, occasionally have a similar origin. Milk absorbs morbid gases and vapours with considerable avidity.

2. *They retain their specific characters and origin.* Small-pox never produces scarlet fever, nor *vice-versâ*; and it is found universally that all the specific fevers "breed true," each one retaining its identity. More than this, a previous case of the same fever can nearly always be detected on careful examination. Rarely do the infectious diseases appear to arise *de novo*, at the present time. It is true that unhygienic conditions, overcrowding, etc., increase the tendency to fevers, but these act chiefly by increasing the fertility of the special contagia. It cannot be denied, however, that certain conditions may possibly determine the change of harmless bacteria into pathogenic (disease-producing) organisms.

3. *A minute amount of the contagium*, if received into the system, is as certain to produce the corresponding fever as a large dose. The disease being due, in all probability, to the multiplication of minute organisms in the system, one organism will produce it nearly as certainly as a thousand.

4. *The behaviour of contagia*, when received into the system, is characteristic of these diseases. There is first of all a period of

For 65 yrs before 1846 no single case of Measles in Faroe isl.ds known to exist. In Sept.r 46 a sailor had ll arrived & an epid.c followed which attacked more than 6000 out of 7782 inhab.ts sparing only the persons who had previously had the dis.e & 1500 others who were kept out of the way of infect.n (S. Murphy).

Klein denies this

Quest.n of dosage seems to be a factor in infect.n
Dilut.n by air seems to stop infect.n of Typhus fever exhal.ns

Immun^{y} f. Dis^{e} – fertile soil req^{d} as well as seed. One attack to algæ ext^{n} protects Same seems true to some ext^{t} of common Thus in Fiji Meas. never known bef. Europ^{n} vis^{d}. the island In beg^{g} of 1875 the king Cacobau return^{g} f. visit to Eng^{d} – when M. prevail^{d}., lit back measles & ascert^{d} had the dis^{e}. One or 2 ships f. Austr^{a} also lit the dis^{e}. The dis^{e} 1st appeard in native constabul^{y} whose duty it is to board the ves^{l}, attack^{g} the whole no of them 147. Within 4 mos of a popul^{n} of 150,000; 40000 were dead of it. Find a pecul^{r} virul^{e} of the dis^{e} on such virgin soil.

Immun^{y} by one attack – it wd appear by compar^{n} of S. Pox, Typhus, Measles &c w. Scarl^{a} F., Diphth^{a}, Erysipelas &c, is in direct relⁿ to intens^{y} of contag^{n}, i.e. aerial communic^{n} of the different^{s} of dis^{e}.

U.S. Commiss^{n} in Rep^{t} on Epid^{c} of '73 give numer^{s} cases of 2nd attacks proving fatal in the same epid^{c}.

Immun^{y} by one attack or by inoc^{n} of modif^{d} virus is explᵈ? – 1/. that virus is livg matr wh. exhausts the soil of the livg animal – 2/. Virus does not exhaust soil. But as it grows prodˢ something pois^{s} to itself – wh. remⁿ in body after being prod^{d} by modif^{d} virus & prevˢ devel^{t} of more deadly virus. 3/. Whether virus is livg matr or not, protect^{e} result is due to Yeast plant pois^{g} by alcohol
educ^{n} of protopl^{c} cells of wh. animal consists. Ex Plunge rumsel f. sea into fresh H$_2$O. shell open & it dies – treat it first w. tackish H$_2$O & no injur^{s} result. Tolerˢ of As &c by grad^{l} incr^{g} doses.

latency or *incubation*, during which no symptoms are manifested. This period varies for the different diseases, being two or three days in scarlet fever, ten days in small-pox and measles, ten to fourteen days in typhoid fever. In the case of hydrophobia, it may be several months; and in ague, several years. The incubation period is followed by the characteristic symptoms of the particular fever, which disappear in a variable period, leaving the patient, as a rule, *insusceptible to a second attack.* The contagium seems to exhaust the soil in which it grows.

Throughout the progress of the disease, except in the period of incubation, the patient is able to communicate his disease to persons about him who have not been rendered safe by a previous attack. The way in which he thus communicates his disease varies in different cases. In scarlet fever, the skin and throat are the chief sources of contagion; in influenza, whooping-cough, and measles, the breath and secretions from the respiratory passages; in hydrophobia, the saliva; in typhoid fever and cholera, the vomit and stools (and these especially if allowed to remain about; at first they are probably not infectious).

Character of Contagia.—(1) When we remember that the contagium of a particular fever produces that fever and nothing else; also (2) that the contagium, however minute in quantity, multiplies indefinitely in the system—and that one patient could, if brought in contact, furnish a supply of infection sufficient to convey his disease to thousands of persons—we are almost forced to conclude that these contagia must be living organisms.

This inference is borne out (3) by the analogy of the brewing of beer, the souring of wine, or of milk—all of which, as well as many other processes of a fermentative and putrefactive character, have been proved to be due to the growth and multiplication of microscopic fungi; and (4) by the knowledge that such microscopic *germs* are present in great numbers in the atmosphere.

There are special organisms (called *Bacteria*) for every specific fever (just as there are special seeds for every plant); and although

wonderfully minute, each of them (like the one mentioned as occurring in phthisis) has a special family history of its own. But, although this is true, it has been shown that the character and virulence of Bacteria can be modified by the *medium in which they are grown;* and it is quite within the range of possibility that the fever-producing Bacteria are modified forms from other Bacteria, which were formerly harmless,—virulence having been acquired, in consequence of the uncleanliness, overcrowding, and starvation which have been so common,—these providing a suitable soil for the acquirement of such properties. Experimental observations bear out this view. Thus Pasteur has actually produced from a harmless Bacterium, one which gives rise to a fatal disease (Bacillus anthracis). On the other hand, the Bacillus to which splenic fever (malignant pustule, wool-sorter's disease) is due, has been propagated outside the body, and so weakened as on inoculation in animals, to produce a modified and slight splenic fever, which, while it absolutely protects against a subsequent attack, does not produce any severe symptoms.

The importance of these researches cannot be exaggerated. They teach us two lessons, which may probably be applied to *all* specific fevers: (1) the specific germs of these diseases are capable of propagation outside the body; and (2) the virulence of their poison depends largely on the soil in which they grow; hence personal and general cleanliness and ventilation are of the highest importance.

Prevention of the spread of the Chief Epidemic Diseases. We may divide the epidemic diseases into two classes. (1) Those which are infectious by contact with the patient or by the atmosphere around him. (2) Those in which the intestinal evacuations are alone contagious; as typhoid fever and cholera. It is evident that the former are by far the most dangerous as regards infection, and that for the latter the only requisite is to thoroughly disinfect the evacuations and secure that they do not obtain access to drinking water, milk, etc. The three chief measures available in any case are (1) Isolation, (2) Disinfection, (3) Vaccination of an attenuated virus. These will be discussed in detail afterwards.

Klein discov^d that hep-typh^d. i.s. pneumo-Sentitis is
characterized by a specif. organism wh. is its cause & wh. can
be cultiv^d. & then the dis^e prod^d. fr. the cultiv^d organism

This now more than doubtful

Pseudo-scrobillary pheu^a obsev^d by Dr Salisbury among the
Confed^e troops in Amer^a civil War as result of sleeping on mouldy
straw_ (W)

Dur.g last 21 yrs in Lond.n S. Pox has been grad.y gaining ground.
Hosp.ls neces.y for isolat.n Evid.ce that asyl. bd Hosp.ls incr. S. Pox in immed.e neighb.d ¼ mile circles drawn by Mr Power round Fulham hosp.l shew.d stead.y decr.g mort.y
Cert.n that pers.l communic.n often the cause of inf.n - as by convey.e friends letters, nurses, sewers &c. are Hosp.ls centres of infect.n per se? Some limit infect.n to 10 yds, others 1 to 2 ms. The gradat.d intens.y of infect.n shewn by Power is a strong argum.t for aer.l infect.n Many cases could not be traced to any comm.n: also those in lines of human intercourse did not specl.y suffer. Evid.ce in disproof of pers.l comm.n neces.y negat.d incompl. Also held that escape of those liv.g near S. P. hosp.ls agst aer.l infect.n

Epid.c prevl. contrld.d by var.s factors. Infl.ce of an accum.n of suscept.e pers.s in interv.s betw. epid.c prevl.e has to be consid.d After 1840, fluct.ns of S. Pox observ.d to have a close relationship w. fluct.ns in qty of unvacc.d chn. - so close that perd. of recurc.e of epid.c S. P. cd be pretty accur.ly forecast.d - but in 71 when one of these recurr.d due, some other undetermd cos. (? secular evolut.n rel.g to undetermd cosmical phen.a) gave rise to the epid.c of 71 & 72, wh. diff.d fr. any epid.c since pers.l introd.n of S. Pox

The gt epid.c of Syphl.s in 15th Cent.y, the excepl.l devel.t of fatal diar.a in this cent.y, gt devel.t of Diphth.a in last 30 yrs (a dis. wh. had been nearl forgott.n), recent appear.ce of Cer. Spinal Fever, - are evid.ce of secular pathl changes, touch. a clue sought by study.g rel.e to secular meteorl & telluric changes. (N. Radcliffe)

Why is Chol.a now endc. when epid.c brought. to India, & then spreading pandemically fr. Dr Bryden has shewn that the diff.t devel.ts of Chol.a within India have v. definc. rel.ns to partic.r meteorl phen.a. Blandford's results tend to shew a close rel.n betw. the gt cycles of meteorl change in India, & cycles of meteorl change in the sun's atmosph. sppl as observ.d in the sun-spots per-

Small-pox. The contagium of this is very strong; and may be wafted from one side of a street to another. All parts of the body and all secretions and excretions contain the infectious material. Not only does it fix itself, as in typhus, to every article in the room, but is possessed of great vitality, and if not exposed to the air may be active after many years. To prevent the spread of the disease, the patient must be isolated; the attendants must have been re-vaccinated; the room must be well ventilated; all extraneous furniture, such as carpets and curtains, should be removed and disinfected; disinfectants should be constantly employed in the room; after convalescence the bedding and clothing should be stoved or burnt; and the room thoroughly disinfected. All persons over twelve or fourteen years of age, and all children whose vaccination marks are not large and distinct, should be at once re-vaccinated.

The chief measure in the prevention of small-pox is vaccination; and had this been universally adopted and efficiently performed, there can be no doubt that small-pox would be now extinct. The history of the origin of vaccination is highly interesting and instructive. Before its discovery, small-pox was an utterly loathsome disease; and, even if it did not kill its victim, involved serious consequences, such as blindness, deafness, deformity, and impaired health. In 1796, the year in which vaccination was introduced, more than 18 per cent. of the total deaths in Great Britain were due to small-pox; and in 1772 they were as many as 15 per cent. of the total mortality. Inoculation of small-pox, in order to produce a milder attack, was commonly practised; but inoculated small-pox was occasionally fatal, and it had this grave and insuperable drawback, that every case of inoculated small-pox became a fresh focus of infection, to which young children especially fell victims.

About the year 1795 Dr. Edward Jenner was informed by a milkmaid that she could not take small-pox, as she had already contracted the natural cow-pox during milking. Many had previously heard this same statement made; but Jenner was the first to put

the matter to the test. He took the lymph or virus from a woman who had accidentally acquired cow-pox (vaccinia) from a cow, and inoculated a boy with it. Some months later he inoculated the same boy with small-pox, and a second time five years afterwards, without producing small-pox on either occasion. Many other experiments were made, all confirming these results; and in 1798 Jenner published his results. Dr. Woodville, of London, confirmed these facts, vaccinating within two years as many as 7,500 persons, and subsequently inoculating about half these cases unsuccessfully with small-pox, and in other ways exposing them to the small-pox poison without any result.

The practice of vaccination gradually became more general, with the result of a progressive decrease in the mortality from small-pox. In the three years preceding 1840, the average yearly number of deaths from small-pox in England was nearly 12,000; during the years 1841 to 1853, in which vaccination was provided by the Government gratuitously, but was not compulsory, it was under 5,250; while, from 1854-63, after vaccination was made compulsory, the average annual deaths were only 3,350 (*see also page 9.*)

An analysis of 6,550 cases of all ages admitted into the Homerton Small-pox Hospital, from February, 1871, to December, 1878, shews that the mortality in the unvaccinated was 45¾ per cent., in those stated to have been vaccinated but without scars 27¼ per cent., in those vaccinated and presenting imperfect scars just over 11 per cent., while in those with good scars it was just under 3½ per cent. The exceptional occurrence of small-pox after good vaccination, is explained by the peculiar proclivity of some persons to catch infectious diseases: thus second and even third attacks of scarlet fever and measles are known to occur.

We may regard vaccine lymph (cow-pox or vaccinia) as being small-pox modified and mitigated by its passage through the system of the cow. Vaccination, using the word to signify the inoculation of a mitigated virus, is at present only practised for small-pox; but what was discovered to all appearances accidentally

Vacc^{n} differs fr. inocul^{n} Sm. pox in 3 points —
1. Gen^{l} susptᵇ of S. P. does not occur. 2. It is not communic^{d} from person to person exc. by inocul^{n} & 3. does not endanger life.

Cow & Horse Pox differ f. other Varᵉ bec. 1). only commᵈ by direct contact or inocⁿ, 2. no severe febrile symps, 3). confined to limᵈ pt of body.

4). French theory – (Chauveau, Fleming &c), descᵈ 4 pms of Varᵉ, in 1st infectn volatle. in 2nd fixed. Thus while Sheep Pox & Sm. Pox, 2 v. simr. disᵉ are not mutually protective, inocⁿ w. Cow Pox a v. dissimr. disᵉ does protect managst Sm. P. forms pvtv to Cow pox owing to Sm Pox.

5). 2nd theory regᵈ the true Varᵉ as so many distinct specific disᵉ, while Cow & Horse Pox not specific indeptly, but only instᵗ of cultivⁿ of S. Pox virus in unnatl soil. On this supposn immunⁿ by vaccⁿ easily understd.

Jenner suggestᵈ identᵗ of disᵉ of Cow & Horse wᵗ Sm. Pox. He maintᵈ that Cow Pox derived f. "horse grease", instᵈ its absence in Ireland where men never employᵈ in milking.

Ceely obtᵈ lymph by inocⁿ S. Pox in Cow, vaccᵈ sev. hundᵈ chn w. it. Dr Martin of Boston in '60 setup epidc of S. P. by attemptᵍ to exptᵗ this – just since variol pus then reinocⁿ his patⁿ w. this.

Voigt at Hamburg inocᵈ 4 cows w. virus f. confltᵗ S. Pox. Only in 4th case a sm. vesᵗ for a few hrs. He contind inocⁿ w. this on calves for 15 generⁿˢ, w. incᵍ ease. He used lymph of 1st cultivⁿ w. v. severe symps (6 nodules formᵍ fluctᵍ tubercᵍ) 3rd generⁿ high fever but normal vaccⁿ. After 8th cultivⁿ ordy results.

Acc. to Voigt wᵈ vaccᵗᵉ alleged case of spontᵉ C. Pox is acᵗᵈ variolⁿ or retro-vaccⁿ In pre-vaccⁿ times mixed Pox, wh. compensᵈ for diffᵗ of the inocⁿ how vaccⁿ more comⁿ as f. mothˢ had vaccᵈ chn

Horse Pox eqˡ protectᵍ w. C. Pox agst Sm. Pox: local symptˢ more severe tho less gen than of C. Pox

Deprivᵈ of power of givᵍ lymph by passᵍ thro. an anim. incapˡ of taking this

Marson said "suppose an unvacc^{d} person inhale Vac^{a} germ on Monday, if vacc^{d} as late as fol^{g} Wednesd., no S. Por wl be devel^{d}; if put off till Thursd. S P. wl. appear but modif^{d}; if delay^{d} until Friday, it wl be gnouse: it wl not have time to reach the stage of areola, the index of safety, before the ill^{s} of S.P. begins.
In Lanc. Jnl '80 said that Russ^{n} student by repeat^{d} vacc^{n} in three succes^{e} days, was able to prod^{e} matured vesc^{s} in 4 or 5 D.

Only fair to state that Pasteur's vaccines have signally fail^{d}. whenever tried by others – even by his own pupils abroad.
In 1883 an outbreak of dis^{e} among cattle in Argentine Repub^{c} so destruct^{e} occurr^{d} that D^{r} Roy of Brown Distct^{n} was sent to investig^{e} it This was Anthrax – Roy returned & discov^{d} that the prairie dog, a rodent, cd be inoc^{d} w. A. & that if the spleen were taken fr such an animal wh. had died of the dis^{e}, & the virus it cont^{d} used for inoc^{n} of cattle, a mild non-fatal form of dis^{e} was prod^{d} wh. protect^{d} agst subseq^{t} attack.

Justif^{n} of Vaccin^{n} – shd only be done for a dis^{e} wh. with^{t} it is nearly inevit^{e} & mort^{y} great. Wd not be worth while for Measles as mort^{y} fr this v. small, unless fr prev^{e} neglect. Wd not be justif^{d} for Hydrophobia even tho. its mort^{y} is 100 %, if mort^{y} fr vacc^{n} were 1 in 1000, &c. & this fr this dis^{e} are only 1 in 10000 of popul^{n}

Expert of Leicester, 2000 ch^{n} unvacc^{d} accum^{d} ea. ep. But three cases imported (24 visit^{s}) the sam^{e} med^{l} & nursing staff & all friends of pat^{s} are revacc^{d}.

in the case of small-pox, has lately in the case of splenic fever been discovered by cultivation of the virus outside the body, and the production of an artificial mitigation. And in France this principle has been already applied for the prevention of splenic fever (charbon) in cattle, and thousands of lives and much money have thus been saved. Similarly in the case of hydrophobia, animals have been protected from subsequent inoculation of unmitigated virus, by the venous injection of a modified virus. It is quite possible that this principle of vaccination will become still further extended in the future, and that we may be able safely and certainly to prevent the onset of any fever.

Objection is taken to vaccination for small-pox, on the ground that constitutional diseases may be inoculated at the same time. There can be little doubt however that with lymph carefully obtained, and unmixed with blood, this is impossible. Most of the cases of constitutional infection described have been in reality hereditary disease, the local irritation of vaccination serving to call into activity the morbid tendencies of the child. Even supposing it correct that some evil constitutional tendency may be introduced by vaccination (which we deny except in very rare instances, where the vaccination has been carelessly performed), the cases in which this occurs are so very few, that we are bound in our own interest to incur this remote risk, rather than the more certain risk of such a loathsome disease as is small-pox in its unmitigated form.

In answer to those who maintain that vaccination ought to be made optional, it is only necessary to say that the persons who would elect to remain unvaccinated, involve their children, who necessarily must abide by their parents' choice, in the same risk of deformity and death; and that all young children below the age when primary vaccination is considered advisable, are similarly involved in risk.

Scarlet Fever.—Scarlet fever is one of the most dangerous and contagious diseases known. It may attack persons at any age, but especially children under five years old. Its contagion

is very powerful, like that of small-pox, so that it is impossible to remain in the same room, or even in the same house, without great risk of infection to all susceptible persons, unless strict isolation is maintained. In many cases, second and even third attacks occur, but these are the exception; usually one attack confers immunity from the disease. It is well to get rid of the idea that *scarlatina* and *scarlet fever* are distinct diseases: they are one and the same disease, and, therefore, equally infectious—the name scarlatina (which would be better abolished entirely from our nomenclature) simply indicating a milder attack.

The disease is infectious during every part of its course, and *until after every scale has been completely peeled off the body.* Each scale is loaded with the specific poison of the disease, and ought to be prevented from floating about the room, or settling in various parts. This is done by keeping every part of the body oiled with olive oil, to which a little carbolic acid has been added.

The contagium retains its virulence for a long time, and persons sleeping in the room occupied by a scarlet fever patient months previously, have been known to contract the disease. The poison may likewise be sent from one country to another in an infected envelope or article of clothing; and where scarlet fever has occurred in a milkman's house, his customers have in several instances had the disease brought to them with their daily supply of milk.

In addition to keeping the body constantly oiled during the process of *peeling*, it is important that all cups and plates, and all soiled linen should be soaked in a weak carbolic solution or some other disinfecting liquid before leaving the room. The nurse ought not to enter the kitchen, nor be in direct communication with the rest of the house. No food should be allowed to leave the room and return to the kitchen. All the evacuations should be disinfected before removal.

After the patient has left the room, the bedding and mattresses should be removed and disinfected by great heat. The wall-paper

2/3 of Sths bef. at 5. D. r. alt. 472 p. 1000.
Autumnl. incr. of mort. Epid. recurr. ev. 5 a 6 yrs.
Defect. drain. aggrav.

Maxim. of Sc. fev. in Nov., of Zy. in Oct - Nov.
Minim " " " Mar. " " " Apr.

Under Contin. Fever - prob. some cases of Zy. Septic., Pn. &
Tuberculosis included.

must be removed, and the room thoroughly fumigated with burning sulphur, and afterwards washed with disinfecting fluids, and allowed to lie fallow for some time before being re-occupied. All toys and books which have been in the room must be burnt.

Measles.—Here again the disease being extremely contagious, the same principles must guide one in preventing its spread as in scarlet fever. The patient should be carefully isolated, throughout the whole course of his disease, as infection is possible in the stage when there is simply a cold in the head without rash.

Inasmuch as measles is commonly not so dangerous as scarlet fever, the precautions for preventing its spread are, as a rule, neglected. It would be well if the common notion that measles, whooping cough, etc., must be had once in a life-time, could be eradicated. The idea seems to be prevalent that one must, so to speak, graduate in infectious diseases, and some even go so far as wilfully to expose their children to infection; or, if one has received an infectious disease, straightway put their other children in the same room, "to have it all over at one trouble!" Such an opinion concerning infectious disease is pregnant with evil results. (1st) Severe cases of these so-called inevitable diseases occur, in which a fatal result ensues; and even where death does not occur, the child may be left weakly and enfeebled in constitution. (2nd) Every additional case forms a new centre of infection. It is like the old practice of inoculation for small-pox: the individual is protected, but becomes a source of danger to all around him. If there is only one case of measles in a family the risk to neighbouring households is much smaller than where several children are infected. The wilful or careless multiplication of sources of infection prevents the desirable annihilation of measles and all other fevers, which is, with proper precautions, quite possible.

Whooping Cough.—Very few people have reached an adult age without having suffered from this disease, as well as measles. But the universal prevalence of these two diseases is chiefly due, as already stated, to the carelessness in mixing infected with healthy

children. One not uncommonly hears the peculiar and characteristic cough of a child with whooping cough, in public assemblies, in railway trains, or in the out-patient rooms of hospitals. The contagion of whooping cough, like that of measles, seems to be capable of travelling a considerable distance, so that isolation must be very complete in order to prevent infection. Clothing, again, conveys the infection easily; visiting of infected children should, therefore, be prohibited to all who have to mix with susceptible children.

The sick-room should be fumigated with carbolic spray, the bedding carefully disinfected, and preventive measures carried out almost as thoroughly as in the case of scarlet fever.

Diphtheria.—Diphtheria is closely associated in its origin with defective drainage. Unless there is a history of direct infection from another patient, we may assume that it is due to foul effluvia from cesspools or drains, or to drinking water or milk, polluted by sewage contamination. It is important, therefore, that the sanitary condition of the house should be at once investigated and all defects remedied. In the meantime, the drains should be flushed, and disinfectants freely employed.

The infection of diphtheria is not capable of being carried far in the atmosphere, being conveyed almost solely by the secretions from the throat, or by the excreta. It is important, therefore, that all the evacuations should be immediately disinfected, and that the breath of the patient should not be inhaled; kissing of the patient should not be allowed. The expectoration should be received into a vessel containing a disinfectant. It is advisable to use small pieces of calico to wipe the mouth and nostrils, and burn them immediately afterwards.

Diphtheria, like scarlet fever, whooping cough, etc., is very apt to be propagated in schools, by children breathing one another's breath, when apparently convalescent; and as attendance at Board Schools is becoming better enforced, there can be no doubt that this source of infection will increase, unless special precautions are taken.

Wh. Cyle most fatal to the youngest chn. Comes next to Sc.f. among 3ry c dis? in fatal? 3/4 of Dths are of chn under 2. Dths of girls nearly 1/3 more than of boys.

D. Turner's report to Loc. Govt. Bd shews that simil dis? in pigeons & fowls fed by human Diph? Pos? closely allied but not ident.l dis? Cats appear may be infect.d f. human beings (13 M. J. Aug. 87)

D? Thursfield (Pub. Health Sep. 90) thinks that comm.n of D. w. filth much has been exagg.d. Too little attn paid to overwhelming influ of personal infect.n Import.e of guarding agt infect.n f. slight cases. Struct.l damps of hse & site combined w. excluded sunlight & impeded air circul.n more closely comm.d w. D. than human off-scourings. Close comm.n w. new & theref. damp hses. Rise & fall of subsoil water nothing to do w. it if struct.l & atmosph. of hse not affect.d

Klebs, Roux & Yersin at Pasteur Inst.e f. Vet. Diph.c germ if protect.d from air & light may be kept an almost indef.e time & still prod.s char.c symp.s in animls inoc.d w. it, but if exposed to air & light it speed.y loses its virul.ce

May now make use of presence or absence of char.c bacil. of Diph.a for purpose of pract.l diagnosis.

Never able to estab. comm.n betw. D. & contam.d water.

D? Ross's experts afford presumptive evid.ce that diph.c germ falls harmless on a healthy & unabraded mucous mem.e This may expl.n why so often follows Measles &c. f. Catarrh sore throats f. wet shoes & clothes frequ.t precursors of D. Cases of infect.n f. cats given by Thursfield & Dr Q & Spa a mem.s a char.c symp.m but by no means constant - injected to old Engl. name Croup & Cynanche.

The hist.ʳ of Typhus is the hist.ʸ of human misery

Even Murchison admits that autochthonous origin of T. is not unassailable.

Typhus Fever.—This disease was formerly known as spotted or jail-fever, and for many ages has been the scourge of prisons and armies, and all collections of people living in over-crowded places, with unsanitary arrangements. It is essentially a disease due to filth, over-crowding, and destitution; but when once established by these conditions, it is capable of being carried by infection to others who live amidst healthy surroundings. It generally occurs in winter, when over-crowding and the consequent foul air are most prevalent; and the first principle in preventing its spread, is to have free ventilation, even though it be at the expense of warmth. With free ventilation, the disease cannot be carried more than a few feet. Indeed, typhus fever (as well as diphtheria) patients are not uncommonly placed in hospitals in the same well-ventilated ward as twenty or thirty patients suffering from other diseases, without the spread of infection. It is important that several typhus patients should not be collected in the same room, as thus the danger of infection is greatly increased.

The main points requiring attention are,—the isolation of the sick as far as is possible; the attendants should by preference have had typhus fever previously; the rooms should be freely ventilated by open windows and fires; all carpets, curtains, etc., should be removed and disinfected; disinfectants should be used in the room, and the excreta received into these; after convalescence the bedding and clothing should be disinfected or destroyed, and the whole room thoroughly disinfected.

Relapsing Fever.—This disease was formerly common in this country, but except in some parts of Ireland has entirely died out. In Russia it is still prevalent. A peculiar Bacillus (Spirillum Obermeieri) has been found in the blood in this disease, the occurrence of which always corresponds exactly to the paroxysms of the disease.

Epidemics of relapsing fever generally follow in the track of typhus fever; and it would seem that over-crowding and filth are the special causes of the latter, while an impoverished condition

and starvation along with a continuance of the over-crowding cause the former.

Typhoid Fever.—The diseases hitherto considered are contagious, that is, can be propagated by the atmosphere surrounding a patient or by actual contact with him. Typhoid fever, cholera, and dysentery on the other hand are not so contagious, but only through the stools or vomit of the patients; which again probably never communicate infection in the fresh condition, but only after being kept a day or two. It is, therefore, essential in the treatment of these diseases, that the stools should be immediately disinfected, and got rid of at the earliest possible time.

Disinfectants should be placed in the bed-pan before its use, and an additional quantity added afterwards. In the country, it is preferable to bury the stools at a considerable distance from any source of water-supply,—earth being an excellent disinfectant. In town they are commonly emptied into the water-closet without complete disinfection, and are carried into the sewers until defective traps or badly-ventilated drains allow the entrance of sewer gas into the house, carrying with it the specific poison; or until the water-supply becomes contaminated with sewage in the house or before its arrival there.

Wherever any danger of typhoid fever, cholera, etc. exists, ensure: (1) that the water-closets have a separate water-supply from that used for drinking purposes, and that there is no possibility of one supply being used for the purposes of the other; (2) that all sink-pipes, waste-pipes, etc., be disconnected from the drain, and the soil-pipe thoroughly ventilated; (3) that all water be *boiled* and filtered before using, and no unboiled milk be drunk.

Isolation is not necessary for typhoid fever patients; but perfect cleanliness is essential. The evacuations and all tainted clothing must be thoroughly disinfected.

The origin of typhoid fever (also known as enteric fever) is somewhat doubtful. All are agreed on one point—that it is a

"Of all the Dis.s attributable to filth, this as an administrative scandal, may be proclaim.d as the very type & quintessence" (Simon)

Report on Chol.a in Europe & India by Dr Shakespeare (Washt.n - Gov.t Printing Office 1891) cont.s fullest inform.n on subject.

Is "see Naples & die" has a terrible literal mean.g after the late Epid.c of Chol.a

Ferran's Chol.a inocul.n proh.d a fallacy. Buchner & others expert.d than Ferran, yet his alleg.d transmut.n of Bac. subtilis into Bac. anthracis twice versâ now gen.l discred.d - as errors of observ.n incid.t to employ.t of fld media for cultiv.n Results of Ferran's inocul.ns do not prove prod.n of undisp.d Chol.a Diar.a collapse & may be prod.d by septic pois.g Ferran has never demonst.d the further develop.t forms of Bac. Comma.

Some recess.l obscur.l Rec. of non-mutual communic.ty of spec. dis.s of man & anim.ls Tubercl.e comm.n to both; anthrax, glanders & ft & mouth dis.e comm.n to each as such, rabies to man as hydrophobia. Diphth.a is comm.l mechang.d to anim.ls; S. Pox Rheum to monkeys only. W. this except.n varied dis.s of man & anim.ls Rec. Enthetic only or inocn in diff.t anim.ls So far as we know. Chol.a Typhus, Ent.c, Sc.f. Measles & pecul.r to man; While Pig-typhus & scarlet f.. Cattle plague & are essent.y distinct & incomm.e

Leprosy not transf.d to anim.ls Rinderpest, Nag.a Guinea Worm

filth disease; the only point in dispute being whether it can arise from unsanitary conditions alone or requires the importation of a previous case. It occurs especially where the contents of a drain or cess-pit are allowed to remain stagnant and decompose, and then obtain access to drinking-water; though whether the emanations from such a source alone suffice to cause it is doubtful (*see also pages 126 and 164.*)

"Gastric fever," "low fever," are names given to ill-defined cases of typhoid fever, and these are especially dangerous to others, as, owing to their real nature not being recognised, the evacuations are not properly disinfected.

Cholera. — Cholera, which was formerly so common, now seldom occurs in this country. In its mode of prevalance and propagation it is very similar to typhoid fever, not being contagious, except through the evacuations. The colourless watery character of these increases the risk of accidental tainting of the room; disinfectants should therefore be freely used in the room, as well as in the bed-pan; and linen and bedding should be carefully disinfected. The aerial propagation of cholera is asserted by some, and in case of an epidemic it would be wise to act as if this view were correct, carefully isolating all patients. It is certain, however, that the chief, if not the sole, mode of origin of cholera is through drinking water contaminated with the choleraic poison.

The same precautions respecting the drainage arrangements of a house should be taken, as in the case of typhoid fever; and all water and milk drunk should be previously boiled.

The same remarks apply to **summer diarrhœa** which is nearly always due to the drinking of water containing some organic poison. Any possible contamination of water must be carefully avoided, and all water must be boiled before drinking. This is a question of great importance, as the mortality from summer diarrhœa, especially among young children, is very great.

CHAPTER XXXIX.

ISOLATION AND DISINFECTION.

Necessity for Isolation.—Legal Penalties for Neglecting Isolation or Disinfection.—Disinfectants.—Deodorants and Antiseptics.—Fresh Air and Cleanliness.—Heat and Cold.—Modes of Applying Heat.—Sulphurous Acid.—Chlorine.—Iodine.—Nitrous Acid.—Carbolic Acid.—Permanganate of Potass.—Sulphate of Iron.—Chloride of Zinc.—Chloralum.—Sanitas.—Terebene.—Charcoal.—Practical Disinfection.

Isolation.—The isolation of patients suffering from infectious diseases is of the utmost importance, in the interests of the community. This and disinfection are our only resources in preventing the spread of the contagious diseases, to which the process of vaccination is not yet applicable. It is essential that this isolation should be strictly maintained, not only in scarlet fever, small-pox, and typhus fever, but also in measles and whooping-cough, in which it is too commonly neglected.

Isolation should be maintained in every case, until the absence of infection is ensured. The sending to school of children just convalescent from infectious diseases is a common cause of epidemics. Mild cases of diphtheria may be unrecognised, and lead to the infection of other children by kissing, etc. Similarly children who have not finished peeling from scarlet fever, or who still have a slight whoop from whooping-cough are not infrequently allowed to mix with other children.

No child should be allowed to return to school after suffering from an infectious disease, without a doctor's certificate.

Certain legal penalties are incurred by those who expose themselves or their relations, while suffering from infectious diseases. Thus, if a person suffering from any dangerous infectious disorder, enters a cab or other public conveyance, without informing the driver of his condition, he is liable to a penalty not exceeding £5. Similarly, any person suffering from any dangerous infectious disorder, who exposes himself in any street, school, church, theatre, or

Quarantine – of indivls or communs, or of objs as luggage, ships &c.
Also inland & maritime. Inland quar. appears never enforced in this country.
Quar. 1st for leprosy (mal de St Lazare) hence lazaret. Quar. bec. 40 d.
Neglected B. & Ireld Quar. Act of Ses. IV – can. out not by L.G.B.d but by Privy Council aidd by Bd of Trade. Maritime quar. has been appld only to 3 dis.s, Plague, Chol. & Yel. F. Agst Chol. not enforc. since '58. Only Y.F. now subj. to it, & this for. com. exigencies.
System of med. inspect. diffs for. Quar. – bec. 1). affords such ships as reas. grd for suspect. have been infect. w. chol. or chol. diar.
2). Provides for detent. of ves. only as long as req. for med. inspect., for deal. w. sick, & carry. out disinfn. 3). Subjs healthy on board to detent. only so long as neces. for med. insp. & sanit. cond.
Machin. of Quar. Act maint. for obt. inform. of exist. of infect. dis. on board foreign-com. ships, & made avail. for all simil. dis. whether quarantinable or not. Duty of Customs to make enquiries of master of vessel, & if any infs. dis. to det. vessel & inform M.OH. of Port.
Quar. revived for Plague at time of recent alarm on Contin., to meet req.ts of other nats who fail. its adopt. here, wd be likely to impose disabil.s on our ships. w. req. to these dis.s

Compuls.y Notifn of Infect.s Dis.e — Objns 1. opposed by gt majority of med. men. 2. Tends to excite ill-feel.g between gen.l pract.rs & san. auth.s 3. Promotes the conceal.t of dis.e 4. Best spread of dis.e. prevs by cases treated by med. men.

Object of notifn not simply regist.n, but prevent.n of dis.e Without power of removal compuls.y notifn of dis.e wd be of comparat.y little avail (Com.rs on S.P. & Fev. Hosp.ls). When pat.t cant be removed with.t risk, san.y A. shd have power to clear use of other inmates, so far as necess.y for isolat.n

In the towns where Compuls.y Not.n has come into force, chief benefit has been attain.t of power to stamp out an epid.c in bud, Leicester with its juvenile popul.n largely unprotected by vacc.n a remark.e example. Compuls.y Not.n see letter re Reading Lanc. Oct. 87.

May be advis.e occ.y to include Measles in Compuls.y Notifn

Householders bet.r with.t disinf.ts smells closet means bad custom a nuisance

Fol.g good disinf.t for warm weather, as given by a Dr to his pat.t —

R. Brush 1, Pail 1, shovel 1, Wheelbarrow 1, broom 1, cloth 1, soap ad lib. 3 aqua pura quantum sufficit (plenty of clean H2O)

(Add a sufficient qty of brains & muscle to cause the whole to be vigorously worked. Use in large qts till complete relief is obtained

Every subst.e in fine powder disinf.ts, whether pt powd. or powd. Sandst. In such bod.s surfs is greatly incr.d, & surfs attract air, thus caus.g oxid.n The steel is the best agent for purif.g & disinf.g

Alcohol is a powerf. antiseptic, but not a deodorant: Condy an instant.s deod.t also disinf.t, but not a good antis.c

Antisepsis is the art of preserving subst.s fr. the attack of the micr.s wh. prod.e decomp.n

other public place, or in any public conveyance, and any person in charge of one so suffering, who so exposes the sufferer, is liable to a penalty not exceeding £5.

Similar penalties are involved in the neglect of disinfection. Thus, the owner or occupier of a house may be required to cleanse and disinfect any house or room, and the articles contained in it—where infectious disease has existed—under a penalty not exceeding 10/- a day, for neglect.

Any person, who, without previous disinfection, gives, lends, sells, or exposes any bedding, clothing, etc., which have been exposed to infection, is liable in a penalty not exceeding £5.

Any person, who lets a house or room, in which there has been an infectious disease, without having it disinfected to the satisfaction of a medical man, is liable to a penalty not exceeding £20.

Any person, who lets or shews for hire, any house or part of a house, making a false statement as to the fact of their being then in the house, or having within six weeks previously been therein, any person suffering from an infectious disease, such person answering falsely is liable to imprisonment, with or without hard labour, or to a penalty not exceeding £20.

Disinfectants.—Disinfectants are substances capable of destroying the poison of the various fevers, acting in all probability by preventing the growth of, and killing the minute organisms to which these diseases are apparently due. The word *germicide* (germ destroyer), in a strict sense expresses the same signification. Disinfectants must be carefully distinguished from *deodorants* or deodorisers, such as charcoal, and from *antiseptics*, such as common salt. Deodorants remove foul smells,—in the case of charcoal probably by oxidation in its substance; other deodorants, like tobacco, act simply by veiling the disagreeable odour, and are not true preventives of infection. Antiseptics prevent putrefaction, and some antiseptics, like carbolic acid, have a strong disinfectant power; while others have little or none.

Disinfectants may be applied *to prevent the origin* of infectious

Value of sanitary of soil water in prev.ⁿ of cuts f. & chol.ª enforced by similar of sowing dunghill stand heap w. mushroom spoon (W/

diseases, or *to prevent their spread.* For the former object, the best measures are an abundant supply of fresh air, and absolute cleanliness; while for the latter object, the same measures are essential, with the addition of certain special disinfectants.

The importance of an abundant supply of *fresh air* in all fevers cannot be exaggerated. It is the most important and efficient disinfectant. Typhus fever is not infectious a few feet from the patient in a well-ventilated room, but most virulently so in a closed-up room. Possibly, it is the want of oxygen that makes the sewer-gas issuing from drains so dangerous; while when sewage is freely exposed to the air, as in the case of the river Clyde, bad effects are rarely, if ever, produced. Pasteur has found in some of his latest researches, that the virus of chicken cholera becomes greatly attenuated by cultivation in a medium rich in oxygen. Exposure to fresh air of infected bedding, clothing, etc., involves not only a salutary dilution of the poison, but also oxidation and disintegration of the organic matter accompanying it, thus rendering it incapable of producing further harm.

Extreme cleanliness is another important agent in preventing the spread of infectious diseases. Most of these diseases spread more rapidly in an atmosphere containing unoxidised organic matter, —an atmosphere which is, so to speak, devitalised—all the ozone being exhausted in oxidising organic matter. The importance of cleanliness is accentuated by Dr. W. B. Carpenter's view of the origin of the contagia of infectious diseases, which we may call the natural history view. He holds that the contagia of infectious diseases are due to the progressive development of innocent germs (from the vegetable world), in conditions by which they acquire their virulent activity. This is confirmed by many recent experiments, such as the conversion of the innocent hay-bacillus into the germ of a severe disease.[x] The conversion from one class to the other is owing to the character of the breeding-ground; and the breeding-ground which is most apt to lead to development of virulent characters, is a condition of filth and

A cert.n med.l lecturer once said – "Freming.ns, gentlemen, are of essent.l import.ce They make such an abomin.e smell, that they compel you to open the window."

+ This stated by Buchner, but now gen.y reg.d as an error of observ.n due to us.g fld instead of gelat.e cultiv.ns

Two theories – (1) attennat.n theory – Klein in oppos.n to Pasteur, who says that a cult.e of Bac. anthr. wh. has bec. inactive for sheep, will yield further cultiv.ns hav.g that char.r, asserts that new cults of bac. anthr. attenu.d by any means will under ordinary cond.ns regain full virul.ce Klein inclines to attribe dim. viral.ce to inhib.y act.n of some collat.l product

P.J.

(4 Theory that a non-pathog^c. can be conv^d into a pathog^c. org^m
This stated in 3 cases – 1/. Buchanan – conversⁿ. of Bac. subtil. into Bac. anth.
This an error of experᵗ – prob^y caus^d by facts that certⁿ. condⁿ. of med^m &
temp. favᵉ to each. – 2/. Suppˢᵈ conversⁿ. of Bac. subtil. into the
bacillus of jequirity – this disproved by Klein.
3/. Stated that spores of ord^y mould wh. flourish at ord^y temp^s. in
acid media, bec. pathog^c by cultivⁿ. at high temp^s in alkal. med^a
Proved by Koch that the spores flourish^g under abt. condⁿˢ are not of
ord^y mould, but of certⁿ species of aspergillus.

Mr W. Blyth in '81 opposed on auth^y of Koch that disinf^t must
kill spores. Now known (Feb 91) that major^y of infˢ dis^s due to mic. orgⁿˢ
wh. do not prodᵉ spores. (SS. 7/9 Chol^a Disp^n Surgisip^s)
Temp. time & strength were the chem^l unities regarding disinf^n.
Behring has recently shewn that CaO one of most powerf^l disinf^ts we possess.
If suffic^t alk. ^y obt^d (eq. to 50 cc normal NaOH) then pathog^c orgⁿˢ kill^d
Fühl using a soln / CaO to 8 H_2O fd that min. 20/0 req^d. to kill
orgⁿˢ Soft soaps supp^d to carbolic as bactericide.
CaO wd fix S. comp^ds – no goods to NH_3 prod^g bodies

overcrowding. This will account also for some epidemics of various fevers being much more severe than others.

The chief disinfectants in ordinary use are :—

1. *Heat and cold.*—Cold is commonly used to prevent putrefactive changes, but is not so serviceable as a means of disinfection. Cold weather often heralds the diminution or stoppage of an epidemic, the exceptional cases being explicable by the overcrowding and artificial heating of ill-ventilated rooms. De la Tour found that dry yeast might be exposed to the extremely low temperature of – 60° C. or – 76° Fahr., without being killed; in the moist state it was killed by any temperature below – 5° C. or 23° Fahr. The resistance of living matter to cold appears, however, to depend greatly on the special form of that matter. Thus, Cohn found that certain bacteria only lose their activity temporarily, when exposed for five hours to a temperature below – 10° C. or 14° Fahr., and sinking for some time to – 18° C. or – 0°·4 Fahr. (Huxley.)

Heat is one of the most valuable disinfectants we possess. A great fire has more than once caused the cessation of an epidemic, as in the Great Fire of 1666 following the Plague. The degree of heat required to destroy the germs of infection is somewhat doubtful. It is possible that the spores of Bacteria may resist a temperature which is fatal to the adult forms. Pasteur found that dry spores of yeast could be exposed without destruction to a temperature of 120°-125° C (248°-257° Fahr), while when moist, they were all killed by exposure to 100° C (212° Fahr.). "But the maximum limit of heat which living matter can resist is no less variable than its minimum limit" (Huxley). Cohen found that exposure of Bacteria for an hour to a temperature of 60°-62° C (140°-143° Fahr.) effectually prevented their development. In many experiments it was noted that long exposure to a lower temperature than that required to immediately destroy life, produced the same result as short exposure to a higher temperature.

Dr. Henry found that the activity of vaccine lymph was destroyed

by exposing it for three hours to a temperature of 140° Fahr., though at 120° Fahr. it retained its properties unaltered. The virus of scarlet fever is said to be destroyed by a temperature of 204° Fahr.; and it is probable that none of the lower infective organisms can resist a dry heat of 266° Fahr., or a temperature of 230° Fahr. when immersed in a liquid.

Three methods of applying heat as a disinfectant are in use.

1st. *Baking* the infected clothing in a hot-air chamber. This plan has proved very successful, in the disinfection of bedding, clothing, etc., when conducted with care. As it requires a special apparatus (such as Ransome's self-regulating disinfecting stove, or Scott's disinfecting chamber), it can only be carried out at some central establishment. The local authorities usually provide this, and the infected articles can be disinfected without any cost to the individual.

2nd. *Steaming* the infected clothing by means of super-heated steam is a very good plan. In ensures the interior of the bedding being raised to a sufficiently high temperature. Moist heat is efficacious in destroying the germs of disease, at a lower temperature than dry heat.

3rd. *Prolonged boiling* in water as a rule completely disinfects clothing, but it is not so satisfactory as baking. Its efficacy is made more certain by the addition of carbolic acid to the water.

A fourth plan is more efficacious than any of the three preceding, namely the *destruction by fire* of all infected articles. In poor and crowded neighbourhoods, where the bedding is of little value, this is by far the best plan; and in all cases, everything of small value should be destroyed. This especially applies to toys and books, which commonly escape complete disinfection.

2. *Sulphurous Acid* is very useful in disinfecting empty rooms; but to obtain it in sufficient strength to thoroughly disinfect an occupied room, it would be necessary to burn a quantity which would render the atmosphere of the room intolerable. It is an antiseptic as well as a disinfectant, and is very destructive to all forms of plant life. After the room is evacuated by the patient

The earliest hot air disinf.t appl.n is D.r Ransome's. Whitelegge says that Bact.a free f. spores kill.d at 220 F in 1½ hr. Spores req.r much higher temp.e as 280° for 30 or 40 hrs. Is in practice f.d to be unsafe to work at temp.e over 255°F or art.s injured in colour strength or texture. Slight diff.ce in penetrat.n; some hrs req.d to raise temp.e of int.r of pillows to desired point. (This nat.l as art.s of cloth.g used for their non-conduct.g powers) add.n of steam to the hot blast furth.s at 253°F. makes it much more effic.t

By disinf.n by steam more rapid penetr.n & destr.n of org.ms & on the whole less injury to org.ms fabrics. By incr.g press.e temp.e of steam can be raised to any desired point. Koch f.d that no org.ms even spores of bacilli resist temp.e of 100°C for more than a few mins. The present steam appl.s expens.d bec. high press.e but may sh.w good results by less expens.e appl.s.

With dry heat, scorch.g apt to occur, white woollen things being scorch.d below 250°F

Steam penetr.s into bed.g &c fur bet.r than dry heat; steam under press.e still bet.r Disadv.e that as much shrinkage as w. ord.y washing, best applic.e to subst.s that wd not bear wet.g nor to leather.

SO_2 may be gener.d 1. by burn.g S in air

2. syphons of SO_2 in wh. the acid is subm.d to press.e of 2 atmosph.s. Tube of syphon pass.d thro. open & closed door & immers.d in a recept.e cont.g H_2O. Syphon is open.d fld forced into H_2O, whence it escapes under the form of gas bubbles

3. by burn.g CS_2 + may burn it in a lge duplex lamp, placing it in a bath of H_2O & wiping cand.s bef. light.g as it is v. inflam.e

Careful exper.ts of Wolffhügel shew that S. not reliable when sowlds under ord.y circumst.ces

Cl. apt to discolour most many fabrics Attack met.c surfs.
(owing lat.ly to Vaselin)

Presence of alb.a fd to protect septic germs to consid.ble ext.t agst act.n of K Permang.te & Cl, but little or no influ.e on act.n of SO_2 & Carbol. Ultim.e fate of contag.m is to be destroy.d by putrefn. Putrefn say of manure f. cattle suff.g f. C. plague shd not be prev.d by sm. add.ns of disinf.ts
For Koch's exper.l results see San. Rec. Mar. 87.

Most convent. source of Cl. is bleaching powder. This shd cont.n 41 % Cl, in practice rarely more than 35%. In disinf.g a room w. Cl. 1 lb of bleach.g powder decomp.d by 1 lb HCl suffic.t for sow. 1000 c. ft space. (Blyth)
Klein's obsern.s as to effic.y of Cl. as disinf.t in cattle plague.

Exper.ts of Riedel on sod. Trichloride (Pub. Health Vol I p 58).

(as after scarlet fever), the chimney and windows are closed. An iron saucepan or shovel is then taken and supported on a pair of tongs over a bucket of water. A quantity of sulphur is then placed in the saucepan and set on fire, and the room is left closed for about half a day. It is usual to allow about one pound of sulphur for every thousand cubic feet of space in the room. If the room is a large one, it is well to burn the sulphur at two or more points, in order to secure thorough diffusion of the sulphurous acid.

3. *Chlorine* is commonly used in the form of chloride of lime, which constantly evolves small quantities, and can be made to give off more by the addition of vinegar. It is doubtful whether the small amount evolved from vessels placed in the sick-room is of great value; and anything above a minute quantity produces great irritation of the lungs and coughing. It is more valuable in purifying rooms after they are empty, and in keeping water-closets sweet. When required to disinfect a room completely, it can be obtained by the addition of strong hydrochloric (muriatic) acid to black oxide of manganese, or by the addition of strong oil of vitriol to a mixture of common salt and black oxide of manganese.

Euchlorine ($Cl_2 O_4$) is also of considerable value as a disinfectant. It is generated by dropping crystals of chlorate of potassium into some strong hydrochloric acid. Like chlorine, it is very irritating to the lungs.

4. *Iodine* occurs as a flaky solid, which gradually evaporates. It is less pungent than chlorine, and not so efficacious as a disinfectant. It is useful, however, to have it in a warm place in the room on a plate, so as to allow it gradually to enter the atmosphere. In case of exposure to infection, where it is important not to carry the disease to children, it is possible to become disinfected in a few seconds by shutting oneself up in a small closet, and burning a small amount of iodine, at the same time holding the breath to prevent the irritating vapour entering the lungs.

The vapour of *Bromine* has occasionally been used as a disinfectant, but it possesses no special advantages.

5. *Nitrous Acid* is a most efficient disinfectant, when used, like the preceding, in sufficient strength. Its power of oxidising organic matter, and destroying offensive smells, is very great. Owing to the very irritating character of the fumes, however, it is only suitable for empty rooms. It is best generated by pouring strong nitric acid (aquafortis) on a copper coin or copper filings.

6. *Carbolic Acid* is one of the most valuable disinfectants we possess; and is in common use in a diluted condition as a dressing for wounds, in which it prevents putrefactive changes. It is important to remember that, like most other disinfectants, it is very poisonous, and has caused the loss of many lives by being mistaken for porter or other liquids. It is commonly employed mixed with some innocuous powder, and in this condition is much safer for common use. Calvert's carbolic powder contains 20 to 30 per cent. of the acid.

For disinfecting a bed-room, carbolic acid is used diluted with water to the extent of one in fifty. According to Dr. Baxter, below this amount of dilution it loses its disinfecting properties. It ought never to be used in the concentrated condition, as it is somewhat caustic in action. It is sprinkled about the room; the floors are washed with it; and a sheet wrung out of the carbolic solution is hung outside the door, to complete the isolation. The infected linen, etc., are steeped in it before leaving the room, and it is especially valuable for this purpose.

It is not very volatile, and is therefore not so valuable for aerial disinfection as the preceding substances; but it may be diffused throughout the atmosphere by the following plan. An ordinary house-shovel is placed over the fire until it becomes hot, but not red-hot; it is then taken into the centre of the room and an ounce of number 4 or 5 carbolic acid is poured on it.

7. *Permanganate of Potass* is usually sold in solution, under the name of Condy's fluid. It can also be obtained in crystals, and a few of these added to a quart of water give it the power of disinfecting linen, etc. It must not be used in strong solution, other-

D. Muter in contribn to Soc. of P. Analysts – ambiy % of carbolics for Ac. Carbol. Thus 10% Ac. Carbol. does not mean 10 % absolute phenol. The liq. usually sold for disinf. purposes consists chiefly of crude cresylic acid (cresol). It is the crude coal tar phenols, i.e. the most of true carbol. acids has been removed by careful conducted distillation, boil. point of Carbol. Ac. being 184° C, & of cresylic acid 203° C. In contracting for Carbol. powders, shd req. it to cont. so much p.c. of uncombined tar phenols (chiefly cresol). Cresol is in no way inf. as antiseptic to carbol. acid or true phenol.

Is a powerf. oxidiser, but quite harmless to the germs of dis.; & as it rapidly combines w. org. matter is inert in a few mins.

$HgCl_2$ — 1% destroys anthrax spores & 1 per 2000 anthrax threads: bac^{i} of tubere. disinf^{d} by 1 in 950 (Blyth)

now stat^{d} to be no better than NaCl.

Koch states that reprod^{e} power of Anthrax spores only destroy^{d} by phenol 5% sol^{n} after 48 hrs, not by 11/2% sol^{n} of SO_2 in 24 hrs, but in 10 mins in sol^{n} $HgCl_2$ cont^{g} 1 pt in ~~5000~~ 9000 of H_2O.

Drawbacks of $HgCl_2$ that it is pois^{s} + in albums liq^{d} or in presence of sulphides forms inert ppt^{e}. The latter diff^{y} is surmount^{d} by add^{g} $HgCl_2$ until light strip of Cu acquire in 1/2 hr a coat^{g} of Hg, indic^{g} nitrates avail^{e}. $HgCl_2$ than 1:5000 (Koch). Colour the sol^{n} to avoid risk of swallow^{g}

wise it browns the linen, or the hands. It should be kept in a bottle with a glass stopper, as it rapidly oxidises. Being completely inodorous, it is very valuable in the sick-room, to add to the excreta, or to water containing soiled linen. It will not purify the atmosphere, owing to its non-volatility.

8. *Sulphate of Iron*, or green vitriol, is a valuable cheap disinfectant for some purposes. It will iron-mould linen, and must not therefore be applied, even in a weak solution, to it. As it also stains floors washed with it, its uses are limited. In solution, it may be poured into drains, or used for disinfecting heaps of manure, cesspools, etc.

9. *Chloride of Zinc* (Sir W. Burnett's disinfectant) is sold as a strong solution of the salt, and is extremely poisonous. It is a powerful disinfectant, and may be used for disinfecting closets, drains, linen, etc.; but is non-volatile, and consequently not useful for diffusion through a room. Burnett's solution contains twenty-five grains of the chloride in every tea-spoonful; when used it should be diluted with eight or ten times its bulk of water.

10. *Chloride of Aluminium*, or "chloralum," according to Wanklyn, is better and more convenient than any agent he knows for removing fœtor and effluvia, being incomparably superior to chloride of lime. It is capable of arresting putrefactive changes; and although non-volatile, and consequently not an aerial disinfectant, is very valuable for use in drains, in washing infected clothing, and in the water used for cleansing rooms.

11. *McDougall's Powder* consists of about thirty-three per cent. of carbolate of lime and fifty-nine per cent. of sulphite of magnesia, the rest being water. It is valuable for disinfecting excreta, sewage, and drains.

12. *Potassium Dichromate* and *Chromic Acid* have been recommended as disinfectants, but their high price and the stain they produce, will probably prevent their general introduction.

13. *Sanitas* has lately come into favour as a disinfectant, and as it possesses a pleasant odour, is somewhat volatile, non-poisonous,

and produces no stain, it is admirably suited for the sick-room. It is a terebinthinate product, is miscible with water, and is quite reliable.

14. *Terebene* is a hydrocarbon derived from turpentine by treatment with sulphuric acid. It has a pleasant pine-like odour, and possesses considerable deodorising powers; in both of which respects it is superior to carbolic acid. It is only slightly soluble in water; but undiluted it is a valuable deodorant for use in commodes. It is sold also in the form of powder, being mixed with other substances which greatly increase its disinfecting powers. The two chief powders are *cupralum* and *ferralum*. The former is a mixture of copper sulphate, alum, and a little potassium dichromate with terebene. It is a very powerful deodorant, and coagulates albumin, as well as neutralising sulphuretted hydrogen and ammonia. Being soluble in water it is capable of free diffusion. It has been adopted by the Government, and is largely used in the army, and for disinfecting the stools in typhoid fever and cholera.

15. *Charcoal* probably has some disinfectant as well as deodorising power. It possesses the power of concentrating in its meshes a large amount of oxygen, which is then capable of oxidising organic matter. Used as a *filter for water*, fresh charcoal oxidises some of its organic matter. It has also been employed as an *air-filter*, placed at the ventilating holes of a sewer, thus oxidising the noxious vapours; and as a *respirator* for the mouth and nose when one is exposed to offensive gases. In the last case, the gases arising in certain chemical works can be breathed without difficulty through a charcoal respirator. In all these uses of charcoal, it is essential that the charcoal should be moderately new, or recently baked.

Practical Disinfection.—1. *Of the patient.* In scarlet fever, olive oil or glycerine should be rubbed on the skin, to prevent the infectious particles being scattered about the room. The expectoration should be received in a spittoon, containing one

Sanitas prod. by pass. moist warm air thro. Ol. Terebinth.
Cont. HCl in sol.

Disinfts req[d] time to act. Typ's stools disinfd & trimmed?
cast into drain is pract[y] undisinfd. - In typ have to
deal w. a spore bearing bacil. ∴ allow disinfts to act for
at least an hr. (Blyth)
Inches in observ[ns] on Boston Hosp[ls] fd that air of hosp[ls] must
germ-free in early sum ∴ recom[d] spray[g] floor & walls of hosp[l]
wards w. 1 in 1000 sol[n] $HgCl_2$ bef. dusting sweeping & bed making.

of the many disinfectants named. The stools and urine, likewise, should be received in a vessel, containing half-a-pint of weak carbolic solution; or of a solution of sulphate of iron, two pounds to a gallon of water; or of Burnett's fluid, one in from four to eight; or some other disinfectant. Before removing them from the room, more strong disinfectant should be added.

When a patient dies of a very infectious disease, such as scarlet fever or small-pox, the body should be washed with a strong carbolic solution, and placed in the coffin as early as possible, cupralum or McDougall's powder being sprinkled freely in the coffin at the same time. Burial should take place without delay; and if the body linen is not buried with the body, it should be destroyed by fire.

2. *The nurse* should preferably have had the disease previously, and should avoid all unnecessary contact with the patient. Her dress should not be woollen, but of some other washing material, such as glazed cotton. No visitors should be allowed in the room, even though they have had the disease, as they are very apt to carry it to others.

3. The *food* should not be kept in the room, and no food must be allowed to return to the kitchen. All cups, plates, etc., leaving the room, must first be dipped in weak Condy's fluid.

4. The *bed- and body-linen* must be disinfected in the room. This is best accomplished by putting them in boiling water, to which some strong disinfectant has been added, and allowing them to soak for a considerable time. Towels and pocket-handkerchiefs must be similarly treated; and rags which can be immediately burnt after use are preferable to handkerchiefs. The linen should never be sent to a laundry, as this is a common mode of spreading disease.

5. *The room* should be freely ventilated, though the patient must be protected from direct draught. All unnecessary furniture, curtains, bed-hangings, and carpets should be removed at the commencement of the illness. The floors should be washed

frequently with a solution of cupralum, or sanitas, or carbolic acid. Isolation of the infected room from the rest of the house must be strictly enforced. The utility of aerial disinfectants in the room during its occupation is somewhat doubtful, but weak chloride of lime, iodine, or small towels wrung out of carbolic solution, may be placed about the room, in addition to the essential sheet wet with carbolic solution outside the door.

6. *Uninhabited rooms* are best disinfected by washing all the furniture with a solution of chloralum, 3 or 4 ounces to a gallon of water, or with strong carbolic solution. The floor and woodwork may be washed with a similar liquid, and the paper removed. Subsequently sulphur is to be burnt in the closed room, as already described ; and after a few hours, the windows thrown open, and the room allowed to remain unoccupied for a few days. Then the ceiling should be white-washed, the wall re-papered, and all the wood-work washed again with disinfectant liquid.

7. The *clothing, bedding, etc.*, should in all cases be disinfected by being exposed for an hour or two to a dry heat of 240° to 250° Fahr., or to super-heated steam.

8. *Water-closets, sinks, etc.*, should be systematically disinfected, when any infectious disease is prevalent, and especially if there is a case in the house. If there is a bad smell in the house, it is important, however, not to trust to the use of such deodorising agents, to the exclusion of an examination of drains, and a removal of sanitary defects. Similarly with regard to cess-pits and midden-heaps, it is better not to allow their accumulation, than to have to adopt measures for their disinfection. When necessary, they may be disinfected by a solution of cupralum or chloralum (1lb. to a gallon of water), or of copperas (3lbs. to a gallon of water). Solutions of chloralum, carbolic acid, terebene, or sanitas, may be used for sinks and closets.

9. *Streets and courts* may be disinfected, where necessary, by Burnett's fluid chloride of lime, McDougall's salts, or Cooper's salts (chlorides of magnesium, sodium, and calcium).

CHAPTER XL.

POISONING, SUFFOCATION, FITS, UNCONSCIOUSNESS.

Symptoms leading one to Suspect Poisoning.—Varieties of Poison.—General Indications for Treatment. — Antidotes. — Antidotes for the Chief Poisons.—Causes of Suffocation.—Treatment of Suffocation.—Drowning: Methods of Restoring.—Fits.—Unconsciousness.

Poisons are substances which are capable of destroying life, otherwise than by means of heat, electricity, or mechanical means. This definition will exclude such substances that may be swallowed, as pins or boiling water. The effect of poisons on the system is produced either by *chemical action* on the tissues, as when oil of vitriol is swallowed; or by *physiological action* on the system after absorption into the blood, as in the case of opium or strychnia.

Symptoms leading one to Suspect the Administration of Poison:—

1. *The sudden onset of symptoms in a person previously healthy*, these symptoms rapidly progressing to a fatal termination. This is not always a certain indication, as (1) many diseases have a sudden onset, and closely simulate the effects of poison. This is the case in regard to cholera, and several fevers. (2) Poisons may be slow in action, the symptoms only developing gradually. Arsenic, corrosive sublimate, or phosphorus, for instance, may, if only small and repeated doses are taken, produce their effects somewhat insidiously; but even here, as a rule, the next indication will hold good.

2. *The symptoms probably are noticed soon after taking a certain medicine or food*, the poison having been introduced into these. But occasionally (1) poisons are given otherwise than by the mouth; thus, chloroform may be inhaled, and morphia inserted under the skin by a small syringe. (2) Symptoms resembling those produced by a poison may arise after taking food or medicine, from some other cause. Thus, unwholesome food may produce violent symptoms; and a copious draught of cold water, when over-heated, has produced death.

3. *If more than one has partaken* of the suspected food, they

will all suffer from similar symptoms; thus helping one to identify the cause.

In all cases of suspected poisoning, it is important to preserve the vomited matters and excreta, and to safely lock up all food or medicine, part of which has been given to the patient.

Classes of Poisons.—Three are commonly described—irritants, narcotics, and narcotico-irritants, combining the properties of the other two. A more accurate classification is into—

1. *Corrosive poisons*, as strong mineral acids, caustic alkalies, oxalic acid, corrosive sublimate, zinc chloride (in Burnett's disinfecting liquid). These destroy the mucous membrane of the alimentary canal, producing ulceration, and even perforating through the stomach or intestines.

2. *Irritant poisons*, such as arsenic, copper and tin salts, phosphorus, iodine, cantharides, etc., act less violently than corrosive poisons—as a rule, producing inflammation without ulceration. They cause thirst and pain in swallowing, vomiting, abdominal pain, followed by diarrhœa and other symptoms. All these symptoms occur in an aggravated form in corrosive poisoning.

3. *Narcotics and narcotico-acrids* may be divided into—

(1) *Poisons producing sleep*, as opium, and large doses of alcohol, ether, or chloroform. There is great drowsiness, followed by heavy sleep, from which it is difficult to rouse the patient, and finally a condition of coma (complete insensibility), passing on to death.

(2) *Poisons producing excitement or delirium*, such as belladonna, stramonium, hyoscyanus, Indian hemp, and alcohol and ether in smaller doses than are required to produce sleep.

(3) *Poisons producing convulsions*, especially strychnia.

(4) *Poisons killing by shock* to the nervous system, as prussic acid.

(5) *Poisons producing suffocation*, as coal gas, carbonic acid, carbonic oxide, sulphuretted hydrogen, sewer gas, etc.

General Treatment in Cases of Poisoning.—The indications

in every case are to—1. *Get the poison out of the system as quickly as possible.* The two chief measures with this object are the use of emetics and the stomach-pump. In cases of chronic poisoning, as from lead, remedies promoting elimination from the kidneys are required, but the prescription of these devolves on the medical attendant.

Emetics must not be used in every case of poisoning. Thus where a strong mineral acid or caustic alkali or oxalic acid has been swallowed, an emetic would only aggravate the symptoms, and increase the danger of injury to the walls of the stomach. In these cases the first indication is to neutralise the poison. But in poisoning by alkaline and earthy salts, by phosphorus, arsenic, lead or copper salts, opium, belladonna, etc., emetics are indicated immediately. In the absence of sulphate of zinc, which is the best emetic (in half drachm doses), give a tea-spoonful of mustard in a table-spoonful of water, and repeat the dose every quarter of an hour until free vomiting is produced. This may be aided by tickling the back of the throat, and by copious draughts of warm water.

The *stomach-pump* is used by a medical man, who ought to be sent for immediately in any case of poisoning. Its use by an unskilled person would not be free from risk.

2. *Neutralise the effects of any poison you cannot remove.* In the absence of a medical man, it is important to know certain simple remedies to give after the adminstration and action of an emetic. These are known as **antidotes**, and there are three kinds of them, only the first two being within the reach of the unskilled.

(1) *Mechanical antidotes*, such as flour and water, magnesia, a mixture of chalk with castor oil and water. These prevent the irritating action of the poison, and so give time for the administration of other remedies. Thus they are useful, for instance, in phosphorus or cantharides poisoning. Animal charcoal is especially valuable in poisoning by strychnia or morphia, keeping them in suspension and preventing their entry into the circulation.

(2) *Chemical Antidotes.*—In the use of these it is important that the antidote should be inert, and incapable itself of doing damage; also that the compound produced by the action of the antidote on the poison should be insoluble in water, and if possible insoluble in the digestive juices. For acids chalk and magnesia are the best antidotes; better than soda or potash, as the latter may form soluble compounds. Thus, if one gave carbonate of potash in oxalic acid poisoning, binoxalate of potash (salts of sorrel) would be produced, which is soluble in water, and almost equally poisonous with oxalic acid. For poisoning by caustic alkalies, lemon-juice or vinegar is the best antidote; for poisoning by lead or barium salts, alkaline sulphates,—these forming insoluble sulphates of the poisonous metals. For corrosive sublimate, the white of egg is the best antidote, an insoluble albuminate of mercury being formed; for opium poisoning, tannic acid acts with some little efficiency as a chemical antidote.

(3) *Physiological Antidotes.*—Different drugs have opposite effects on the circulation, or respiration, or nervous system, and this may be utilised in poisoning. Thus, belladonna is a partial antidote to opium; Calabar bean a complete antidote to strychnia. It is important to remember that the antidote in these cases may destroy life equally with the original poison, if in excess.

3. *Combat the individual symptoms that may arise.*—With this object in view, after emetics and antidotes have been administered, it may be necessary to give stimulants where there is collapse; strong coffee or tea where great drowsiness occurs (as in opium poisoning), and opium in cases where there is great pain. These and other remedies ought in all cases, where possible, to be given under the direction of a medical man.

Antidotes for the chief Poisons. *Alkalies* (caustic potash, soda, or lime).—Do not use emetics or stomach pump; give vinegar and water or lemon-juice at once; then administer olive oil (thus converting the alkali into a soap), and plenty of milk.

Antimony (tartar emetic and butter of antimony). If vomiting

Turpentine a most wonderful antidote
to P. poisoning (W. Blyth)

not already present, induce at once. Then give anything containing tannin, such as strong boiled tea or nutgalls, followed by draughts of milk.

Arsenic (chiefly white arsenic, a tasteless powder). Induce vomiting at once; after this give a mixture of milk and raw egg; sugar and magnesia in milk is also useful. Subsequently salad or olive oil may be given, and stimulants to counteract collapse.

Salts of Lead (sugar of lead, paint, etc.)—Give an emetic, and follow this with a dose of Epsom salts, which forms an insoluble sulphate of lead.

Salts of Mercury (especially corrosive sublimate).—Encourage vomiting, then give white of egg in plenty of milk.

Phosphorus (matches, rat poison, etc.)—Encourage vomiting by emetics and large draughts of warm water; then give large doses of magnesia or chalk in water. Avoid any oily or fatty matters, as they dissolve phosphorus, and so aid its absorption.

Mineral Acids (oil of vitriol, aqua fortis, spirit of salt).—Do not waste time in giving emetics, but proceed at once to administer chalk and water, or better still, calcined magnesia. If these are not obtainable at once, then whiting or wall plaster will answer the purpose.

Oxalic Acid.—Never begin by using the stomach pump or giving emetic draughts; but give at once large quantities of chalk or magnesia in milk. If, after this, there is no vomiting, an emetic may be administered. The advice is good to "scrape the ceiling and administer the scrapings, if you can get nothing else."

Prussic Acid.—There is no time for emetics or possible antidotes. Dash cold water over the head and face and back; then rub the skin until warm and dry, and repeat the douche. Artificial respiration may be carried on at the same time. Hold strong smelling-salts to the nostrils, and, if obtainable, fresh chloride of lime held near the mouth is valuable. Brandy and sal volatile internally are useful, swallowed if possible, or injected into the bowel. It is important to remember that the oil of bitter almonds, largely used

in the kitchen for flavouring, contains a considerable amount of prussic acid.

Carbolic Acid is not uncommonly swallowed by mistake. Give at once an emetic of mustard and water; then uncooked eggs *ad libitum*, followed by olive oil, or better still, a mixture of olive and castor oil, with magnesia. The administration of stimulants is necessary, as collapse soon occurs.

Chloral hydrate poisoning is usually the result of an accidental overdose, taken to produce sleep, and is generally not discovered for some hours, if at all during the patient's life. If discovered early, give an emetic; if later, give stimulants freely, and perform artificial respiration.

Strychnia.—The stomach-pump, used while the patient is under the influence of chloroform, is the proper treatment; but failing the possibility of this, emetics should be given, followed by a large dose of powdered animal charcoal. The antidotes are chiefly medicinal, and ought to be given by a doctor; but in the absence of the latter, an injection into the bowels, containing half a small teaspoonful of laudanum with brandy and milk, is justifiable.

Opium or morphia.—Give emetics at once. Then apply a cold douche to the patient's chest and head, to thoroughly rouse him. After this, keep him walking about between two men, not allowing him to lie down on any account. If he is in a condition of profound unconsciousness, with slow breathing, artificial respiration is advisable, and the free use of the galvanic battery. Strong coffee is a useful adjunct to the treatment.

Poisonous gases (chloroform, coal-gas, etc.) Carry the patient into the open air, and carry on artificial respiration persistently for at least half an hour, if no sign of returning breathing.

Suffocation.—Suffocation may result from various diseases; but, independently of these, it is occasionally the result of attempted suicide or murder, or of accident. In these cases it is highly important to know exactly what to do, and to do it without a

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moment's delay. In all forms of suffocation breathing is impeded, and probably stopped, and the circulation of blood through the lungs and right side of the heart is brought to a standstill. The three main indications are—(1) to induce the natural process of breathing; (2) to keep the heart going; and (3) to keep up the temperature of the body. Artificial respiration, ammonia to the nostrils, and a cold douche to the head and neck, are the means to gain the first end; warm applications over the heart, galvanism, and friction to the extremities for the second; while hot bottles or hot bricks and blankets, with the aid of friction, meet the third indication.

When a person is found *hanging*, it would appear obvious that the first thing to do is to cut him down; but many a life has been lost by the finder of the suicide first running for help. Next remove all tight clothing from the neck and chest, and commence and persevere for a considerable time with artificial breathing, as described for drowning.

Strangulation generally means murder; while hanging (except in the case of executions) nearly always is suicidal. The treatment is similar to that for hanging. Remove all constrictions from the neck, perform artificial respiration, rub the extremities, and apply hot bottles. These things cannot all be done by the same person; but, whatever else is neglected, in all cases of suffocation (including apparent drowning) artificial respiration ought to be kept up without any interval.

Suffocation is occasionally produced by *some foreign body pushed into the throat*, accidentally or with a murderous intent. Here the first thing in treatment is to remove the substance, if it can be reached; or, if this is impossible, send for a medical man with the greatest haste, as opening the trachea below the throat may be necessary in order that breathing may occur through an artificial channel.

Smothering is not uncommonly produced by the *over-laying of children*. This chiefly occurs between Saturday and Monday,

when the parents are intoxicated. According to the Registrar-General, almost one case a day happens in London alone.

Suffocation is occasionally due to *poisonous gases.* Occasionally sewer-gas has been the cause; more commonly the carbonic acid gas accumulating at the bottom of wells or near limekilns. Sometimes a leakage of coal-gas has occurred in bed-rooms, and their occupants have been found dying or dead in the morning. In all such cases, immediately remove the patients into the open air, commence artificial respiration, and carry it on even after it seems quite hopeless; at the same time, adopting measures to stimulate the heart and keep up the temperature.

Drowning is the most important instance of suffocation, and the one in which it is most essential that every one should know how to proceed in attempting restoration. The indications are to *restore the breathing*, and *promote warmth and circulation of blood.* Do not waste time in running for help; but after removing all clothing from the chest and arms, commence artificial respiration. Hanging up by the heels and all other rough methods are strongly to be condemned.

The rules are—1st. Cleanse the mouth and nostrils from any foreign matters (such as weeds or mud); draw forward the tongue, and keep it forward by means of an elastic band over the tongue and under the chin, or let some one hold it forward.

2nd. Place the patient on his back on a flat surface, having a firm cushion (or folded coat) under his head and shoulders.

3rd. Grasp the patient's arms just behind the elbows. Draw them over above the head, keeping them so for two or three seconds. Then reverse the manœuvre for about the same length of time, pressing the arms firmly against the sides of the chest.

4th. Repeat the movements with the arms steadily and perseveringly fifteen times in a minute, at regular intervals, taking care not to perform them hurriedly. It is convenient to have some one at hand to time the movements; the common error is to exceed the above number of movements per minute, and then they are not so efficiently executed.

Acc. to Coroner for Central Middlesex in his district alone, 120 inquests held annᵈ on chᵉ who have been overlaid. Says he in Jerom's it is criminal to allow the young chd to sleep w. adult.

In Amerᵉ edit⁼ of Aesop's fables a kind-hearted she-elephᵗ heedlessly set foot on a partridge wh. she crushᵈ. to death within a few ft of the nest cntᵍ its callow brood. "Poor little things", said the generous Mammoth. "I have been a mother myself, & my affectⁿ shall atone for the fatal cruelty of my neglect." So saying she sat down on the orphaned birds. (Queen)
Not every mother be entrustᵈ w. an orphan asylum or w. a baby.

Sylvester's method.

Howard's method Dipt f. this.

Pulling the arms above the level of the head, expands the chest, and a partial vacuum being produced in the lungs, air rushes in to supply its place; pressing the arms against the chest, imitates the natural process of expiration.

The above movements should be persevered in, until natural attempts at breathing occur, or for more than half-an-hour even when there is no apparent return to life.

At the same time, attempts to *excite respiration* may be made by someone else, though these should never interfere with the steady performance of artificial respiration. Such means are—tickling the throat with a feather, or exciting the nostrils with snuff or smelling salts. Another operator may be engaged in procuring dry and warm blankets, and in rubbing the legs upwards towards the trunk firmly and steadily; the friction to be carried on under warm blankets. As soon as the patient is sufficiently recovered, small quantities of warm brandy and water or coffee should be given, and large mustard poultices over the chest will often relieve the distressed breathing.

Fits.—Fits are most commonly due to epilepsy or hysteria; but occasionally they are due to drunkenness, insanity, apoplexy, or other causes. The immediate treatment in all these cases is somewhat similar. The convulsions may result in severe injury to the patient; it is important, therefore, to prevent him from falling into the fire, or into water, or against any hard and sharp object. Those who are subject to fits should be carefully watched and tended between the attacks. In the fit itself, the tendency is for the breathing to be impeded, and the patient becomes blue and livid. Remove all tight ligatures from the neck and chest, and if the fit is prolonged, it will be useful to help breathing, by the performance of artificial respiration. Occasionally, the tongue is bit severely during the fit; it is advisable, therefore, to put a spoon between the teeth to prevent this; and if there are any artificial teeth, care should be taken to prevent the patient swallowing them.

Hysterical fits are nearly confined to women, and chiefly those of an emotional temperament. In these attacks the patient is certain not to injure herself, and may be allowed to fall where she likes. The application of a cold douche to the head may assist her return to consciousness, or, better still, a good shock from a galvanic battery. Where it is not certain (from the screaming accompanying the fit, or the previous history), that the attack is hysterical in character, it is preferable to treat it as one of the more serious forms of fit, until there is time for enquiry.

Epilepsy is occasionally *feigned* in order to obtain alms, etc. In the true epileptic attack there are three stages. In the first the patient is pale and completely rigid; in the second there are convulsions (jerkings), accompanied with lividity and dilated pupils; in the third the patient lies quiet and unconscious for a varying period. Impostors generally overact the convulsions and become heated at once. They never fall so as to hurt themselves; and their eyeballs cannot be touched without making them flinch.

Unconsciousness.—A person may be found in the street in an insensible condition. It is highly important to know what may cause this, as many more serious cases of insensibility have been mistaken for drunkenness. It must also be remembered that a drunken person may suffer from some of the other causes of insensibility; and that, before he is carried to the police-station, it is well to ascertain the absence of these. Many unconscious people have been locked up for the night, on the supposition that they were *drunk*, when, as a matter of fact, they were *dying*.

The chief causes of unconsciousness are:—1. *Drunkenness.* Here there is the odour of liquor in the breath (but there may be this in the other cases); the patient can usually be roused, and talks incoherently. In this case give an emetic, and apply warmth to the extremities. 2. *Apoplexy.* The arm on one side of the body falls more helpless when raised than on the other; the breathing has a peculiar snoring character. Raise the head; undo the clothing around the neck; procure medical aid at once.

Convulsn in chn f. ½–2 yrs old nearly alw. assoc?
w teeth?, but due to gastro-intest? irritn

Sunstroke— pour cold H2O on head

3. *Epilepsy.*—The patient may be found unconscious after an epileptic attack. It is only necessary to keep him quiet and warm.

4. *Syncope or Fainting.*—Lay the patient on his back, and raise his legs so as to help the flow of blood to the head. Half a teaspoonful of sal-volatile to be given in water as soon as the patient can swallow it. 5. *Shock* from fright or grief, lightning, etc.—Help the restoration of circulation and warmth, and give small quantities of stimulants cautiously. 6. *Injuries to the Brain*, as concussion, fracture of skull, etc. Place the patient in a dark quiet room; apply warmth to his body and limbs, and do not give any stimulants. 7. *Uræmia* (blood-poisoning from kidney disease) may simulate the symptoms of apoplexy or opium poisoning, if the patient is found in the streets. It is essential, therefore, in all cases to procure the attendance of a medical man. 8. *Opium or Morphia Poisoning.*—The treatment of this condition has been already described. The means of distinguishing it from the other causes of unconsciousness are often very difficult, especially in the absence of any history.

CHAPTER XLI.

WOUNDS, HÆMORRHAGE, BURNS AND SCALDS, BITES AND STINGS.

Varieties and Treatment of Wounds.—Varieties and Treatment of Hæmorrhage.—Means of Arresting Arterial Hæmorrhage.—Burns and Scalds: Immediate Treatment.—Treatment of Bites and Stings.

Wounds.—Cuts or wounds require immediate treatment, especially when deep or extensive, and it is important that what is done before a medical man arrives should not be injudicious, and require doing over again.

The chief varieties of wounds are *incised wounds*, in which there is a clean cut; *contused wounds*, in which bruising accompanies the cut; *lacerated*, where the parts are torn; *punctured*, where the wound is small, but probably penetrates deeply.

1. In all cases it is important, first of all, to *remove all coverings*

from the wound, and ascertain its exact condition. Do not be deterred by the presence of free bleeding: even when this occurs it is better to expose the wound to the air for a short time.

2. Next *wash the part carefully* with clean cold water. This tends to diminish bleeding, and at the same time removes dirt or bits of clothing, etc., from the wound. Where the wound has closed, pull its edges apart, to make sure that no dirt is secreted between them.

3. *Arrest the hæmorrhage* if possible. The treatment of this will vary according to circumstances (see next section); but do not try to arrest it by a multiplicity of bandages. These simply, in severe cases, hide the bleeding without stopping it.

In the treatment of incised wounds, after washing the wound, the hæmorrhage usually ceases naturally on bringing the edges together. The edges are fixed together most conveniently by narrow stripes of adhesive plaster, applied transversely at intervals if the wound is long. Over this a strip of linen wrung out of cold water is wrapped, and not allowed to become dry. It is important to place the patient in an easy position so as to avoid straining the wound; and the part should be carefully kept at rest. If the wound is in the cheek for instance, speaking and mastication should as far as possible be prevented; if in the leg no walking must be allowed, etc.

Contused and lacerated wounds are more difficult to heal, owing to the more severe injury to and irregularity of the edges of the wound. In these cases, as for incised wounds, the indications are to wash carefully and remove all foreign matters; to arrest the hæmorrhage, and replace the parts as far as possible in their natural position; afterwards applying carbolised cold water bandages. In the after-treatment of all wounds, and especially contused and lacerated wounds, it is highly important to keep the wound "sweet" and free from decomposition; for this purpose the best dressing is pieces of lint dipped in a solution of carbolic acid, one in sixty of water.

Punctured wounds are frequently dangerous, owing to their penetrating deeply, and occasionally injuring important vessels or internal organs. Examine the wound carefully, to discover if any clothing or other foreign matter has been driven in; if so, remove it where possible. Then wash the wound carefully with carbolic lotion, and keep the injured part completely at rest.

Occasionally wounds may be complicated by the protrusion of internal organs, as when a wound in the abdomen occurs. If a doctor is not quickly obtainable, wash the protruded part carefully with warm water, and push it gently into the cavity of the abdomen, unless it seems irretrievably injured.

Hæmorrhage.—Hæmorrhage, or bleeding, is the result of rupture of a blood-vessel. The *rupture* may result from a wound, or disease of the walls of a vessel, or a sudden strain. It may be *external*, from the surface of the body; or *internal*, from the lungs, stomach, etc.

There are three kinds of blood-vessels, and corresponding to these, there are three varieties of hæmorrhage—arterial, venous, and capillary. In *capillary hæmorrhage* there is simply a general oozing of blood from the injured surface, and it speedily ceases on compression, or when the wound is closed.

In *arterial hæmorrhage* (1) the blood comes out in intermittent jets, corresponding to the contractions of the heart; and (2) it is of a bright scarlet colour.

In *venous hæmorrhage* the blood (1) flows slowly, in a continuous stream; and (2) is of a dark purple hue.

Arterial bleeding is by far the most dangerous form, and not a moment ought to be lost in treating it. In the interval before a medical man arrives, one must be prepared to adopt the necessary measures, as otherwise a valuable life may be lost. The treatment will differ somewhat according as the wound is situated in the trunk or in one of the extremities; but the general indications are these:—

1. Expose and examine the wound. Nothing more embarrasses

the treatment than a number of superfluous wrappings. These should at once be removed, and the exact source of bleeding ascertained.

2. Wash the wound with cold water. If the artery is a very small one, this may even stop the bleeding.

3. Elevate the bleeding part, so as to diminish the flow of blood to it. If the wound is in the palm of the hand for instance, the arm must be held aloft.

4. Apply pressure so as to control the flow of blood through the wounded vessels. This may be accomplished (1) By pressing with the two thumbs directly over the point in the wound, from which the blood is seen issuing in spurts.

(2) By applying a small pad made of linen folded into a compact lump over the bleeding point, and tying a bandage tightly around the limb, in order to keep it in position. This is successful in many cases, but as a rule not so good as direct pressure by the thumb over the bleeding point, kept up until a surgeon arrives.

(3) By pressure on the main artery *on the heart side* of the bleeding point. There are certain main trunk arteries which carry the blood to the four limbs. If one of these is wounded the hæmorrhage is very severe, and unless at once controlled, will prove speedily fatal. The best way to control it, is to compress the artery higher up in the limb. Similarly if a branch of an artery is wounded, the bleeding is best controlled by compressing the main trunk. The main trunk can be more easily compressed than any of its branches owing to its great size, and compression of a branch is often ineffectual owing to the anastomoses or communications between several branches. In exerting pressure on an artery it is always best to choose a point where the artery can be pressed against some bone as a point of resistance. Thus when there is a wound in the forearm or hand, the best point to control the hæmorrhage is about the middle of the upper arm, where the trunk artery can be pressed against the inner side of the humerus (arm bone). Similarly in any dangerous bleeding from the leg, the best point of pressure is at the bend of the groin.

(4.) Another form of pressure which is useful, and in slighter cases of bleeding may suffice, consists in bending as much as possible the joint above the wound, so as to diminish the flow of blood into it. Thus, by bending the elbow as much as possible, a severe bleeding from the forearm or hand may be greatly diminished; by flexing the knee to its utmost, bleeding from the leg or foot may similarly be diminished. This mode of compressing the trunk arteries must not be relied on, but is useful in conjunction with other measures.

Compression of the trunk artery higher up than the wounded point is best exerted by the thumb over a point where the beating of the artery can be felt near some bone. The thumb is placed firmly over the artery, and pressed towards the bone; while the thumb of the opposite hand is placed over its fellow, in order to steady it.

Compression of the trunk artery may also be exerted by a tourniquet, which is an instrument exerting pressure at one point, and fastened round the limb. An imitation of this may be improvised by taking half of a large cork, wrapping it in a handkerchief, and after placing it over the artery above the bleeding point, tying it firmly in its place by means of a bandage round the limb.

4. Other means of arresting arterial hæmorrhage, such as tying the wounded artery, and the application of substances (called styptics), to the wound to arrest hæmorrhage, are best left to medical men. The application of ice to the wound is useful in the less severe forms of hæmorrhage. It may be washed also with weak vinegar and water, but in the severest forms of hæmorrhage this would be ineffectual, while in the less severe forms it would be unnecessary. It is better to trust to pressure over the bleeding point, or at a higher part of the limb.

Venous bleeding may occur along with arterial or by itself. As most of the arteries are deeply placed, a superficial wound is more likely to divide veins than arteries. It is important in treating severe hæmorrhage from veins to remember *the direction of*

the circulation in veins, which *is towards the heart.* It is evident, therefore, that pressure on the vein nearer the heart than the wound, by retarding the flow of blood from the wound, would simply increase the hæmorrhage. The indications in treating venous hæmorrhage are—(1) To expose and examine the wound; (2) to wash it well in cold water; (3) to elevate the limb, so as to aid the flow of blood from the wound and diminish the flow to it; (4) to apply a pad and bandage over the wound; (5) to remove any pressure or obstruction to the circulation, such as tight clothing on the heart side of the wound, except where arterial bleeding accompanies the venous.

Dangerous venous bleeding sometimes occurs from varicose (that is, enlarged and dilated) veins of the leg, or from ulcers in the same situation. It can be immediately stopped by elevating the limb, and applying a pad over the bleeding point, firmly fastened by a bandage round the limb.

Capillary bleeding is easily controlled, usually ceasing when the edges of a wound are brought together, and compressed by the dressing. The application of iced water or weak alum and water may be occasionally necessary.

Internal hæmorrhage is much more difficult to treat than external. The forms most commonly occurring are bleeding from the nose, stomach, or lungs. In all these cases, keep the patient perfectly quiet; give him iced drinks, and ice to suck; and direct him to avoid coughing, so far as possible. For bleeding from the nose, apply an ice-bag across the forehead, and syringe the nose out with a weak solution of alum in iced water. If these measures fail—and in all severe cases other measures are required—a surgeon ought to be sent for. In vomiting or coughing of blood, maintain perfect quiet, give ice to suck, and iced drinks, and obtain medical help at once.

Burns and Scalds.—A *burn* is caused by the application of some substance in actual combustion, or capable of acting chemically, to the skin. A *scald* is produced by hot or boiling liquids. Its

Epistaxis
Haemoptysis
Haematemesis

Attend to faint not alw. an indic. for stimults

A saturd. soln. of Sod. Bicarb. relieves pain remarkly

severity varies with the character of the liquid and its temperature. Thus boiling oil produces much more severe injury than boiling water.

There are different degrees of burns and scalds, according to the amount of injury produced. In the first degree, the skin is simply reddened; in the second a blister is produced; in the third a part of the true skin (cutis) is likewise destroyed; in the fourth it extends to the subcutaneous tissues; and in the fifth and sixth the muscles and even the bone is charred.

The treatment of burns and scalds will vary considerably with their severity; but we may divide it into two parts—*constitutional* and *local*. As regards the constitutional treatment, the only matter coming under the treatment of the non-professional friend, is to diminish the primary collapse and prostration which may prove fatal in severe cases, by giving a warm stimulant immediately, and applying warm bottles to the limbs. It is important to remember (especially in the case of children), that a burn or scald on the trunk is much more dangerous than one of equal size on a limb, and that an extensive superficial burn or scald is much more dangerous than a small though deeper one.

In the local treatment (1) remove the burnt clothes immediately, and as gently as possible, so as to avoid pulling off the skin with them.

(2) Soak strips of linen in a mixture composed of equal parts of linseed or olive oil and lime-water, and apply these over the wound, covering the whole with a sheet of cotton-wool, fastened on by bandages.

If no lime-water is obtainable, then simple olive oil will answer the purpose, and is preferable to dusting any powder on the wound.

(3) Place the burnt part in such a position, that deformity will not result from the occurrence of contractions. In severe cases this is often difficult to avoid. Suppose the burn is on the front of the forearm, for instance, the skin becomes contracted as

it heals, and the arm cannot be extended. This would not have resulted if the elbow had been fastened in the extended position. Similarly, the head may become permanently pulled to one side by a scald on one side of the neck, unless great care is taken.

Bites and Stings.—*Stings of insects*, as of bees, wasps, mosquitoes, gnats, though painful, seldom produce any serious trouble; yet occasionally they have been fatal, by inducing erysipelas; or by the great irritation resulting from a large number of stings, as from a swarm of bees; or owing to the character of the part stung, as the eye, or the interior of the mouth or gullet (from swallowing a bee in a piece of honeycomb). The venom of the mosquito is specially powerful and irritating.

The irritation may be relieved by applying an alkaline lotion, such as weak ammonia (liquor ammoniæ) or soda, or rubbing the part with olive oil. In the case of wasps or bees, if the sting has been left in the wound, it must be removed before the alkali is applied.

The irritation from *nettle-stings*, (which is due to formic acid), is similarly best relieved by the application of an alkali to the affected part.

Snake-bites are seldom fatal in England, the adder and viper not possessing a sufficiently strong poison to kill a healthy adult. In the more severe poisoning resulting from the bite of the rattle-snake, cobra, etc., the only hope of success lies in treating the case immediately. It is all-important to prevent the poison from the bite reaching the general circulation. Tie a bandage round the limb at a higher point so tightly as to prevent all circulation through it; Next push a red-hot iron or cinder into the wound in order, if possible, to destroy the poison at its point of entry. Then allow bleeding to occur freely from the wound, helping it by friction of the limb. Washing the wound out with a strong solution of permanganate of potash (Condy's fluid) has also been recommended.

Bites of Rabid Animals.—Bites of rabid animals are only followed by hydrophobia when the skin is penetrated, and then six

Hydrophobia only produc^{d} by inoc^{n} P. C. fr. bites of rabid anim^{s} fr. 20–70 o/o. Dogs & cats most suscept^{e}, then man & dog, next ruminants. 3 stages in dog – premon^{y} alter^{n} habits, dribbl^{g} &c – irrit^{e} – paral^{c} – disp^{g} jaw &c.

In man has been acq^{d} fr. wound rec^{d} in dissect^{g} rabid anim. Healthy dog has given the dis^{e} by a bite immed^{y} after fight^{g} w. a rabid anim. post^{y} fr. sal^{n} hang^{g} ab^{t} jaws. Has result^{d} fr. teeth being used to loosen a knot on a rope w. wh. a rabid dog had been tied. Cases in wh. bite of dog who did not fr. ser^{y} wks subseq^{y} fr. recog^{e} devel^{d} rabies, prov^{d} by disph.

Prop^{n} of mas to fem^{s} 3 : 1, & same in dogs.

Cases of ser^{y} yrs incub^{n} post^{d} a 2nd unknown infect^{n}. But as hard to expl^{n} incub^{n} of 1 yr as of 5 yrs.

Attend^{ts} on hydr^{c} pat^{s} shd have no abras^{ns} & shd caref^{y} wash away any spit^{g}. No auth^{c} case of communic^{n} in this way.

The use of Pot. Permang. to the wound also recom^{d}.

Incub^{n} period of 2 yrs 4 mos in a child bitten by mad dog (BMJ Feb 7. 91)

weeks usually elapse before any symptoms appear. Hydrophobia may also result from a dog licking its master's hand or face, if the skin be cracked or sore, even though the dog is only suffering from the premonitory symptoms of rabies, which may not be characteristic. On the other hand, only a very small proportion of the bites of rabid animals result in hydrophobia, owing to the fact that the legs are usually bitten, and the saliva gets wiped off the teeth before the latter penetrate the skin. The bites of rabid wolves or cats are much more dangerous, as these generally fly to the throat or face.

There is, unfortunately, no cure known for hydrophobia; our exertions are confined to preventing it. Remembering that only in a small minority of cases does hydrophobia result from the bite of a rabid dog, one may reasonably encourage the patient. *Immediately* the bite has been received, a ligature should be tied round the limb at a higher point, so as to obstruct the venous circulation; and bleeding should be encouraged by friction and bathing the wound with warm water. Then the wound should be enlarged with a sharp pocket-knife to the depth of a quarter of an inch, and strong carbolic acid inserted into every part of it. This is better than lunar caustic (nitrate of silver), which forms a superficial film and does not penetrate deeply.

SYLLABUS OF THE SCIENCE & ART DEPARTMENT,
SOUTH KENSINGTON.

SUBJECT XXV.—HYGIENE.

Elementary Stage.

1. *Food, Diet, and Cooking.*—Classification and uses of food substances.

Animal food, vegetable food, condiments; Diet, requisites for maintenance; Cooking, roasting, and boiling; Advantageous preparation of food; Cooking apparatus.

2. *Water and Beverages.*—Different kinds of water, sources of water, good drinking water; Sources of contamination of water and its deleterious effects; Cisterns and wells; Tea, coffee, and cocoa—preparation and effects; Fermented drinks—effects.

3. *Air.*—Amount of air necessary for each person; Movements of air brought about by changes of density; Composition of air; Impurities of air; Deleterious gases.

4. *Removal of Waste and Impurities.*—Principles of ventilation; Natural ventilation; Washing and soap; Removal of parasites; Danger of dirt.

5. *Shelter and Warming.*—Materials of clothing; Sufficiency of clothing for infants and adults.

6. *Local Conditions.*—Soil, and its drainage; Aspect; Elevation.—Hill, plain, and valley; Distance from the sea; Influence of surrounding objects; Winds.

7. *Personal Hygiene.*—Habits; exercise, rest, and sleep, cleanliness, attention to the action of the skin and bowels.

8. *Treatment of Slight Wounds and Accidents.*—Treatment of cuts, burns, scalds, bleeding, fits, drowning, suffocation, poisoning, bites, and stings.

Advanced Stage.

1. *Food and Adulterations.*—Economical and wasteful diets; Calculation of diets.

2. *Water and Beverages.*—Examination of water filters; Constant and intermittent systems of service; Aërated waters and other beverages.

3. *Examination of Air: Chemical and Microscopical.*

4. *Removal of Waste and Impurities.*—Artificial ventilation; Closets, sinks, and baths; Good and bad drains; Construction and ventilation; Traps of drains; Dry and wet methods of removal of sewage; Cesspools and main sewers; Sewer gas and septic organisms; Antiseptics, deodorizers.

5. *Shelter and Warming.*—Injurious clothing and modes of dressing; Poisonous dyes; Materials used in the construction of house walls and roofs, and their properties; Foundations and basement floors, damp-proof courses; Floors, covering of walls, dangerous papers; Fire-places, stoves, and grates; Products of combustion; Radiation; Warming by hot air and water-pipes; Introduction of warmed air.

6. *Local Conditions.*—Rainfalls and moisture of the air.

7. *Personal Hygiene.*—Influence of sex, age, temperament, idiosyncrasy; Heredity.

8. *Prevention of Disease.*—Prevention of endemic diseases, *e.g.*, Consumption, Scrofula, Rickets, Rheumatic Fever—Marsh Diseases; Prevention of the spread of epidemic diseases, *e.g.*, Small-pox, Scarlet Fever, Diphtheria, Measles, Whooping Cough, Typhus and Typhoid Fevers, Cholera; Isolation and disinfection.

HONOURS

In addition to the topics enumerated under the Elementary and Advanced Stages, questions will be set in the following subjects :—

Trade Nuisances.
Vital Statistics.
Sanitary Law.

INDEX.

	PAGE
A B C process of sewage purification	255
Acarus Scabiei	000
Aeroscope	172
Accessory foods	12, 60
Ague, production of	357
Air, composition of	141
,, composition of expired	146
,, impurities in	148, 165
,, examination of	167
,, purification of	173
,, movements of	175
Albuminous foods	13
Alcohol	77
Alum in bread	27
Amyloids	16
Ammonia in air	171
,, water	117
Analysis of air	167
Anderson's process of sewage purification	255
Animal charcoal as a filtering agent	134, 136
,, as a disinfectant	380
Animal matter in water	115
Antidotes for poisons	385
Archimedean screw ventilator	196
Arrowroot	29
Arsenic in paints	283
,, papers	281
,, tests for	285
Artesian wells	97
Ashes	229, 257
Aspect	308
Bacteria	342
,, in air	145, 154, 172
,, temperature required to kill	131
,, conditions favourable to development of	374
Banner's ventilators	241
Barff's coating for iron pipes	103
Barley	27

PAGE

Barracks, ventilation of - - - - 179
Bathing, good effects of - - - - 338
Baths, amount of water required for - 92
,, arrangement of waste pipes of - 231
Beans and peas - - - - - - 28
Bedding, purification of - - - 382
Beef - - - - - - - - 20
Beer - - - - - - - - 88
Beverages - - - - - - - 62
Bird's plan of purifying sewage - - 255
Bite of a mad dog - - - - - 400
,, of poisonous reptiles - - - 400
Bleeding, treatment of - - - - 395
Block-tin pipes - - - - - 104
Boiling of meat - - - - - 51
,, of drinking water - - - 131
Brandy - - - - - - - - 90
Bread, preparation of - - - - 54
Bronchitis, from dust - - - - 154
Buchanan, on relation of typhoid to drainage - - - - 267
,, on earth closets - - - 263
,, on causes of consumption - 297
Building sites - - - - - - 308
Burnett's disinfectant - - - 379
Burns and scalds - - - - - 398
Butter, composition - - - - 25
,, adulteration of - - - - 26
Cabbage - - - - - - - - 30
Caffeine - - - - - - - - 70
Calcium carbonate in water - - 111
Calculi, effects of water in producing - 123
Calorigen, George's - - - - 203
Calvert's carbolic acid powder - - 378
Carbolic acid, as a disinfectant - - 378
Carbon-filtration of sewage - - - 256
Carbonates in water, action on lead - 114
Carbonic acid, amount eliminated - - 147
,, amount in air - - 156
,, in air, estimation of - 169
,, in soil air - - - 292
Carbonic oxide, effects of - - - 157
,, from stoves - - - 211
Carbonisation of sewage - - - 261
Casein - - - - - - - - 24
Cement - - - - - - - 269, 272
,, made from sewage - - - 256
Cesspools, construction of - - 249, 259
,, dangers from - - - 249
Charcoal, as a disinfectant - - - 380
,, filters - - - - 134, 136
,, ventilators - - - - 251
Cheese - - - - - - - - 24
Chemical agents, in purification of air - 178
,, in preserving meat - 59
Chicory, selection of - - - - 71
Children, clothing for - - - - 227
,, infectious diseases of - - 366
Chimneys, smoky - - - - - 189
Chlorides in water, action on lead - 114
,, significance of - - - 114
Chloralum, as a disinfectant - - - 379
Chloride of lime, as a disinfectant - 377
Chloride of zinc, ,, - - - 379
Chlorine as a disinfectant - - - 377

PAGE

Cholera, relation to water supply - - 128
,, relation to subsoil - - - 296
,, prevention of - - - - 370
Cisterns, materials for - - - - 105
,, arrangements of overflow pipes 105, 231
Clarke's process, of purifying water 112, 132
Clay soils - - - - - - - 291
Cleanliness as affecting health - - 334
Climate - - - - - - - - 299
Closets, ash - - - - - - 261
,, earth - - - - - - 262
,, pail - - - - - - 260
,, trough - - - - - 237
,, tumbler - - - - - 239
,, water - - - - - 234
Clothing, requisites of - - - - 216
,, materials used for - - - 223
,, amount required - - - 225
,, disinfection of - - - 382
Cocoa - - - - - - - - 72
Coffee, constituents of - - - - 70
,, properties of - - - - 72
Cold Bath - - - - - - - 338
Combustion, vitiation of air by - - 161
Comparison of Animal and Vegetable Foods - - - - - - 43
Condiments - - - - - - - 60
Condy's fluid, as a disinfectant - - 378
,, as a water purifier - - 132
Constipation, ill effects of - - - 315
Contagia, nature of - - - - 360
,, modes of propagation of - 359
,, effects of chemical agents on 373
Cooking, methods of - - - - 50
,, objects of - - - - 48
,, of animal food - - - 50
,, of vegetable food - - - 54
Cooking ranges - - - - - 58
Cooking utensils - - - - - 56
Cotton - - - - - - - - 224
Cowls, use of, in ventilation - - - 192
Cretinism - - - - - - - 123
Cubic space, amount necessary - - 179
,, relative importance - - 181
,, measurement of - - 182, 183
Cupralum, as a disinfectant - - - 380
Cuts - - - - - - - - 393
Cysticercus cellulosæ - - - - 35
Damp houses - - - - - - 276
Death rate, diminution in - - - 9
Dew, a source of water-supply - - 93
,, point - - - - - - 305
Diarrhœa, produced by impure water - 125
,, unwholesome food - - 36
,, summer - - - - - 125
Dietaries, construction of - - - 47
,, proportion of constituents - 47
,, table for calculating - - 47
Diphtheria - - - - - 129, 164
Dirt, dangers of - - - 148, 288, 341
Disconnection of pipes from sewers - 230
Disease, prevention of - - - - 351
Disinfectants - - - - - - 373
Disinfecting chambers - - - - 376

PAGE

Drainage of soil - - - - - 298
Drains, construction of - - - 242, 249
Drinking-water, characters of - - 108
,, impurities of - - 109
Drowning, treatment of apparent - - 390
Dry closets - - - - - - 261
Dust-bins - - - - - - 258
Dwellings, materials used in constructing - - - - - 267
,, foundations and floors of 277, 287
,, walls of - - - - 278
,, roofs of - - - - 289
,, site of - - - - - 308
Dysentery from impure water - - 125
,, prevention of - - - - 370
Earth closets - - - - - . 262
Effluvia from decomposing animal matter 165
,, sewers and cesspools - 162
,, offensive trades - - 165
Eggs, composition of - - - - 22
,, test for quality of- - - - 23
Elevation, effect on health - - - 299
Enteric fever—(*see Typhoid*) - - —
Entozoa, dangers from sewer irrigation 257
,, modes of propagation of - 349
Ergotism - - - - - - 38
Epidemics, prevention of - - - 359
Erysipelas - - - - - 130, 155
Euchlorine as a disinfectant - - - 377
Excreta, amount of - - - - 229
,, disposal of - - - 253, 258
Exercise, amount desirable - - - 322
,, physiological effects of - - 318
,, effects of excessive - - 321
,, effects of deficient - - . 323
,, varieties of - - - - 326
Extract of meat - - - - - 71
Farms, sewage - - - - - 256
Ferralum - - - - - - 380
Ferrous sulphate, as a disinfectant - 379
Fevers, varieties of - - - - 360
,, causes of - - - - - 361
,, prevention of - - - - 372
Filters, varieties of- - - - - 135
,, cleansing of - - - - 136
Filtering beds - - - - - 133
Filth diseases - - - - - 126, 164
Filtration of sewage - - - - 256
Fireplaces - - - - - - 207
Fits - - - - - - - - 391
Floors - - - - - - - 286
Flour, properties of good - - - 26
Food, amount required - - - 46
,, diseases connected with - - 34
Foods, preserved - - - - - 58
Forests, influence of - - - - 302
Fumigation - - - - - - 376
Fungi, edible- - - - - - 31
Galton's stove - - - - - 200
Gangrene, hospital - - - - 155
Gas, effects of, on health - - - 161
Gaseous impurities of air - - - 155
,, water - - - 109
Gelatin, food value of - - - - 19
Gin - - - - - - - - - 90

PAGE

Gluten - - - - - - - - 26
Geological formation, influence of on drinking water - - - 110
,, influence of on healthiness of site - - 290
Goitre, origin of, from water - - 123
Gout, causation of - - - 40, 83
Goux system of sewage - - - - 261
Grates, construction of - - - - 207
,, improvements in - - - 209
Gravelly soils - - - - - 290
Graveyards, air of - - - - - 166
,, water of - - - - 117
Ground-water - - - - - 293
,, and cholera - - - 296
,, and enteric fever - - 296
Guarana - - - - - - - 76
Gully-trap - - - - - - 230
Habitations, desiderata for - - - 276
Habits, influence of, on health - - 314
Hæmorrhage, treatment of - - - 395
Hardness of water, varieties of - - 111
,, effects of - - 123
,, commercial importance of - - - - 153
Hay fever or asthma, cause of - - 153
Heat, as a disinfectant - - - - 376
,, modes of carriage of - - - 205
Heating, by hot-water pipes - - - 212
,, by steam - - - - 213
High-heeled boots - - - - - 221
Hills, influence of, on climate - - 300
Houses, materials used in construction of - - - - - 267
,, prevention of damp of - - 277
,, drainage of - - - - 230
,, warming of - - - - 207
Humidity of air - - - - - 142
Huxley, on chemical analysis of water 120
Hygiene, scope of - - - - - 11
Hygrometers, use of - - - - 172
Ice and snow as sources of water - 93
Indigestion - - - - - 40, 69
Infectious diseases—(*see Fevers*) - - —
Inlets for fresh air - - - - - 186
Inoculation of small-pox - - - 363
Insufficient supply of water - - - 130
Intemperance - - - - - - 81
Intercepting tank, Cheshire's - - 260
Intermittent downward filtration - 133
Intestinal worms - - - - - 348
Iodine as a disinfectant - - - - 377
Iron buildings - - - - - 274
Irrigation of sewage - - - - 256
Itch or scabies - - - - - 345
Jail fever - - - - - - - 81
Kidney, disease of, due to gout - - 83
,, relation of functions to skin - 334
Kitchen, floors and walls - - - 286
,, utensils - - - - - 59
Lead, amount required to poison - - 124
,, action of water on - - - 114
,, effects of - - - - - 124
,, tests for - - - - - 115
Lead cisterns, bad - - - - 105

PAGE

Liebig's extract of meat - - - - 71
Lierneur's system of sewage - - - 260
Lime processes for sewage - - - 255
,, salts in water - - - - 111
Linen - - - - - - - - 225
Lodging-houses, cubic space required in 180
Liver diseases, from alcohol - - 79, 81
Loch Katrine, water of - - - 95, 112
Louse - - - - - - - - 347
Louvred ventilators - - - - 188
Lungs, effects of exercise on - - - 319
,, excretion by the - - - 146
,, disease of, due to irritating matters - - - - 150
McDougall's disinfecting powder - - 379
McKinnell's ventilators - . - - 190
Magnesian lime-stone waters - - 123
Manufactories as affecting health 150, 157, 165
Manure, value of sewage as - - - 255
Malaria, cause of - - - - 296, 357
,, prevention of - - - - 357
Measles, prevention of - - - - 365
Meat, diseases from unwholesome - 34
,, preserved - - - - - 58
,, varieties of - - - - - 19
Microscopic examination of air - - 172
,, ,, of water - - 121
Milk - - - - - - - 13, 23
Miner's phthisis - - - - - 151
Mines, ventilation of - - - - 200
Minor stimulants - - - - - 75
Mixed diet - - - - - - - 44
Moule's earth-closet - - - - 262
Muscles, exercise of - - - - 316
Mustard - - - - - - - - 61
Mutton - - - - - - - - 21
Nitrates and nitrites in water - - 114
Nitrogenous food - - - - - 113
Nitrous acid as a disinfectant - - 378
Norton's tube-well - - - - - 98
Noxious trades - - - - - 165
Oatmeal - - - - - - - 27
Objects of cooking - - - - - 48
Ocean currents, influence of - - - 303
Oils - - - - - - - - 24, 32
Ophthalmia, from sewage - - - 259
Organic matter, in water - - 115, 124
,, ,, estimation of 117
,, in air - - - - 171
Organisms, in air - - - - - 154
,, in water - - - - 120
Outlets for air - - - - - 187
Overcrowding - - - - 160, 180
Overflow pipes of cisterns - - 105, 231
Oxalic acid poisoning - - - - 387
Oxygen, in air - - - - 141, 169
,, in water - - - - - 109
Ozone - - - - - - - - 122
Pail system of removing excreta - - 260
Parasites, vegetable - - - - 342
,, animal - - - - - 345
Pastry - - - - - - - - 55
Pellagra - - - - - - - - 38
Pemmican - - - - - - - 58
Pepper - - - - - - - - 61

PAGE

Perchloride of iron for purifying water 133
Perkin's hot-water pipes - - - 213
Permanganate of potash, for purifying water 132
,, ,, for cleansing filters 136
,, ,, for estimating organic matter 132
Perspiration - - - - - - 333
Pettenkofer's researches on ground water 296
Phthisis, causes of - - - - - 352
,, relation to subsoil drainage 297, 352
,, from vitiated air - - - 353
Pipes, water - - - - - - - 103
Pipe-sewers, advantages of - - - 250
Playfair, on diet - - - - - 46
Poisons, classification of - - - 384
,, antidotes for - - - - 385
,, irritant - - - - - 384
,, narcotic - - - - - 384
,, narcotico-acrid - - - 384
Poisonous fish - - - - - 36
,, meat - - - - - 36
Population, influence of density of, on mortality - - - - 160
Pork - - - - - - - - 21
Potatoes - - - - - - - - 31
Pouchet's aeroscope - - - - 172
Precipitation of sewage - - - - 254
Preserved foods - - - - - 58
Preventible diseases, proportion of - 9
Prevention of disease, measures for the 351, 359
Punkahs - - - - - - - 196
Purification of sewage - - - - 256
,, of water - - - - 131
Radiant heat - - - - - - 206
Rain as a source of water supply - - 93
Rainfall, amount of - - - - 94
,, estimation of available - - 95
Rain-water pipes - - - - - 230
Relapsing fever, organisms in - - 343
Reservoirs for water - - - 95, 103
Residual air - - - - - - 146
Respiration, influence of, on the atmosphere - - - - 146
Rest and sleep - - - - - 326
Re-vaccination - - - - - 363
Ringworm - - - - - - 344
River-water, quality of - - - - 100
Roasting of meat - - - - - 50
Rum - - - - - - - - 90
Salts, uses of - - - - - - 17
Sanitas, as a disinfectant - - - 379
Sanderson, on temperature required to kill Bacteria - - - 131
Sausages, poisoning by - - - - 36
Scarlet fever, modes of propagation of - 364
,, prevention of - - - 366
Scavenging - - - - - - 258
Scott's process of sewage purification - 256
Scurvy, causes of - - - - - 39
,, prevention of - - - - 8
Sewage, constituents of - - - - 229
,, carbonisation of - - - 261
,, cement - - - - - 256

Man whose great grandfather was a "high liver" - the descendt
has the gout, the prefather the wine. Ecclesiastes. Eyes. Eyes
son has to wear spectacles. The son of Hagar the Egyptian
could not inherit the promises - the son of a slave of power
nature & lower faith. The children follow their mother in this
inner life. The word of it is, that no man liveth himself
and no man dieth to himself, & the shadow of such a truth is
just as sure as the light.

Smoke

PAGE
Sewage, farms - - - - - 256
,, dry methods of disposal of - 258
,, wet methods of removal of - 253
Sewers, construction of - - - - 249
,, flushing of - - - - 252
,, ventilation of - - - - 251
Sheringham valve ventilator - - - 193
Ships, ventilation of - - - - 192
Shorland's grate - - - - - 200
Silk, for clothing - - - - - 224
Site, choice of - - - - - 308
Skin diseases from parasites - - - 344
Slate for cisterns - - - - - 105
Slops, disposal of - - - - - 264
Small-pox, propagation of - - - 363
,, prevention of - - - 363
Soap, action of - - - - - 336
,, composition of - - - - 336
,, test, for hard water - - - 111
Soft water, advantage of - - - 112
Soil, air of - - - - - - 292
,, diseases from - - - - - 296
,, drainage of - - - - - 298
,, varieties of - - - - - 290
,, water of - - - - - - 293
Spirits - - - - - - - - 89
Splenic apoplexy of sheep - - - 34
Spring water - - - - - - 96
Starchy foods - - - - - 16, 29
Steam pipes for warming - - - 213
Stewing of meat - - - - - 52
Stings of insects - - - - - 400
Storage of water - - - - - 101
Stoves, ventilating - - - - - 203
,, dangers of cast-iron - - - 211
Subsoil drainage - - - - - 298
Suffocation, treatment of - - - 388
Sugar, varieties of - - - - - 33
Surface water - - - - - - 95
Suspended matters in air - - - 148
Sylvester's plan of ventilation - - 192
Syphon traps - - - - - - 245
Table of food substances - - - 48
Tank, Cheshire's intercepting - - 260
Tape-worms - - - - - - 349
Tea, constituents of - - - - 67
,, preparation of - - - - 68
,, properties of - - - - - 68
Temperature, circumstances influencing - - - - 299
,, for various conditions - 205
Terebene as a disinfectant - - - 380
Theine - - - - - - - - 67
Theobromine - - - - - - 74
Thread-worms - - - - - 348
Tight-lacing, effects of - - - - 219
Tin lining for pipes - - - - 104
Tobin's ventilating tubes - - - 194
Trades, unwholesome - - 150, 157, 165
Traps, varieties of - - - - - 243
PAGE
Traps, inefficiency of - - - - 246
Trees, effect of, on soil - - - - 298
,, on local climate - - 302
Trichinosis - - - - - - - 35
Trough-closets - - - - - 237
Tumbler-closets - - - - - 239
Typhoid fever, origin of, from impure air - - - - 164
,, origin of, from polluted water - - - - 125
,, origin of, from polluted milk - - - - 37
,, prevention of - - 369
Typhus fever, origin of - - - 367
,, prevention of - - 367
Unconsciousness, causes of - - - 272
Urea, elimination of, during exercise - 320
Vaccination, efficacy of - - - - 365
,, explanation of - - 366
Vegetable foods - - - - - 26
Venomous bites - - - - - 400
Ventilation, artificial - - - - 195
,, natural - - - - 187
,, of drains - - - - 242
,, of mines - - - - 200
,, of sewers - - - - 251
,, of water-closets - - - 240
,, principles of - - - 178
Vinegar, effects of - - - - - 62
Washing, of clothes - - - - 340
,, personal - - - - 337
,, value of soft water in - - 111
Warmth, different kinds of - - - 205
Warning pipe, for constant water supply 108
Water, amount of, obtainable from rainfall - - - - - - 94
,, effects of impure - - - 123
,, origin of pollutions of - - 122
,, purification of - - - - 131
,, quantity required - - - 91
,, sources of - - - - - 93
Water-carriage system of sewage - - 229
Water-closets, situation and construction of - - - - 234
Water-proof clothing - - - - 225
Weare's process of sewage-purification - 256
Wells - - - - - - - - 96
Wheat - - - - - - - - 26
Whiskey - - - - - - - - 90
Whooping-cough, prevention of - - 367
Windows, ventilation by - - - 187
Winds, action of, in ventilation - - 176
Wines, amount of alcohol in - - - 78
,, varieties of - - - - - 89
Wool, for clothing - - - - - 223
Wool-sorter's disease - - - - 150
Wounds, treatment of - - - - 393
Zinc cisterns - - - - - - 105
,, chloride as a disinfectant - - 379
,, roofs - - - - - - 274

List of Illustrations.

Fig.		Page
1.	—Mountain Stream, contaminated by Drain and Cesspool	99
2.	—The Unsanitary Arrangements of a Cistern	106
3.	—Organic Impurities of Water	121
4.	—Contamination of Surface-Well from Neighbouring Closet	127
5.	—A Home-Made Filter	135
6.	—Granular Charcoal Filter	137
7.	—Manganous Carbon Refrigerator Filter	137
8.	—Maignen's Patent Filter	138
9.	—Setting the same	138
10.	—Cleansing the same	138
11.	—Spongy Iron Filter	139
12.	—Diagram of Respiratory Tract	144
13.	—Termination of Bronchial Tubes in Air-Vesicles	145
14.	—Minute Capillaries spread over Air-Vesicles	145
15.	—Window Ventilation	188
16.	—Boyle's Mica Flap Ventilator	190
17.	—Boyle's Air-Pump Ventilator	191
18.	—Section of the same	191
19.	—Hayward's Sheringham Ventilator	193
20.	—George's Calorigen Stove	203
21.	—Slow Combustion Calorigen	211
22.	—Boyle's Patent Air Warmer	214
23.	—The Natural Figure	220
24.	—The Figure produced by Tight-Lacing	220
25.	—Stiff's Stoneware Kitchen Sink	232
26.	—The Weatherly Disconnector Waste-Water Tap	233
27	—Perforated Ventilating Brick	234
28.	—Syphon Waste Preventer	235
29.	—Twyford's National Wash-out Closet	238
30.	—The Banner System of Ventilation of Soil Pipe	241
31.	—Weaver's Ventilating Sewer-Air Trap	244
32.	—Stiff's Intercepter Sewer-Air Trap	244
33.	—Buchan's No. 2 Patent Drain Trap	245
34.	—Watts' Patent Asphyxiator	247
35.	—Vertical Section of Skin	333

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