DOMESTIC ECONOMY
IN
THEORY AND PRACTICE

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DOMESTIC ECONOMY

IN

THEORY AND PRACTICE

A TEXT-BOOK FOR TEACHERS AND STUDENTS IN TRAINING

BY

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PREFATORY NOTE.

THIS volume is intended for students in training to become Teachers of Domestic Science Subjects. It is an effort to combine truly scientific knowledge with practical experience, so that both may have their due proportion in the training of Teachers of Cookery, Laundry-work, Housewifery and other domestic arts. On the one hand we desire an accurate scientific treatment of such elementary science as is required in this training, on the other a practical knowledge of these subjects, and of the methods by which they can make their human appeal to those who wish to learn them.

It is a discredit that Teachers should expound theories which they hold unintelligently, or which are scientifically incorrect; it is not less essential that the art taught should be practised with skill, and with the beauty of complete success. A dominant question, therefore, for those responsible for the training of Teachers in Domestic Science is how to give their due proportion to theory and to practice in this training.

It is the experience of all of us that where the aptitude for science is strong, the skill in practice is not seldom weak, and vice versâ. But the Teacher is bound to reject such a divorce of *method* from the *knowledge* which alone makes it elastic and efficient. We hope that the volume now published exhibits science and practice in their due relation to each other. Those who are interested in this education will recognise that the scientific portion of the book comes from the pen of an author who has lived in the clear atmosphere of scientific truth, whilst the practical portion is eminently imbued with the knowledge both of Domestic Economy as a practical art and of the methods of teaching it.

Apart from the claims that the present work has to the favourable attention of those responsible for the direction of the organised teaching of Domestic Economy, the general public may be brought by the perusal of this volume to a larger knowledge of the importance of this education for their daughters, not only from a utilitarian point of view, but also as valuable training in powers of observation, in drawing out individual energies, and in other essential mental and moral qualities.

MARY E. PLAYNE,

President of the National Union for the Technical Education of Women in Domestic Science.

June 1901

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NOTE ON THERMOMETRIC SCALES.

The use of the Centigrade Thermometer is at present so widespread that the following equivalent temperatures should be ready in the mind of students of any science:

0° C.	= 32° F.	Freezing point of water.
15° C.	= 59° F.	"Ordinary temperature."
36°·9 C.	= 98°·4 F.	Temperature of the healthy human body.
40° C.	= 104° F.	Temperature of severe fever.
50° C.	= 122° F.	Destructive to almost all life except that of spores.
70° C.	= 158° F.	
100° C.	= 212° F.	Boiling point of water.

PART I

THEORETICAL

By MARION GREENWOOD BIDDER.

solely empiric,—that there are certain established facts of the physical sciences with which it is in accord. So that while the second part will tell, as clearly as may be, **how** the house is to be ordered, the first part will endeavour to show **why** that ordering is good.

Thus:—the problems of *Ventilation* centre round the chemistry of air and the physiology of breathing, the right choice and *preparation of Food* are determined largely by the chemical characters of food-stuffs and the facts of human digestion; while the habits and life-history of disease-producing organisms offer strong reason for most stringent rules of Sanitation and personal cleanliness. It is true that the aesthetic instincts often guide the choice of clothing, and of the dwelling, but they are not unerring guides, and we wish to show that, setting them aside, sound reasons may be given for this or that practice in the ordering of a House which is a Home.

Now the great central group of facts which make these reasons valid is that group which belongs to the **Physiology of Man**; and there can be no doubt that all teachers of Domestic Economy should be students of Physiology, since it is that science which studies and endeavours to explain the physical phenomena of life. But no student of physiology is properly equipped for his study without at least a rudimentary knowledge of chemistry and physics. For these sciences deal with the properties and behaviour of the substances which make up the material universe, and of these substances living substance is one, although the most complex, the least stable, the hardest to examine; and its relations with other substances, and with its own constituents, are determined by physical laws.

The reader who wishes then to draw all that can be drawn from such discussion of the problems of Domestic Economy as is presented here, should come to its consideration armed with, at least, some slight knowledge of Physiology. The equipment cannot be provided in this book, but belongs to special treatises on that wide and ever-growing subject. But what we may try tò do briefly in this introduction is to lay stress on one part of physiological teaching which is often neglected in the elementary text-books—or rather by the students of elementary text-books—and which is yet second in importance to none, whether for our purposes, or for the pure study of physiology. This is the teaching concerning the place of the **Nervous System** in man's life. Let us consider, a little, of what importance this is.

When we speak of *Living Substance*, we mean substance of complex chemical constitution which is unlike all other substances in the chemical activity it displays. It is continually breaking down and repairing its own mass, carrying on processes which, for the most part, can be imitated in no Laboratory. And any portion of living substance which has a separate, individual existence we call an Organism. Thus "organism" is the most general term for a living creature; it may be a man, a monkey, or a forest-tree; it may be almost without permanent structure, like the simple *Amoeba*, it may be so small that (like a *large* bacterium) several hundred million would be needed to fill an average cigarette. All these organisms have living substance as their foundation, and have separate lives; they build up this substance from food which is not living: they all have living creatures as offspring. But with this fundamental likeness, organisms exhibit also profound difference. We have just said that the *Amoeba* is almost without permanent structure, that is to say that if we were to break it up we should find the parts much alike[1]: any part of its exterior shrinks from the disturbance we call a stimulus; any part of its interior can pour forth digestive fluid; at any point a finger-like process or pseudopodium can be put out. But were an organism like a man to be shaped by aggregation of amoebae, with the properties of the simple amoeba unmodified, we can hardly imagine any

[1] We may leave out of account for the moment the *cell-nucleus*.

gain in general activity, or indeed anything but hindrance as a consequence of the bulky multiplication. The body of man is an aggregation of units, but not of organisms; the units are minute portions of living matter which are for convenience termed *cells*, and they do not lead separate, individual lives, but are bound together into tissues (muscular, nervous, epithelial), and these are shaped into organs, such as the foot, the eye, the heart. The cells of any one tissue are like each other, and they do the same work, but they are unlike the cells of all other tissues and the work they do is different;—briefly, the body of man shows *physiological division of labour*. Thus:—*protective cells* (the external epithelia), cover the surfaces of the body: it is by the action of *muscular cells* that the body and its parts are moved: the cells of the alimentary canal form *digestive fluids*, and pour them on food that has been eaten: the cells of the kidney take from the body certain *waste matters* which are to be cast away. And as each tissue excels in one department of physiological work, there are others in which it is inactive: the epithelial cells do not contract; the digestive cells do not support (as do cartilage and bone); the kidney cells do not digest. Thus it becomes of the first importance that these tissues of varying activity should have a common bond. This bond exists and is twofold: it is in the first place the bond of a common nutrition made possible by the **vascular system** (*heart*, *blood-vessels*, *lymph-vessels*); and in the second place it is a bond of government, the government of the **nervous system.** The blood, charged with oxygen in the vessels of the lungs, enriched by the products of digestion in the capillaries of the intestine, freed from waste matters in the vessels of the lungs, the skin, the kidneys, acts (with the lymph) at once as nurse and scavenger of the tissues; each tissue draws upon the blood and lymph for food materials; each yields to the blood and lymph its own waste.

The nervous system is, like all other tissues, fed by the blood and drained by the blood, but it may be called the **master tissue** of the body. By its special activity the activities of all the other tissues are controlled; there is no part of the body into which its ramifications do not spread; we could not find two regions which may not be brought into physiological relations by means of these ramifications. For the nervous tissue of the body is in part *peripheral*,—present in every organ and interpenetrating every tissue,—and in part it is *central*; there is a great central mass of nervous matter to which all the peripheral nervous matter leads or from which it radiates. To unravel the complexities of even one part of this orderly, nervous tangle may be the work of a life-time; here we cannot even give a brief description of the whole. We will leave aside all distinction of nerve-cells and nerve-fibres; we will lay no stress even on the relationships of brain, spinal bulb and spinal cord. We will only remember these important divisions of nervous matter: first, **central** nervous-tissue; second, tissue which bears messages or impulses *to the centre* and is called **afferent**; and third, tissue which, conversely, bears impulses *away from the centre*, and is called **efferent**. It is the office of the central tissue to receive afferent impulses, to discharge efferent impulses, to correlate the one with the other, and to check efferent impulses which might give rise to harmful action. In chapter VII. and chapter VIII. §§ 56, 60, we discuss some examples of the ordered action which is the result of this ceaseless activity of restraint and excitation, and all the events of healthy life furnish illustrations. From the closure of an eyelid to the hardest gymnastic exercises, there is no "voluntary" bodily movement which is not set up and guided by nervous impulse: there cannot be an important change of posture which is not accompanied by some adjustment of the blood-vessels of the body, some change of heart-beat, some widening or narrowing of arteries, and it is the **nervous system** which brings about these changes. And there is good evidence that it is nervous impulse which causes the gland-cells to build up their own substance, and, again, to pour out the secretions whereby digestion is effected, or waste matter is cast out from the body. On the other hand every sensation—not only of sight, sound or smell, but of heat, cold, touch, or pain—is inseparable from nervous impulse. Thus when we gasp at the touch of a cold shower-bath, or flush in the heat and movement of a ball-room; when the mouth "waters" at the sight of food, or some smell, or taste, sets up nausea or vomiting; then it is the central nervous tissue which, excited by afferent impulses reaching it from the periphery, discharges the efferent impulses which move the muscles of breathing, which widen the arterioles of the skin, which excite the secreting cells of the salivary glands, and the muscles of the abdomen and stomach-walls. And accompanying these nervous actions (which are fairly easy to observe) are others, more subtle, less obvious, but as important to the welfare of the body: among such are the efferent impulses which guide the nourishment—we may say the self-support—of the tissues, so that gland-cells, muscle-cells, and the like, remain healthy and vigorous. And among them too are those afferent impulses which stream from the periphery, to register, in the central nervous tissue, all muscular contraction. This is not the place, and not the moment, to discuss these subtleties of nervous action, but their existence should be remembered in considering the physical elements of the life of man. Man is not to be pictured mainly as an animal who breathes, who possesses certain digestive powers, certain glands capable of excreting waste matter, a system of blood-vessels by means of which nourishment is gleaned from the stomach, while waste is carried to the kidney. He is an organism full of delicate adjustments; an organism whose parts have constantly varying activities and needs; an organism which must meet changing strain and stress. The tissues cannot be "set" at one level of action; the muscles must contract slightly or strongly or must relax; the blood-vessels must widen or narrow here or there; the glands must pour out their secretions or depress this activity while others of their activities are heightened. And it is the work of the Nervous System to order and control these changes,—to adjust the impulses which stream to it from the periphery and the impulses which it sends out to the periphery so that the action of the whole shall be harmonious and helpful. There are no facts of man's life which should be rather borne in mind than these, in the ordering of a House which is a Home.

CHAPTER II.

Bacteria and Housewifery.

§ 1. It is probable that during the last twenty years no plant or animal has been so much before the attention of man, as certain forms which are perhaps the simplest, and certainly the most minute of all plants. These are the **Bacteria**; and we ought probably to include with them, as sharing some of the notice they have won, the *yeasts* and the *moulds*,—much larger indeed than the bacteria but still simple in structure.

In disease, in commerce, in domestic life, the power of these tiny creatures becomes recognized increasingly year by year, and to give a brief sketch of what they are, and what they do, is no unfitting introduction to the study of some of the main problems of **Domestic Economy.**

We are accustomed to divide the living beings in the world into *Plants* and *Animals*, and this broad distinction is based on differences which are very striking when we compare such an animal as the dog with such a plant as the geranium. There are differences of form, of habit-of-life, differences in many of the substances which are present, but above all, differences in the nature of food and in the mode of feeding. But further, plants and animals differ greatly among themselves; thus a dog is clearly very unlike a herring; both these differ widely from a black-beetle, this again from a snail, and all of these from a sea anemone. And among plants a geranium stands far apart from a fern, and a fern from the moss or lichen which clothes a wall. Indeed, as we pass from the highest or most complex plants to those which are very simple, we lose that distinction into *stem*, *leaf*, and *root* which we associate constantly with the field flowers and the forest trees. In the same way, examining a whole series of animals, each simpler than the last, we find some which lack not only the *nerves*, *muscles*, and *backbone* which we cannot separate from our ideas of a dog or a fish, but which want also a *mouth* and *stomach* as these words are commonly understood.

And yet the simple creatures which stand at the end of each series are truly plants and animals respectively, and truly unlike each other.

We have said that bacteria must be placed among the plants, though among the simplest and smallest. Now the most characteristic feature about the life of *green plants* is the great power possessed by them of building up the substances of which they are composed, from comparatively simple materials. This power is not possessed by animals which, being also composed of highly complex substances, feed either upon plants (as a sheep does) or upon other animals (as a cat does) or have such a mixed diet as that of most Europeans. It is true that the food thus taken in by animals needs important change before it actually nourishes the eater, such change as when the saliva forms soluble sugar from insoluble starch, as when the gastric juice turns the indiffusible proteins of lean meat into peptone, as when the secretion of the pancreas breaks the fat of butter into tiny particles suitable for absorption. Nevertheless, the lean meat, the starch, and the butter are in themselves complex bodies and, unless bodies of this description be available for food, an animal will starve. But green plants do not need proteins, fats, or carbohydrates as food[1]; in their substances all these bodies are present, but they are built up by the plant out of compounds so much less complex that to animals they would be useless as food.

[1] A brief account of these bodies is given below, § 23.

This great building-up power belongs to plants of all kinds *provided that they hold the green colouring matter chlorophyll;* it is displayed by the oak, the geranium, and by the small and simple thread-like or one-celled plants which sometimes form the green scum on a stagnant pool. Now among animals there are certain forms which do not only need complex food, but need it prepared for absorption. They cannot digest, but live a degraded life, inseparable from some other animal which nourishes them. Of these we may take the Tape-worm as an example; they are known as parasites. Among plants too there are parasites; thus the Dodder, whose twining, red, stems are often seen on heaths, although it is nearly related to the Convolvulus and to Jacob's ladder, cannot live independently. It has no chlorophyll, and fastens itself upon and feeds upon other plants which are green and can therefore build up the substances which it and they require. In the groups of simple plants (those in which stem, leaf, and root cannot be distinguished) those forms which have not chlorophyll are known as Fungi, and *the bacteria belong to the group of the fungi.* Destitute of chlorophyll, they must have complex food to form their own substance, and they live either upon other living creatures, or upon substance which has been living in the recent past, or upon compounds which, although simpler than those which an animal needs, are much less simple than those which serve as the food of green plants. Indeed there is but little living or dead[1] matter upon which (unless it be too acid or too alkaline, too hot or too cold) bacteria of some sort will not thrive. What living creature, if killed, will not presently decay? And decay or putrefaction is a popular name for one form of bacterial change. Bacteria abound in every human intestine, not preying upon the living epithelium of its walls indeed, but feeding abundantly upon the broken-down, digestive contents. Before the use of antiseptic dressings

[1] Dead is used here, not of inorganic bodies, but of substance which, having lived, now lives no longer.

in surgery became usual, it was well established that a wound exposed to the air became the home and nursery of what we now know to be bacteria; indeed it would probably be difficult to find air, food, or water (unless these have received special treatment) in which they are not present. We may ask then "What are bacteria like? what is the importance of their widespread presence?"

§ **2.** (*a*) In structure the bacteria are extremely simple. Each is a tiny mass of living matter—such a mass as Physiology teaches us to call a cell—having a protective, outside covering (or wall) of different and less complex composition. Some of these individuals have no power of independent movement, but are carried about passively by the movement of the surroundings in which they live; others move by means of outgrowths of their substance,—thread-like and exquisitely fine,—which have an action roughly comparable to that of the oars in a boat; others move by snake-like undulation of the whole body.

(*b*) In shape the bacteria are *threads*, *rods*, *spheres*, *dumb-bell-shaped*, or *comma-shaped*: in size they are so small that for satisfactory observation with the microscope they must be magnified 800 times or 1000 times linear. Some of the smaller spheres or *cocci* as they are called measure less than 1 *micromillimetre in diameter*[1]; what is perhaps the largest

[1] A micromillimetre is the one-thousandth part of a millimetre; a millimetre is ·039 inch. It is not easy to give to anyone ignorant of microscopic work a clear picture of the size of bacteria. Let us suppose that we take a small form (a coccus) and a 'full-stop' in the text of this book and magnify them the same number of times. When we magnify the coccus so that it becomes the natural size of the full-stop, the full-stop, equally magnified, will appear a rounded patch of black, *covering the whole of two open pages of this book*. Many bacteria are larger than the cocci, as we have said, though still very minute; in life they are, for the most part, colourless and very bright (*highly refractive*), so that under a

bacterium known is $2\frac{1}{2}$ micromillimetres wide and 10 micromillimetres in length; thus, although small absolutely, it would hold 100 of the tiny cocci just described. But the rarity of this large size is indicated by the name *Bacillus megatherium* which is given to the bacterium in question.

Turning to our second question "What is the importance of the widespread presence of these minute creatures?" we may answer it somewhat as follows. The importance springs (*a*) from the rapidity and success with which bacteria multiply or reproduce themselves, (*b*) from their mode of nourishment and from the nature of the substances formed by them as they grow.

(*a*) *The reproduction of bacteria.*

It is clear that if we take a living being of many unlike parts,—for example a trout or a chicken—to split off or divide the whole individual or any part of it would not give rise to 2 new individuals, but would merely injure or maim. A young trout or a chicken is built up gradually as the work of organs of the parent specially set apart for that use, and all the complex parts of the perfect creature grow gradually from simple beginnings in the egg.

But on the other hand if we consider a bacterium such as the tiny *coccus* mentioned above, to split the coccus completely is to form 2 cocci, 2 *new individuals.* This form of multiplication is characteristic of bacteria and at times goes forward very quickly. Indeed it has been calculated that, taking for granted favourable conditions for this division, one bacterium, twice as large as a coccus (that is, the same breadth and twice the

good microscope they are shining threads or dots. For proper examination they must not only be highly magnified, but also stained with different and suitable colours, to bring out their characteristic shape, to distinguish their outside wall from its contents, and to show the presence or absence of *spores* (cp. below).

length), will increase at such a rate that, in two days' time, 2 *billions of bacteria* have sprung from it—enough to fill a ½ litre flask (nearly a pint). Fortunately for man and for the other inhabitants of the world, external conditions are often unfavourable; different bacteria destroy each other, and, when crowded, they are self-destructive, so that this possible increase is not attained. But the actual increase *is* very great, and this form of multiplication—by division or **fission** as it is technically called—brings enormous numbers of bacteria rapidly into existence from a single specimen.

For the *second* form of multiplication there is special preparatory change in the bacterium. Probably there is change in the little mass which forms the living part of the individual, certainly there is change in the surrounding envelope or wall. And the change is of such a nature that *the altered form is much more difficult to kill.* Among bacteria which have not undergone this special change there is great difference in the ease with which they can be killed. But we know, on the whole, that very great cold and more especially great heat do injure them beyond repair; that drying, shaking, the passage of electric currents, light, and, above all, sunlight are hurtful or fatal to them. When however they are changed in the fashion indicated above they can resist much more successfully these ordinarily harmful conditions. The changed bacteria are known as **spores**, and it has been shown that *some spores, dried for more than three years, can grow if moistened* again, and that a certain bacterium destroyed by a twenty minutes' exposure to boiling water *has spores which are not destroyed at the same temperature under* 3 *hours.* It is these two characters which give to spores their special power and danger when it is a question of destroying bacteria: heating and drying, which would cripple the fully grown forms, do not destroy the life of the spores. Added to this, the spores although varying in size are, for the most part, smaller than the bacteria to which they respectively belong, and, when dry, float readily,—or to be accurate sink very slowly—when by any means they are cast into the air[1].

It may be asked "How is the vitality or life of spores shown?" It is shown by changes which may be (quite roughly) compared with the germination of a seed. As a seed which has been apparently unchanged through a long period of drought gives rise, when suitably moistened, warmed, and nourished, to a young plant, so the tiny spores, when suitably nourished, germinate, and from them arise bacteria with all their great and characteristic power of quick multiplication by fission.

(*b*) *The nourishment of bacteria and the nature of the substances formed by them in growth.*

The phrase "when suitably nourished" leads us to dwell for a time upon the second reason given for regarding bacteria as of high importance to the life of the world. And in this respect they are mighty for evil and for good.

§ 3. *The power for good* is often overlooked in popular thought and writing, but if we merely enumerate certain of the processes which are dependent on the activity of bacteria, we see it clearly.

In **commerce** the preparation of *flax* and *hemp* from the plants which produce them, the preparation of *skins* before tanning, the preparation of *tobacco leaves* before the tobacco we know is made,—these and others are processes in which bacterial activity is all important. Different forms are of course concerned in the different processes, but all bacteria have this in common, that they live upon liquid food and that they have most remarkable, though various, powers of breaking down complex matter outside themselves, in which action they obtain the nutritive liquid wherewithal to thrive and divide. At the same time they bring about other profound changes.

[1] A discussion of the conditions under which solid particles are found abundantly in the air is given below, § 10.

In **agriculture** we find bacteria active in all successful making of *hay*; and we find them enormously important in so altering the substances in soil that the crops grown can be well nourished. This activity is shown both in connection with the history of gaseous nitrogen and compounds of nitrogen in the soil and in connection with cast-off cellulose. Cellulose, as we know, is the non-nitrogenous substance of which the walls of plant cells are made and it is extremely difficult to dissolve: saliva, gastric juice, and pancreatic juice are alike without action—they can only pass through the cellulose envelope and attack the nitrogenous, starchy, or fatty, bodies lying within. Yet bacteria can dissolve it and even more resistent wood, and all the fallen leaves and twigs which "rot" upon the ground are being changed by the agency of these minute creatures into substances which, being set free into the air and the soil, are at the service of other plants and of animals.

In **domestic life** we find familiar examples of the activity of bacteria in changes which go on in milk, cheese, butter. In brewing, and in the formation of vinegar, they take active part, and it must not be forgotten that one of the yeasts (we shall speak later of these near neighbours of bacteria) is of daily use in bread-making. In fresh milk bacteria are always present, but usually they may be regarded as an evil[1]. In butter they abound, either carried on from the sour cream, or added deliberately after being separately cultivated: indeed butter is said to owe its delicate flavour to them. Cheese is always teeming with bacteria, and they have a most important share in changing the insipid "curd" to the highly flavoured, ripe cheese which we know.

Such bacteria may be regarded as working for good because on the one hand they bring about important changes

[1] It is now well-known that Metchnikoff regards lactic acid bacteria and the products of their action as of great value in checking putrefactive change in the large intestine. But, until our knowledge of this action is wider and more definite, the use of sour milk and its products should be directed by experts.

useful to man and because on the other hand they are not sources of disease when introduced into the human body; they belong to what are technically called the **non-pathogenic** bacteria.

But the power for evil of certain other forms can hardly be overestimated. These forms are the **pathogenic** (or disease-producing) bacteria: they are a minority when the whole group of the *Bacteria* is looked at from the point of view of numbers, but when we consider their effects it is hardly surprising that, to the popular imagination, they have thrown into the shade the beneficial action of some non-pathogenic forms. As one infectious disease after another has been carefully investigated in recent years, each has shown that bacteria are present in the blood and in various organs of the sufferer, and that the bacteria vary characteristically with the disease. *Diphtheria, scarlet fever, typhoid fever, cholera, wool-sorter's disease, consumption, tetanus* ("lockjaw"), *leprosy, small-pox*,—these are only some of the diseases in which bacteria are growing within the living body, poisoning its parts with the products of their activity, and lessening its vitality. And the issue of the struggle is recovery or death,—recovery if the bacteria and the substances which they form can be gradually destroyed by certain processes which each healthy body has at its command;—death if these processes fail (and we know how often this is the case), and the vitality of the diseased person is not only lessened but destroyed.

§ 4. Now the disease-producing bacteria concern us here, because it is within the power of a housekeeper to aid or check their spread in a house, or even their admission to it. This is seen clearly if we name some of the points of danger in the attack of these small enemies and some of the methods of defence which may be used.

A. *How may pathogenic bacteria enter or spread in a house?*

a. They may enter with someone who suffers from an

infectious disease or with some article of furniture, dress, or ornament from an infected house.

They may spread from all excreta of the patient, from clothes soiled by him, rooms inhabited by him, utensils of food, or books used by him, especially in those diseases in which there is "peeling" of the skin.

b. They may enter with **water** and spread with the drinking of it. Water is a fruitful source of bacterial infection, and pollution of the water-supply of some towns has been associated with grave epidemics of typhoid fever, cholera, &c.

c. They may enter with **milk** and spread with its use. Tuberculous cows and goats are only too familiar as sources of diseased milk which may convey tuberculosis (consumption) to a child or to another animal, and milk, contaminated after it has left the cow, often carries *typhoid* bacteria, and has been known to carry the infection of *scarlet fever.*

d. They may enter with **meat**. Probably all meat which has been "hung" contains bacteria of some kind,—on its surface—or beneath the surface, if the interval since death has been long. But there is some meat, taken from unhealthy oxen or calves, in which a bacterium is present, which has been shown (with its products) to give rise to the marked and sometimes fatal symptoms which accompany meat-poisoning in man. "Unsound meat" is probably sometimes used carelessly or culpably in the making of meat pies, but the pathogenic bacterium may be present without giving rise to any suspicious change in the smell, colour or texture of the poisoned meat, and *then the danger is most insidious.*

e. They may be introduced by *domestic animals.* This is not a well-recognized source of infection, indeed it is perhaps too lightly regarded. The domestic reticence of cats is a safeguard in their case, but a dog is as indiscriminatingly enquiring abroad (even among refuse) as he is effusively affectionate at home. And these habits, which probably do make him a carrier of higher animal parasites, may well aid, sometimes, in the transference of pathogenic bacteria.

B. We turn then to ask *what methods of defence can be opposed to these subtle attacks?*

a. A general answer is found in naming some of the conditions which are hurtful to the life of bacteria. Foremost among these we must place the substances known as **antiseptics.** *Corrosive sublimate*, *chloride of lime*, *sulphurous acid*, more lately *boracic acid*, and *formalin* have grown familiar terms. In different degrees they act harmfully, some when present in very minute amount. But it must be remembered that, injuring bacteria, they also injure all living things, so that while their use is wholly for good in the sick-room, they should never be used in the kitchen.

b. Hardly less important than the use of antiseptics is the process of **sterilization.** To make a fluid, or solid, sterile is *to destroy all living creatures in it, and* **this is the great safeguard of the kitchen and the nursery.** Raised to a sufficiently high temperature in the dry, or wet, all food and drink is sterile. Now a high temperature is often hurtful to the nutritive matter in food, but sterilization may be brought about either by a short stay at a high temperature, or a longer stay at a lower temperature, or by repeated treatment with moderate heat (say 50° C.). Boiling is of course the rough, domestic form of sterilizing, though all forms of cooking, properly carried out, should rank with boiling. The effect of **cold** (as it can be applied in the kitchen) *is* **not** *to sterilize.* It does however check the development of bacteria and is therefore of great value.

c. A most important aid to the destruction of bacteria is found in the **daylight**, and especially in **bright sunlight,** and it is of great interest that the pathogenic bacteria are, on the whole, most hurt by the sun. It has been found that when many thousands of a form of bacterium which is constantly present in the human intestine are added to water (100,000 bacteria to 1 c.c. of water), *no living specimens could be found after one hour's sunlight*, and equally marked destruction of the bacteria which belong to typhus, to anthrax, to asiatic cholera, has been observed. Thus it is clear that the policy of darkening dwelling-rooms is short-sighted in the extreme, and that the evils of "fading" carpets and curtains are not to be compared with the evils of fostering the growth of bacteria by shutting out the sunlight.

d. Lastly we must note that the human body, so disastrously fitted to be a home to pathogenic bacteria, may be made unsuitable for this purpose, or, in technical words, *immune*, by **inoculation.** This immunity, varying in completeness and in duration, is of course a thing not of the kitchen but of the surgery; yet it cannot be unnamed, for it is a powerful weapon in the war with bacteria.

This brief statement is substantially an answer to the general question which went before it. Each point will be taken up in detail in the following pages, as that part of the subject is considered with which it is closely connected. And, if asked how briefly to arm a thoughtful housekeeper against the dangers of bacterial action, we can only say that, while no procedure will hedge about a household in complete security, she is well armed in observing,

1. *in the sick-room, rigid cleanliness with use of antiseptics;*
2. *in the larder, cleanliness with a temperature as low as may be;*
3. *in the kitchen, intelligent and above all* **thorough** *cooking;*
4. *throughout the dwelling-house, the admission of sunshine and fresh air.*

The extinction of non-pathogenic bacteria in the field and in commerce would be a measureless disaster, but in the kitchen their use is at an end, and they may be ruthlessly destroyed,—lest, by chance, side by side with them there grow the pathogenic forms[1].

§ 5. It may perhaps seem strange that in the foregoing paragraphs mere mention has been made of the *yeasts* and *moulds*. Like bacteria they are simple plants, though differing from bacteria and from each other in minute points of structure; like bacteria they are fungi, and exist on living or dead substance, breaking it down and changing it profoundly. But in the first place with rare exceptions they are non-pathogenic, in the second place they are less insidious in attack. Unsound meat, tuberculous milk, poisoned water do not necessarily show anything of their bacterial contents, but mouldy eatables are soon rejected in disgust. Briefly, we may say that, aiming at bacteria, the housewife kills moulds and yeasts as well.

[1] In this brief account much that is important from a scientific aspect, has been omitted; the actions of bacteria in nitrification, in fixing free nitrogen, in breaking up and using carbonic acid in the absence of sunlight;—these are of the highest interest. It seemed well however to make a deliberate choice of such activities as mainly affect *domestic life*. It may be mentioned with regard to the familiar terms *micro-organism* and *microbe* that the latter is practically a popular equivalent for *bacterium*, while *micro-organisms* include not only bacteria, but yeasts and moulds, and certain very simple animals, microscopic members of the group *Protozoa*. The term *micro-organism* is indeed one which lays stress on the likeness among these minute forms (since all are living), rather than on the differences which make us group some with animals, some with plants; and it is to be noted that recent researches have proved that certain diseases are due to Protozoa, almost as minute as bacteria.

CHAPTER III.

Air in relation to Life.

§ **6.** We may look upon the atmosphere as a sea of air, bathing the earth. At the bottom of this air-sea (that is upon the surface of the earth) the pressure of the atmosphere is in equilibrium with a column of mercury 760 millimetres high; it is therefore under such a pressure that the majority of plants and animals live.

But the air which forms this sea is practically never still. Rising when it is warmed, and thus producing directly and indirectly currents of varying strength; constantly gaining moisture, and as constantly losing it; made foul and purified by different actions of living beings, the "open air" is like a chemical laboratory, the scene of varied and profound chemical change. It will be readily understood that profound changes taking place in any medium do not necessarily alter the final composition of that medium, provided that the different changes balance each other. And we find that the "open air," unless it is in close contact with such powerful pollution as that springing from thick-set chemical works, or from large masses of putrefying substance, has a constant composition. Taking account of water in the gaseous state (which is always present though in varying amount) we may accept the following analysis of air as typical:

"Nitrogen"	78·35 parts
Oxygen	20·77 parts
Moisture (water)	0·85 parts
Carbonic acid gas	0·03 parts
Air.................................	100·00 parts.

It must be remembered here that the "Nitrogen" does not now represent one indivisible substance—one element. But argon or the other inert gases which have lately been described in air do not, so far as we know at present, touch the relation of air to life.

§ 7. We know from the teachings of Physiology that it is as a *source of oxygen* that air is all important to plants and animals, and it is in connection with this use that we must now consider it further.

There are however three points that may first be noticed.

(*a*) Firstly, certain living creatures, members of that group of the fungi which we know as bacteria[1], can exist and reproduce themselves in *nutrient liquids which contain no oxygen.* Some of these forms are indifferent to the presence of oxygen and can thrive in its presence or absence, but to others the gas acts as a poison, they can only live in its absence. Bacteria, important as the work of recent years has shown them to be, alike from a commercial and a medical point of view, form only one subdivision of that great vegetable group the fungi, and the fungi again form but a small part of the physical life of the world. Nevertheless in considering the relation of the air to life, it must be remembered that *certain living creatures are entirely independent of it.*

(*b*) In the second place another group of bacteria have very remarkable relations with the nitrogen of the air. We know

[1] See above, chapter II.

that the element nitrogen is a necessary part of all proteins and that proteins are a necessary part of all living substance; but we also know (§ 1) that animals draw their nitrogen from the proteins of other animals or of plants, and that plants build them up from simple materials, such as nitrates found in the soil. But the group of bacteria of which we are now speaking, and they alone, can *use the free nitrogen of the air* and make it enter into chemical combination. They live in or upon the roots of certain plants—members of the order to which the pea, the lupin, the clover belong, and these plants are fed with the nitrogen "fixed" by the bacteria. These facts are of great practical importance to farmers, for crops thus fed by bacteria are much less dependent upon nitrogenous manuring than are oats, wheat, or potatoes, and may even leave the soil richer in this respect; they are also of the greatest scientific interest, since the behaviour of these bacteria to the inert nitrogen of the air is so unlike that of all other living things.

(*c*) In the third place the atmosphere must be regarded as a source of *carbonic acid to all living creatures which hold chlorophyll*—that is, all green plants and a few green animals. Carbonic acid is a gas which is difficult to decompose, yet in the presence of sunlight, protoplasm holding chlorophyll can decompose it, and all the carbon that is found in living substance (and it is a very wide-spread element—found in proteins, in fatty matters and in starchy matters) has once been present in the air in the form of carbonic acid gas. From this form it is taken by green plants and worked up to complex substances, and these substances become part of animals who live upon vegetable food, and thus, part of animals who are carnivorous.

§ 8. It is however in relation to the act of **breathing** that we wish to consider the air in detail, and looked at from this point of view it becomes a great storehouse whence oxygen is drawn and into which carbonic acid is poured. When air is cut off from an animal, then, as is well known, the animal dies. And short of this extreme state of things, changes in the surrounding air have most important effects on breathing.

I. *The pressure of the air which is breathed may be changed.*

Sometimes this special medical treatment is applied locally in the case of certain diseases of the chest; the patient is made to breathe air that is especially compressed, or especially rarefied. But with these cases we have no concern here; changes of pressure in the air during health are changes to which not only the lungs but the whole body is exposed.

Thus the pressure may be *increased* as it is in the closed chambers in which the builders of great bridges work. In the chambers or "caissons" which were formed in the building of the Forth Bridge, air was supplied at a pressure more than three times as great as the pressure of the atmosphere.

On the other hand the pressure may be *decreased.* As we rise above the surface of the earth the air is increasingly rarefied or "thin," and high in the Alps or Himalayas, or in high balloon-ascents, the difference of pressure may be very great.

Now great changes in either direction may be brought about slowly with no ill effect. The workmen who build a bridge are placed in an "air lock" where the pressure is increased gradually, and they can then not only exist but work in the condensed air of the caisson. In the same way, passing through the air lock, they can come back to the earth unhurt. And men live and work in high Himalayan villages as easily as in London. But when the changes are extreme or sudden, injury, even death may follow; with *increased pressure,* slow and deep breathing, pain in the head, sometimes breakage of the drum of the ear: with *decreased pressure,* irritation of the skin, disturbance both of movement and feeling, sometimes unconsciousness and death. These are probably symptoms of an upset in the balance between the blood and the gases which it holds at the normal atmospheric pressure; this upset, carried everywhere because the blood in which it takes place travels everywhere, injures the delicate, nervous tissue which is so wide-spread, and thus brings about wide-spread injury which may be even fatal.

II. *The air breathed may be more or less loaded with moisture or may be exceptionally cold or warm.*

In the case of healthy persons changes of this nature, unless they are extreme, do not touch the breathing *directly*. They have of course very important action upon the skin with its blood vessels and sweat glands, and it is a well-known fact that extremes of heat and cold are more difficult to bear without injury if the air be loaded with moisture than if it be dry. We know that, be the surroundings hot or cold, the temperature of a healthy warm-blooded animal hardly varies; when however it is raised above the normal by some extreme external change or by disease, then the breathing is much more rapid. And what is unusual in man is usual in the dog; the panting or quick breathing of a heated dog is familiar to everyone—it probably brings about great loss of heat by evaporation from the windpipe, nose, and mouth, and thus is an aid in cooling the animal.

III. *The composition of the air breathed may be changed, not by the introduction of any new element or constituent, but by change in the gases usually present*, **nitrogen, oxygen, carbonic acid.**

We may put aside the question of change in nitrogen. This does not occur under ordinary or even under unusual conditions of life, at least not in any degree which affects breathing. Nitrogen, indeed, is only important in respiration if it interferes with the proper inspiration of oxygen.

In like manner we may put aside the question of increase in the oxygen present. It may be increased considerably without distinct effect on breathing, and we do not meet with this increase under natural conditions.

But there are two possible changes which are all important in their effect on breathing—decrease in the amount of oxygen in the air and increase in the amount of carbonic acid. In careful experiments these two changes may be separated from each other, and each is found to be injurious and, if carried far enough, fatal; that is, a man may be killed by sufficiently reducing the oxygen in the air he breathes, and in a somewhat different way, by greatly increasing the carbonic acid present.

But practically the two changes come before us together, for the consumption of oxygen by all living creatures forms one side of the shield, while the other is the giving off of carbonic acid. The oxygen may be reduced considerably from the amount present in fresh air (20 vols. p.c.) without marked injury to breathing; it is the amount of carbonic acid present which is usually taken as the index of harmful change, partly because of its special ill effects, but (probably) even more because, under the conditions in which it is usually abundant, other subtle and injurious changes in the air have been brought about. Of these we shall speak later.

The **free air** is, as we have said above, remarkably uniform in its composition, indeed, taking Dr Angus Smith's figures, we may notice that there is hardly more carbonic acid in the street air of a crowded city than on a mountain top.

Percentage of carbonic acid in Air.

From the streets of London (mean)...		·0343 p.c. or 3·43 parts in 10,000.
From the top of Ben Nevis,	„ ...	·0327 p.c. or 3·27 parts in 10,000.

This uniformity is, of course, due not only to the fact that activities of opposite character, tending to balance each other, go on in the air, but that owing to such agencies as rain and winds the air is in free movement[1]. Pure air is indeed attainable for all living creatures whose life is an out-of-doors life. But for the most part human life is in-doors, in limited spaces of air cut off more or less completely from the atmosphere. These are constantly fouled by carbonic acid arising from every human being or other animal inhabiting them, from every burning candle, gas-jet or lamp. *Plants* also give off carbonic acid, but not in great amount, and in the sunlight they are sources of oxygen. *Domestic animals* are by no means negligible, but are important consumers of oxygen and producers of carbonic acid,—thus, in proportion to weight, a dog gives rise to two or three times as much carbonic acid as a man. But except in buildings specially devoted to them the numbers of domestic animals are small; the chief sources of impurity

[1] The proportion of carbonic acid varies somewhat in different towns, and it is, as might be expected, higher in foggy air. In considering those balancing activities which keep the composition of air constant it is interesting to note that as regards the amount of carbonic acid present, there is a tendency *to place too high* the combined influence of plant life in the sunshine (consumption of carbonic acid) and animal life (evolution of carbonic acid). There is good evidence that this influence sinks into insignificance compared with chemical reactions in which life is not directly concerned. Carbonic acid is still emitted from the earth in enormous quantities by volcanoes and springs, and it is only kept from loading the air by constant chemical combination. Thus, instead of existing freely as a gas, it forms part of substances which dissolve in fresh water or in the sea (such as carbonate of lime) and in the long-run help to form the solid substance of the earth. But as regards the renewal of oxygen in the atmosphere, *green plants are all-important.*

which we have to consider are found in **man** and in the different forms of **burning.**

§ **9.** A man, when he is breathing quietly, sends out at every breath about 500 cc. (say 30 cubic inches) of air loaded with carbonic acid to the extent of 4 p.c.; a man working actively gives off much more. Now the air of a room should ideally contain the same percentage of carbonic acid as does the fresh air, namely 3·5 parts in 10,000. It is found that air containing more than this may, however, be breathed without injury or discomfort; but when the increase due to breathing is more than 2 parts in 10,000, that is to say when the whole carbonic acid present exceeds 5 or at most 6 parts in 10,000 (2 of those parts springing from respiratory action) then the air becomes unwholesome.

We have taken 30 cubic inches as a measure of the amount of air taken in and sent out at each breath, but we know that this amount varies greatly even in healthy breathing. In the same way, the number of breaths taken in each minute, shows great variations from time to time, even in men of the same age. But we may take 15 as representing a fair average in quiet breathing, remembering however that departure is frequent both from this number and from 30 cubic inches as the volume of "tidal" air. Now if 15 breaths be taken in each minute, 900 will be taken in the course of the hour, and during this time 27,000 cubic inches or $15\frac{3}{5}$ cubic feet of air will be fouled with the products of breathing, carbonic acid being present to the extent of 4 p.c. But respiratory carbonic acid (as we have seen) must not exceed 2 parts in 10,000 if the air is to be wholesome, that is to say the $15\frac{3}{5}$ cubic feet of expired air must be diluted 200 times. This will give about 3000 cubic feet of fresh air as the quantity with which a man should be supplied hourly under the given conditions, and about this quantity is contained in a room 17 feet square and 10 ft. 6 in. high. It is clear that to drive 3000 cubic feet of fresh air across one end of such a room, hourly, would not give the necessary supply to a man stationed at the other end; on the other hand it is clear that, could the products of breathing be removed as they are formed, wholesome air would be maintained with intimate admixture of considerably less than 3000 cubic feet of fresh air in the hour.

So far we have considered the necessities of a man who may be taken as an **average man**, resting, or at least not doing hard labour. It should be remembered that women and children need slightly less than this amount, while, for a man working hard, the hourly supply of fresh air should probably be doubled.

§ **10.** When we consider not only indoor life, but life in *artificial light* new sources of impurity affect the air. Candles, lamps, and gaslights, are all consumers of oxygen, and the amount of carbonic acid they produce is large. It varies of course with the wax, paraffin, or gas respectively used; but it is probably not overstating the truth to say, that an ordinary **oil lamp** produces 3 times as much, and a batswing **gas burner** between 3 and 4 times as much carbonic acid in the course of an hour as does a man. Carbonic acid and water are the only important additions made by lamps and candles to the air in which they burn; the fouling of air due to gas, on the other hand, is partly due to products to which, in addition to carbonic acid, its burning gives rise. Looked at from this point of view, gas must be regarded as the least wholesome of illuminants, when it is burnt without precaution in inhabited buildings. And although the carbonic acid produced by any ordinary illuminant is (volume for volume) less harmful than that produced by breathing,—not of course because of difference in the carbonic acid but because of accompanying changes—yet the action of all forms of artificial light, except the electric light, must be reckoned with seriously in considering the healthful housing of man.

IV. *The composition of the air may be changed by the introduction of gases not usually present which have important effects on its relation to life.*

(*a*) *Carbon monoxide* (*also known as carbonic oxide, and to be distinguished carefully from carbon dioxide or carbonic acid*). This gas is found in the fumes from brick-kilns or lime-kilns, in the gases which come from blast furnaces, and from stoves in which coke or charcoal is burnt. It is also found at times in the air of coal-mines, and is present in **coal gas**. Indeed it forms about $\frac{1}{12}$ of coal gas as we ordinarily burn it; an escape of gas would thus set free a comparatively large amount of carbon monoxide into the air. Now it has been said more than once that the main value of air to living creatures consists in the fact that it is a source of oxygen, and we know that the substance which carries oxygen from the air throughout the body is, in man and in all the higher animals, *haemoglobin*—the colouring matter of the red corpuscles of the blood. Only by means of this haemoglobin united with oxygen (and then known as *oxyhaemoglobin*) can the body gain the element which is so essential to its well-being; and the most dangerous form of starvation is oxygen-starvation. Carbon monoxide is poisonous because it brings about oxygen starvation. Like oxygen it unites or combines with the red colouring matter of the blood, but more firmly than does oxygen. Thus if a solution of haemoglobin be exposed to air holding both oxygen and carbon monoxide, the union with the latter takes place more readily and more firmly than that with the former, *carbonic oxide haemoglobin* is carried by the circulating blood instead of *oxyhaemoglobin*, and the body dies for lack of oxygen. It dies indeed as if oxygen were absent; air loaded with carbon monoxide is of no more service for breathing than if it contained no oxygen at all.

It is probable that no year passes without the occurrence of deaths from carbon monoxide poisoning, but as domestic life is arranged at present in England (with its attendant fires and lighting) the danger is faced rather by men engaged in special work than by the dwellers in houses.

(*b*) *Sulphuretted hydrogen.* This is the ill-smelling gas which is given off from rotting eggs, and from the putrefactive breaking up of other nitrogenous substances; it is present for example in sewer gas. It is also found in, or readily formed from the waste of certain chemical works. Sulphuretted hydrogen is a powerful poison, but cannot be regarded as an insidious poison, for even in traces it is detected by its repulsive smell When present in the air in sufficiently great quantity, its poisoning action has some resemblance to that of carbon monoxide. It combines readily and firmly with oxygen, and can prevent the red colouring matter of the blood from combining with the oxygen which properly belongs to it. Thus, as in the case we have just considered, the body dies from oxygen-starvation. Sulphuretted hydrogen does not itself unite with any part of the blood but is simply dissolved, probably in the blood plasma, and thus it differs from carbon monoxide. The oxyhaemoglobin, deprived of its oxygen, is left uncombined with any gas; it becomes then the body which we know as *reduced haemoglobin*; and which, in health, is characteristic of venous rather than of arterial blood.

(*c*) *Nitrous oxide.* This is not a common impurity in air but is well-known as an anaesthetic in dentistry. Its physiological action forms an interesting contrast to those just considered for it does not in any way hinder the union of haemoglobin with oxygen. But, dissolved in the blood during its passage through the lungs, it is carried to all the capillaries of the body, bathing all the tissues and, among others, the central nervous system. And in small quantities the gas wakes up or *stimulates* certain of those cells of the nervous system so that the uncontrollable movements which have given to it the name of *laughing gas* are excited: in larger quantities it deadens the nervous tissue for a time, and thus, insensitiveness (anaesthesia) is produced.

V. *The composition of the air breathed may change according to the nature and amount of solid matter present.*

Other gaseous impurities are present in air in certain places and under special conditions, but those just named are of the highest general importance. But in studying the air in relation to life we have to deal with matter which like them is no integral part of the air, but which, unlike them, is solid matter.

The air, as we know, has mass and weight; and offers great resistance, e.g. to the rapid movement through it of an open umbrella. This resistance is not seen clearly when some rather large mass of heavy material such as a stone or a sovereign is thrown or falls to the ground. But whereas a stone can be thrown with the hand fifty yards, a handful of sand of the same weight (and sand is only stone broken small) cannot be sent more than a few feet. And when a sovereign is beaten out into gold leaf it is carried on the lightest breath of air, although gold is almost the heaviest substance known. This is because the total surface of the sand-fragments and of the gold leaf is enormously greater than that of the stone and of the sovereign respectively, and the air resists their passage much more. And it comes to pass that substance which is hundreds of times heavier than the air may, if it is in sufficiently fine particles, fall through the air so slowly as practically to float in it. Such particles are the **dust** of the air; and we may say that atmospheric dust is present abundantly for a height of one mile, or in places for many miles, from the surface of the earth. In the higher (and rarefied) layers of air these particles are exquisitely fine; near the surface of the earth they are coarser,—particles such as we see when a sunbeam falls into a darkened room. This dust of the air is always shifting, falling however slowly on the land and the sea and being constantly renewed, so that the dust of to-day is not the dust of a week ago. And the change of place of dust particles may be most striking: volcanic dust from an eruption of Vesuvius has fallen to the earth at Constantinople, and after the great eruption of the volcano Krakatoa it was calculated that the fine dust, thrown many miles into the air, must have travelled more than once round the globe before it fell.

§ 11. Now in domestic life we have to deal with **dust** which, as compared with that in the air of a mountain-top, is greatly increased in amount and is of more varied nature. But the particles which make it up fall into two great groups, separated by a distinction which, if it is rough, is convenient. There is in the first place *organic solid matter* in the air, and this may be popularly described as matter which is or has recently been part of living beings: in the second place there is *inorganic solid matter*, matter which has not immediate or recent connection with living beings, and is often popularly called mineral.

Inorganic particles in dust. Organic bodies, of which we have just given a rough definition, are, to the chemist, compounds in which the element carbon is present; for in everything that lives or has lived there is carbon—for example, in skin, in wool, in silk, in paper, in cork. But carbon, existing alone, is more properly included among the inorganic solid matters of the air, and it is probably the commonest impurity with which men come in contact. For soot—condensed and aggregated smoke—is carbon, and, at least in a country so smoky and so densely populated as is England, there can be few who do not daily breathe air in which soot is present. Some of the particles thus breathed are stopped in the complicated and twisted passages of the nose, some are stopped in the windpipe and bronchial tubes and cast out with the discharges (secretions) of these passages. But enough carbon, very finely divided, reaches the lung-tissue proper, to deepen its tint from the pinkish colour of the baby's lung to dirty or even blackish red in grown men, and this change is of course especially striking in the dwellers in cities.

Considered from a mechanical point of view, the presence of much foreign matter in the lungs is disadvantageous, but carbon is probably the least harmful solid substance taken in in breathing, for it is not a poison nor an acute irritant. But sometimes positive injury to the delicate lung tissue follows the breathing of fine mineral dust which fills the air when certain trades are carried on. Stonemasons and miners,—for example those who work in the gold mines with "dry bore"—suffer greatly from this sort of irritation, and the short lives of the "dry grinders" of Sheffield were notorious some years ago. Even with the improved arrangements for work, and the careful legislation of recent years, injury may be still great, and one well-known form of diseased lung is known as *stone-mason's lung.*

Organic particles in dust. These are sometimes actually living substance, and sometimes they may be called the *débris* of living beings; they form the greater part and certainly the most dangerous part of domestic dust. Almost all friction of solids (unless these are bathed with liquid) sets free into the air minute fragments which have been attached to, or have formed part of one or both of the solids thus rubbed. For example the thin surface-scales of skin (epidermal cells) are shed daily by all animals possessing them; tiny fragments of dried excreta, of hair, cotton, fur, and feathers are very widespread, and in the carrying-on of certain different trades the two last named are present in dangerous amount. The dust-like pollen of flowers is, at times, a noticeable element in dust, especially such comparatively light pollen as forms what has been called the "smoke" of the yews and pine trees, (the so-called *showers of sulphur*) or the odorous dust of the hay-field. And other products of simpler plant-life abound. We know that all jam, damp bread, jelly, and many other eatables *mould* if exposed to the air, especially in summer. The **moulds** which are so familiar as blue-green or white, dusty patches, are really simple plants, visible to the naked eye only when they are gathered into masses. The spores of these plants (see above § 2) are in all air, and when suitable material for their growth is exposed to the air, they grow, and give rise to moulds. Very nearly related to these are the particles popularly known as *disease germs*, which we have recognised as exceedingly simple plants, members of the group of **Bacteria** and properly known as *pathogenic bacteria*[1]. We have said that bacteria of many different kinds may be present in the air (either as spores or as bacteria themselves) and this especially when they are dry. This being so, they are taken in with the breath, the harmless and the harmful alike. Now there is perhaps no sheet of living matter more delicate than those membranous cells, which are all that separate the air in the lungs from the blood that courses through the lung-capillaries. Moreover the extent of this delicate tissue is great; it has been estimated that the surface of the human lungs spread flat would cover an area of 90 square metres; in other words, the lining cells would form a sac or bag able to line completely the floor, the ceiling and the walls of a room 14 feet square by 10 feet high. Delicate as these cells are, when they are whole and sound, even disease-producing bacteria may be inhaled without necessarily producing disease. But some weakness which has existed from birth, or some local injury due to cold, or the irritant effect of some inorganic particles breathed, or constant exposure to impure air, may produce spots of injury where the "germs" can find a home and food-material, and whence they, or poisons made by them, enter the general circulation; just as an open wound will always form good growing-ground for the bacteria of the air if it be exposed to them. We have seen above (§ 11) that consumption may follow the breathing of poisonous dust, and it was a common sequel to the work of dry grinding in past years,—not because steel dust could in itself give rise to consumption, but because, irritating the lungs, it weakened them, and made them especially susceptible to the *bacterium* proper to that disease.

The well-known *wool-sorter's disease*, again, is directly associated with poisonous dust: as the Alpaca wool is "sorted,"

[1] Cp. above § 3.

anthrax and its spores (which have been lurking in the fleece) are shaken into the air. But anthrax is the special *bacterium* which gives rise alike to the wool-sorter's disease and the splenic fever of cattle, and its constant presence in the air, breathed during each working day, enables it to get a hold on at least the majority of the men long occupied in the sorting-room, with disastrous, often fatal results.

CHAPTER IV

Ventilation.

§ 12. THE foregoing considerations touching the ordinary constituents and the accidental and changing impurities of air are far from complete, but they may put us in a position to understand the problems with which we have to deal, in **ventilation.**

We are concerned with the maintenance of fairly healthy life under difficult conditions.

In the first place it is the life of men in *limited spaces of air*, and men are at once taking from the air the element which is all important to life and pouring out into it an actively injurious gas.

In the second place it is largely *life in artificial light* (at least in the case of most town-dwellers); and almost all sources of artificial light have a vitiating action on the air, comparable with that due to man.

But in the third place it is the life of persons dressed in **clothes** *which are for the most part imperfectly clean.* We know that glands of two kinds are constantly passing their secretions on to the surface of the human body,—the *sweat glands* and the *sebaceous glands*, the latter opening at the bases of the hairs. The sweat carries water, common salt, some complicated fatty (often odoriferous) compounds and some urea, which last we know as an important nitrogenous waste matter; the sebaceous secretion is mainly the changed and broken-down cells of the little glands which yield it, and is rich in fatty matters with some admixture of nitrogenous substance. Now the amount of these secretions varies greatly (there may be from 2 litres to 20 litres in the course of 24 hours) but they are constantly formed; of sensible perspiration we are conscious when the temperature round us is high, especially in moist air, or the exertion is great,—but insensible perspiration is present at all other times. What is its fate? There is of course loss by evaporation, loss of water and of some of the more volatile constituents of the secretions, but a residuum must always be deposited upon the skin, or must soak into the clothes. Let us suppose that the skin is cleansed completely by bathing twice in the day; the clothes worn near it will in one day not be seriously polluted, and their exact condition will depend largely on the substance of which they are made. Thus the most pervious clothing naturally allows the most free escape of the water of the skin secretions and accompanying volatile matters, while relatively impervious clothing (such as linen and cotten) causes the deposition of liquid sweat which soaks the garments in contact with it[1]. The list of impervious clothing is headed by such articles as are "waterproof"; most persons are familiar with the discomforts of exertion taken while macintosh is worn, and the sensible discomfort is only the expression of hindrance to that free escape of matter which, in an unclothed man, would attend the vigorous action of a flushed skin. However carefully bathing is carried out, however carefully the materials of clothing be chosen, still it is evident that in the course of a few days, some complex **organic matter,**—very susceptible to putrefaction and other

[1] See below, § 63.

chemical changes—must impregnate the garments worn near the skin. And when we remember that even daily bathing is not customary among the bulk of the inhabitants of England, that clothing is often carelessly chosen and impervious, that some articles of dress which are worn for weeks or months may be in daily contact with the skin (this is the case with some *dress bodices* of women) we realize vividly the power of clothes for evil.

Fourthly, we are considering the life of men *in furnished dwellings.* Here we have a source of impurity which is closely related to that last named. We know how the moisture given off from human beings condenses into drops on the wall of a crowded room. Something like this condensation is always going on in inhabited dwellings, on walls, ceiling, and furniture; furniture is, moreover, constantly touched by hands which may be unclean, but which, if they are clean, always bear the natural (and healthy) grease of the skin. We are familiar with the "close" smell and oppressiveness of the air in a heavily furnished room which has been shut up for some time without occupation; it is probably the traces of human life in the past now undergoing putrefactive or other chemical changes which give rise to unwholesome and offensive products. It has long been taught that air vitiated by breathing is especially poisonous because it bears from the lungs organic matter apt to putrefy. But the latest observations and experiments on this point give ground for believing that it is *not from the breath itself* but from *want of cleanliness in the body or in the room inhabited*, that these odorous and harmful substances spring.

Lastly, we deal in many cases with the life of *unhealthy men.* Much sickness, especially infectious sickness, is of course gathered into the special dwellings which are arranged for its careful treatment. But in schools, in public meetings, in carelessly ordered homes, and in the crowded homes of the very poor, there must be sometimes conscious, sometimes unknowing, admixture of the breath and other waste matters of the **unhealthy** with those of the strong. Few things can be more dangerous than the *sputum* of a consumptive patient left to dry upon the floor and then rubbed to a light dust by passing feet, and there is upon record, actual death of an apparently healthy person from this source of infection.

§ 13. Consideration of the actual **methods of ventilation** by which the difficulties named above are dealt with, belongs clearly to the practical side of domestic economy; there are however certain aims which must be before the practical worker even if they are not entirely capable of realization. In noticing these we may fitly speak at once of the gaseous impurities of air, and of dust, for as we have seen, even the free, country air is not dustless, while the dust of dwellings helps to form a serious problem in domestic life.

We may say truly, though with apparent contradiction, that the treatment of impurities of all sorts in the air should be *preventive* and *curative*.

As preventive treatment we may group the following:—

(*a*) *The fitting of interiors, and the choice of furniture.* A room abounding in cornices or mouldings with flat upper surfaces (especially in places which are difficult of access) is clearly fitted to gather dust. This is recognized so far that, in some new hospitals, the flooring joins the walls at a curve from which dust can easily be cleaned, and the more frequent replacement of a right angle by a curve, or of flat surfaces by sloping or bevelled surfaces would be a distinct sanitary gain. The dangers of upholstered furniture are familiar; where the inhabitants of a dwelling are leisured and few in number careful treatment may practically abolish these dangers, but when great numbers of ill-cared-for human beings are gathered together there should be no furniture which cannot be subjected to severe and effectual cleansing.

(*b*) The choice of *means of lighting and heating* is of high importance where such choice can be made. It will be readily gathered from the foregoing pages that all illuminants, all fires, all stoves, are not alike, in detail, in their effect upon the air,—that they vary in heating action, in drying action, in their use of oxygen, and in the giving out of different injurious gases; it is clear that by the use or rejection of certain of these lighting and warming agents the fouling of the air may be hastened or checked.

(*c*) *The use of sunlight in rooms* can hardly be too much advocated as a check of putrefactive change. We have seen (§ 4 *c*) what a remarkably destructive effect the sunlight exerts on the great majority of bacteria, and it is probable that no room, bathed in sunlight, would ever show vigorous bacterial growth on its walls, on its furniture, or in its air. *Dove non va il sole, va il medico* (Where the sunlight does not enter, the doctor comes) is an old Italian proverb which recent researches only confirm, and no one who is intelligently concerned for domestic purity will shut out the sun.

(*d*) It is perhaps departing slightly from the point, to touch on the relation of sickness to these preventive measures: yet the necessity of isolating invalids who suffer from infectious disease and of the careful destruction of all their excreta can hardly be too often pressed home. And, as the lack of care in these matters, may readily give disease-producing bacteria as an element of household dust, the matter really touches that we have in hand.

§ 14. By the neglect of these preventive measures however, or in spite of them, the fouling of air is an undeniable fact,—indeed the commonly accepted meaning of ventilation is that it is a process which removes, rather than prevents, impurity. And successful curative ventilation is such that certain ends are reached or approached. The chief of these ends may be stated as follows:

(*a*) The fresh air supplied is *mixed intimately* with the existing air of the room. We have pointed out (§ 9) that to drive great volumes of fresh air across one end of a room is not efficient ventilation, and unless free circulation or very thorough mixture in some form is assured, parts of the air of a room into which even a breeze is blowing may remain astonishingly foul.

(*b*) The fresh air is admitted *without the formation of a "cold draught."* It would of course be possible to bring about complete change of air by means of cold draughts properly arranged, but so many other disastrous results follow that such a scheme cannot be called successful. In the open air there is probably nothing which can be called a draught; in closed rooms, especially when the temperature is high, currents of cold air are especially felt by the human skin, and produce sudden discharge from eyes and nose closely resembling that of hay-fever, or the more lasting effects of cold or chill.

(*c*) The entrance of fresh air is accompanied by the *removal of the products of breathing and burning.* This is a great economy; it is the fouling rather than the exhaustion of air with which we have to do in breathing or in burning; if the impurities remain, a much larger volume of fresh air must be admitted to bring about proper dilution of them than if they are carried off wholly or in part. And this removal is of special importance when diseased persons are present,—as they may well be in schoolrooms or crowded halls.

§ **15.** As in the case of preventive ventilation, so in the case of curative ventilation, the *dust of dwellings* must be reckoned with. All vigorous rubbing of dusty fittings and furniture adds new impurity to the air, and the gentle removal of dust by wiping can hardly be urged too strongly. Damp cloths, which hardly give the highest polish to furniture, are most valuable for this gentle removal, and in sweeping floors the value of damp particles, such as sawdust, tea-leaves, or (in America) finely torn paper, is generally recognized. It would hardly be going too far to say that no furniture should be polished which is not first nearly dust-free. The aim of dusting of course is permanently to remove dust from the room where it is found; thus the frames of beds, and hollow heads to beds, bookcases, or wardrobes—if such be necessary—should be covered with some non-absorbent covering which may be removed at intervals and carried completely away with the dust which has settled upon it.

§ 16. In leaving this subject,—the relation to life of the air which is at once so important in purity and so easily made impure,—it is perhaps worth while to urge what great power (in the matter of personal health) lies in the hands of each individual. The more vigorous is the life,—that is the sum of all the chemical changes—in a living body, the more fitted is that body to withstand the ill effects of harmful surroundings. It has been said that there is a "margin of resistance to injury," and this is widest in health and is narrowed in the weakly. One great promoter of vigorous life is, of course, the vigorous action of the skin, and this is aided by careful cleansing and by frequent change of healthy clothing. But there is another activity—that of breathing—which is often grossly neglected. Many persons hardly ever take deep breaths from the chest; the possible lung capacity for each individual is hardly ever used to the full. This is a form of oxygen starvation, perhaps not directly suicidal, but enough to injure one of the main sources of life; there can be no doubt that the habit of taking deep breaths, especially in the fresh air, would give increased mechanical strength to the lungs and increased vigour to their delicate, lining cells. If, in addition to this, the habit of *breathing through the nose* become fixed, an additional safeguard is provided. The cold air is warmed and further moistened before it actually reaches the lungs, and, the complex nasal passages act as ground where dust particles, dead or living, are checked. And this checking is of the greatest importance, as mucin and the remnants of cells are constantly being sent to the exterior, and with them may be carried that foreign matter which, did it reach the actual substance of the lung, would irritate or poison.

CHAPTER V.

Water in relation to Life.

§ 17. We are here concerned with water considered in relation to life. And in this relationship we have to deal with it as a drink, as a means of bathing and cleansing the person, and as a means of cleansing clothes, household furniture, dwellings and the surroundings of man. As a *constituent of the air* we have already named it (§ 8), and as a *constituent of food* we shall deal with it in succeeding chapters. But it must not be forgotten that the presence of water in food has much to do with its use as a drink: if a rabbit be fed on lettuce or cabbage it need drink no water (in 100 parts by weight of lettuce, 96 are water), but water should be supplied with its dry food. In the same way we are conscious that the need for drinking arises much more strongly when we eat a sponge-cake than when we eat milk porridge; in the one case water is a large constituent of the article of diet, in the other it is taken as an adjunct. Whether water be used much or little, however, its quality is of high importance; and though this is true especially of water used as a drink, it is true in a less degree of that used for cleansing purposes, although different characteristics are harmful or advantageous to the different uses.

§ 18. To say that the quality of water is of high importance is to say, by implication, that what is chemically one substance has important varieties. And this is true:

chemically pure water is never found in nature. It may be prepared by distillation, and, since the water of the air has arisen by evaporation, which is the first stage of distillation, we might perhaps expect it to be pure and constant in quality. But when this atmospheric water reaches the earth once more, as dew, or rain, it is pure no longer. We have seen (§ 6) that the air is a mixture of gases, and that immense numbers of fine particles, forming atmospheric dust, are suspended in it; now *water has very great solvent power*, and this solvent power is shown, both as it passes through the air, and, later, as it passes through the earth. It dissolves the atmospheric gases with certain other matters (varying with the region of the air concerned), and, further, it carries down in suspension some particles which are not dissolved, such as the carbon particles which may be seen in the rain-water collected in a smoky town. Thus rain, although probably the purest natural water (especially when it is gathered in the country, and at the end of a long wet period), has many and varied impurities; and dew[1], which must rank with the purer forms of rain, can hardly have more than a romantic use for drinking and for washing. The questions that are before us then are the following: *what is the nature of the impurities in water? what is their importance?* how far may they be disregarded in the use of water for what are commonly called domestic purposes?

A. *The characters of the impurities in natural waters.*

§ 19. In the first place, **gases** are present; we have said above that this is true even of rain-water, and we may add, further, that it is true of the waters of the sea, of springs, lakes and rivers, and wells. It is of course from oxygen dissolved in

[1] In the dew-ponds, which are of such interest and have been lately investigated, we find large quantities of dew-water, but these ponds are too rare to be dwelt upon here.

water that the plants and animals which are "water breathers" draw the oxygen necessary for their healthy life. All water exposed to the air dissolves not only oxygen, but those gases which are normally present in the atmosphere, and others which are present frequently or rarely. Nitrogen (with argon) is the least soluble of the ordinary constituents of air; oxygen is twice, and carbonic acid about seventy times as soluble. Consequently, when water takes up gases from the air the proportions in which they exist are changed, and "dissolved air" has not the composition of the air of the atmosphere. We have seen in § 6 that 100 volumes of atmospheric air contain

"Nitrogen,"	78·35 volumes,
Oxygen,	20·77 volumes,
Carbonic acid,	·03 volumes.

If air of this composition be in contact with 100 volumes of water at ordinary temperature and pressure, the water will dissolve

"Nitrogen,"	1·16 volumes,
Oxygen,	·62 volumes,
Carbonic acid,	·03 volumes[1],

so that in the *atmospheric air* there is 1 part of carbonic acid to 700 of oxygen and 2600 of "nitrogen," while the "*dissolved air*" in the water consists of 1 part of carbonic acid to about 20 of oxygen and 40 of "nitrogen."

[1] This calculation is from tables for 15° C. Except in the case of hydrogen, the amount of gas absorbed increases as the temperature becomes lower, and at freezing point 100 volumes of water will absorb from the air at atmospheric pressure

"Nitrogen,"	1·59 volumes,
Oxygen,	·854 volumes,
Carbonic acid,	·054 volumes,

making a total of 2½ volumes. This is the amount of gases commonly dissolved in 100 volumes of rain-water.

At higher temperatures, less of these gases is taken up; and by boiling the water they are completely expelled.

Sulphurous acid is nearly 3000 times as soluble as nitrogen, hydrochloric acid more than 30,000 times, and ammonia more than 50,000 times as soluble. Thus, the air is purified from these gases by the rain, which, in some manufacturing districts, may become even poisonous to vegetation because of what it has dissolved. These highly soluble gases are not driven off from water by boiling.

When water is exposed to a mixture of gases, such as air, the quantity of any one gas taken up by the water is proportional to the **quantity of that gas** in contact with the surface of the water; or, more exactly, with a square inch of surface. We have seen above that, under ordinary conditions, 100 volumes of water will dissolve from the air ·03 volumes of carbonic acid; if the air contain twice its usual percentage of carbonic acid, the water will dissolve ·06 volumes, and if pure carbonic acid replace the air (at the same pressure), the water will dissolve $\frac{10,000}{3}$ times as much, that is, it will take up its own bulk of carbonic acid[1]. Now the quantity of gas in contact with the water can be still further increased by increasing its **pressure**; when the pressure of air (or any other gas) is doubled, every cubic foot contains twice as much air (or gas) as it did before. Hence, water exposed to carbonic acid at a *pressure of 2 atmospheres* will take up twice its own bulk of the gas, or—to put the same fact in other words—nearly 7000 times the amount that water can take up from ordinary atmospheric air. This property is used by the manufacturers of aerated waters: they pump carbonic acid gas at several atmospheres' pressure into iron tubes containing water, and the water, taking up many times its own volume of the gas, is bottled in this condition. When the bottles

[1] We have seen (§ 6) that in 10,000 parts of fresh air there are 3 parts of carbonic acid.

are opened the gas escapes, at first violently, then more gently, until the quantity of gas contained in the water is equivalent to that which it would take up from the air around it. A similar "loading" or "charging" with gas characterizes some natural waters, such as those of *Seltzer* or of *Spa.* In their underground wanderings they encounter carbonic acid gas (formed by some of the chemical actions which are always going on in the earth's interior), and at high pressures. They absorb it, and so become converted into the effervescing waters that we know.

In the second place, **substances in solution** (other than gases) are present. These are substances dissolved by water as it passes through the air (rain, dew, fog), or as, later, it passes through the earth (streams, lakes, rivers, wells, and the sea), and they may be conveniently distinguished as **inorganic** and **organic** (compare above, § 11).

Of the **inorganic substances** in solution perhaps the most important are the *salts of calcium*, that is, *lime.* These are found in all water which has fallen upon or trickled through limestone rocks (calcium carbonate) or rocks in which sulphate of lime is present, and are found all the more abundantly because the water contains carbonic acid: in pure water, they are but slightly soluble, but when carbonic acid is present, they dissolve with ease. Calcareous waters are termed *hard waters*, a term which has come to denote their behaviour with *soaps.* Soaps, when they are mixed with pure water, form a lather,—the peculiar filmy froth with which everyone is familiar. But soaps are alkaline salts of fatty acids, and they form insoluble salts by chemical action with the salts of hard waters: curdy precipitates fall—precipitates of these insoluble salts,—and not until the chemical action which they indicate is at an end, can the "lather" be found. Thus some soap is wasted, so far as the purposes for which soap is used are concerned. It is clear that rain waters can never be hard; much of the spring water of England and some well water is very hard, and river water is, as a rule, intermediate, holding less chalky matter than many springs.

We have spoken of these calcareous salts as the most important soluble, inorganic constituent of waters, both because of their widespread distribution, and because, as we shall see, they are especially important from a domestic point of view. Other salts are richly present in some waters, mainly in the water of springs: among these are *sulphate of magnesia*, found in the saline springs of *Epsom*; *sodium carbonate* in the waters of *Vichy* and *Malvern*; *carbonate of iron* in the chalybeate wells of *Tunbridge.* The boiling springs of *Iceland* which are familiar as *geysers* have a good deal of *silica* dissolved in their waters,—that is, of the substance of which rock crystal and flint are composed,—and the brine waters of *Droitwich* are rich in *sodium chloride*, *bromide*, and *iodide.* All these however are medicinal and commercial, rather than domestic. But there are yet two inorganic salts which must be named, because both are due to the actions of man. The first is **sodium chloride**, occurring not as it does in the brine springs just named, nor in the waters of the sea, but in waters whose derivation shows that it can have had no legitimate origin, but is rather an indication of impurity springing from the refuse of man. The second is a **salt of lead**, generally the oxide combined with water (that is, the hydrate) which is formed by the joint action upon lead, of water and air. Rain-water standing on leaden roofs, or in leaden gutters, comes to contain this impurity, so also does any "soft" water which stands in leaden pipes; water containing sulphates and carbonates does not act upon and dissolve lead in this way, so that the hardest waters are usually lead-free.

But **organic substances** are also found in solution in water. From this group, since we are dealing with soluble substances, we must exclude all living creatures, for the tiny organisms which inhabit water are, of course, not dissolved in it. But we include substances which *they produce as part of their life work*, either turned out from themselves (all soluble excreted matter), or produced in their surroundings. We have said above (§ 1) that all putrefaction is the result of the work of bacteria, and one feature of this work is the production of substances which can be carried off in solution by water which comes in contact with decaying matter. If we consider for a moment the little runnels which, draining off a patch of peaty soil, form some small stream, or the water draining away from a farmyard, we can readily realize how rich water may be in the products of decay. Even when these small beginnings run into rivers, and become mixed with rain water and spring water, soluble organic matters may still be present, although they must be greatly diluted and have sometimes undergone chemical change. In rain, in deep wells and in springs, soluble organic impurities are not common; it is in the water of lakes, of rivers and of surface wells that they are often found. And this is what we might expect; rain has not yet touched the decay of the earth's surface; the water of deep wells and springs has undergone changes in its slow journeyings through the substance of the earth; but lakes[1], rivers and surface wells are more immediately connected with the excreta or the decaying remains of animals and plants.

There can be no doubt that the soluble organic substances of which we are now speaking must be very various in nature. All living creatures can be killed and then broken up into substances which are very much the same for each creature, if the breaking up is carried far enough; such are *free nitrogen*, *ammonia*, *free hydrogen*, *sulphuretted hydrogen*, *carbonic acid*. But what are called intermediate products, or by-products, are different according to the nature of the

[1] Lake water is very variable in composition, and sometimes has very little matter inorganic or organic in solution.

organism from which they are formed. Speaking of them as impurities in water, however, we usually group them together as "organic substances," partly perhaps because their special nature is not always determined (in "domestic" water their quantitative amount is small), partly because, as we shall see, it is important not to neglect organic matter whatever may be its nature.

Closely connected with the soluble organic impurities of water are certain bodies, themselves inorganic; these are **nitrates** and the less highly oxidized **nitrites**. They form a most noteworthy link in the chain of chemical processes by which plants and animals are bound together, for they are the bodies which form the main nitrogenous food of green plants living on the earth. At the same time their source is found in all decaying animal and vegetable matter, in all the nitrogenous excreta (or waste matter) of animals. The soil, the mud of rivers and lakes, every sewer and every refuse heap, all these are rich in organic nitrogen, i.e. organic nitrogen-holding compounds. And among these compounds, when the conditions of temperature and moisture are suitable, bacteria are working incessantly; certain forms break up the proteins; other forms break up the less complicated nitrogenous matter of the excreta (urea or uric acid); others finally seize on the broken-up matter (ammonia) and build it into the nitrates of which we are speaking. So it comes to pass that when nitrates or nitrites are found in water they are taken as indicating that organic matter is or has recently been present; it is inferred from their occurrence that the water holding them has come in contact with the processes of putrefaction, or of that special form of it, ammoniacal fermentation, and therefore certainly with bacteria, and with substances suitable for the propagation of the bacteria of disease.

In the third place, **substances** are found, **suspended in water.** These are most varied in nature, for we can say briefly that any particles which go to make up the dust of the air may also be suspended (if they are insoluble) in water exposed to the air. As dust "settles" it settles upon water, as upon land, and though most water is constantly moving—trickling or running from higher to lower levels—nevertheless it can only escape from dust when it moves within the earth—for in the air, dust is everywhere, and everywhere is falling. In § 11 we have considered the nature of dust; we have seen that inorganic and organic particles may be present in it and the classification made there may be applied to the particles in water. The sooty rain-water of towns is rich in **suspended carbon**, and it is mainly *inorganic matter* in very fine division which gives a **glacier stream** its well-known milky colour. In the mud of any muddy water, too, there is abundance of suspended inorganic matter, and a moment's thought reminds us of the **sand** and **gravel** washed down from high lands in many rapid mountain streams. But *organic particles* are often present too, and, as we shall see, have an importance all their own. Among them we must distinguish all *débris* of plants and animals which are insoluble in water, on the one hand, and, on the other, the tiny organisms which inhabit water and are invisible to the naked eye. Such are certain members of the Protozoa (as that group is named which contains the simplest animals known), the *amoeba*, the *flagellate infusoria*, which are sometimes made the subjects of popular scientific shows; such too are the **Bacteria**, and it is with them that we are concerned here. We have seen in an earlier chapter that the presence of bacteria or their spores is almost universal. In the air, on the surface of the earth, in all natural waters, even in glacier-ice they are found, of various species, and of varying habit. But it is when the conditions best suited to their life are realized, that they are vigorous, and grow and increase. Thus, in distilled water they may live, and as many as 35 specimens have been found in a litre of rain-water, but in these fluids there is no abundant food; again, we can hardly suppose that the bacteria in glacier-ice are in full activity for the time being. Water is indeed all important for their well-being, but it must be water bearing some food-materials. These are found both in soluble organic matter and in dead organic matter in suspension; the waters of springs, lakes and rivers contain bacteria in numbers which depend largely upon the amount of organic matter present, and water which has received the outpourings of sewers becomes a nutrient fluid in which bacteria thrive. It has been estimated that 1 *cubic centimetre* of the water of the river Spree taken above Berlin contains about **6000 bacteria**, while in 1 *cubic centimetre* of water taken below the city **243,000** are present. The total number of these minute creatures at any moment, in any water, must depend on very complex conditions; even the water of rain is unlike, according as it has fallen through dusty air or through air washed by long previous rain; and the waters of deep wells have lost by filtration through the earth varying numbers of the small organisms which they gathered on the earth's surface, while the completeness of the filtration must depend on the nature of the layers, or *strata*, which have acted as a filter. Again, a shallow river flowing through sunny land has its bacteria exposed effectively to the action of sunshine, and we have learned that sunshine is a valuable germicide. It can naturally act much less in the turbid waters of some deep river flowing between high banks or beneath clouds and smoke. And in addition to these factors we have what is of great importance, the strife of different kinds of bacteria. When many different kinds are present in any given water it is practically certain that a struggle takes place among them; some are weakened or killed; others are able to get the upper hand, and flourish, making use of such food matters as the water supplies.

In Chapter II. we have distinguished between pathogenic and non-pathogenic bacteria,—those respectively which do and do not produce disease in human beings. Many of the organisms found in the water of springs and rivers belong to the latter group; they are not disease-producing; but disease-producing forms do occur, for example, when water has been in contact with human refuse. It will be readily understood that such refuse is often disease-bearing, and the soil of the earth, always rich in bacteria, almost always contains some pathogenic forms when it is taken from cultivated spots, such as gardens.

We see then that *natural waters are never pure.* Their impurities are:

(*a*) **Gases** of various kinds; the gases of air, although not in the proportion in which they exist in the atmosphere; sometimes nitric acid; sometimes ammonia.

(*b*) **Inorganic substances in solution.** The salts of calcium (hard waters) have the widest distribution; salts of magnesium, sodium and iron are also found. Nitrates and nitrites springing from the breaking down and mineralization of organic nitrogenous matter occur, and salts of lead follow the action of soft water on leaden pipes, gutters, and roofs.

(*c*) **Organic substances in solution**, mainly the products of the activity of plant life and animal life, or substances immediately arising from the breaking down of these.

(*d*) **Inorganic substances** not dissolved but in **suspended particles**; mainly carbon, or the solid substance of the earth, and therefore very varied in nature.

(*e*) **Organic substances** in suspension; living or dead **microscopic organisms**; Protozoa or Bacteria or other very simple fungi.

B. *The importance of the impurities in natural waters.*

§ **20.** We have now to ask, What is the importance of these foreign constituents? How far may they be disregarded in what is commonly called the use of water for domestic purposes?

(*a*) **Gases.** Ammonia and nitric acid are poisonous except in exceedingly small quantities, but the gases of ordinary atmospheric air are without effect in drinking water except upon the palate (that is, probably, upon certain nerves), and their presence does not touch the value of water for cleansing purposes. The action on the palate is clear with most persons; water from which the atmospheric gases have been expelled by boiling is usually distasteful, and the "stimulus" of abundant carbonic acid (in sparkling waters) gives rise to sensations that are generally pleasurable. It is urged by some that carbonic acid has a further action, tending to promote movements of the intestines and so to work against constipation. The action is not recognized universally, but we could readily imagine that the gas might act mechanically, stirring up the nerves of the intestinal wall, or perhaps the muscles themselves, and thus provoking muscular contractions.

(*b*) **Inorganic substances in solution.** These have important action in washing waters and in drinking waters.

In *washing waters* it is salts of lime which are especially disadvantageous. We have said that it is they which make water "hard," and that the term "hard" expresses the fact that the water which it describes is a *soap destroyer*. But the use of soap, in cleansing either clothes or utensils, is to break up the greasy matter which helps to form "dirt" so that by rubbing and other suitable treatment it may be removed; if the soap is used to make chemical combination with the salts of hard waters, i.e. is "destroyed," it is **wasted** from a commercial point of view. To a less degree, the hardness is a drawback when water is used for cleansing the person. Probably, for cleansing all but the very unclean, water and rubbing are more important than soap; they are enough to stimulate or excite the skin to proper activity, and to remove the products of its action. But, for susceptible or delicate skins, water charged with lime is harmful, not as a soap destroyer but in another way. Unless used carefully, it may irritate the skin surface generally, or it may aid in blocking the exit ducts of some of the minute skin glands, so that small "cysts" filled with hardened substance, or with matter, arise. As a *drink*, hard water offers a protection when leaden pipes are employed for carriage; the series of chemical changes by which the pipes are eaten away and a compound of lead is dissolved in water, does not take place, at least where carbonates are present in the water. Drunk in small quantities the salts of hard water have not been shown to be harmful, except in cases of special delicacy of the stomach or intestines, but it is a doubtful benefit to drink large quantities of such waters. Thus a patient, carrying out the Salisbury cure, in a limestone district, would probably be ordered to use distilled water for his large daily consumption, rather than the natural chalky waters of limestone earth.

Of the other soluble inorganic impurities of natural waters, we may say that their importance lies in their presence in drinking-waters, rather than in cleansing-waters. We might, without serious harm, wash a floor with a solution of Epsom salts or with Vichy water; we might wash body-linen in water containing some salts of lead; but these waters used for drinking have marked effect. The *saline waters* are, for the most part, aperient[1]. They induce passage of unusual quantity of fluid from the capillaries of the intestinal walls into the intestine.

[1] See below, § 27.

Thus the waste matters moving down the intestine become more fluid than their wont; their passage is more rapid, their expulsion more easy. It is clear that such an action may be of great service occasionally, and when used intelligently, but that it would upset the healthy action of the body if the waters provoking it were drunk indiscriminatingly. Waters containing *nitrates* and *nitrites* are of themselves without special effect in domestic use, but they are often avoided as undrinkable, lest the inorganic salts should indicate the presence of organic matter, still unchanged, or only partly changed by chemical action (cp. above). *Salts of lead* are a most serious impurity in drinking-water. Even in very small quantities they are poisonous, even fatally poisonous; indeed, among the harmful inorganic impurities, they must be placed first.

(*c*) **Organic substances in solution.** The effect of these depends on their nature; some organic substances may be dissolved in drinking-water without acting for ill, but *many soluble products of bacterial action are most harmful.* These are often grouped together and spoken of as **toxines**; for, though physiological proof of their existence and power is well established, they have not in many cases been isolated as separate chemical bodies. Thus, the bacteria of *tetanus* (lockjaw) produce a toxine which can set up lockjaw if introduced into a healthy animal; and the bacteria of *diphtheria* gives rise to a toxine which can set up fatal diphtheria. These actions are performed when, by careful experiment, the toxines are freed from the bacteria of tetanus or of diphtheria respectively, but it will be readily understood that in cases of water-pollution the *disease-producing bacteria and their poisonous products are present together.* We may say, indeed, that organic matter in solution in drinking-water is **always suspicious**: it may have a special harmful action of its own; it does indicate the presence of bacteria with all their possibilities for evil. In cleansing-waters the importance of soluble matters of this nature is less; but it would be inadvisable to bathe or to wash such utensils, as were to be used for the purposes of eating and drinking, in water rich in soluble organic matters.

(*d*) **Inorganic substances in suspension.** We may say, briefly, that these are undesirable in drinking-waters, and often injurious in waters used for cleansing. Thus, the rain-water of large towns cannot generally be used for washing clothes because of its suspended carbon, and this, although its softness would make it an excellent medium for washing. Again, glacier water, or the water drawn from some deep wells, and containing sand, would not be chosen for purposes of washing or bathing, although it may be argued that the scrubbing action of the fine particles is cleansing and stimulating, and, certainly, a Swiss laundress would not hesitate to make use of a glacier stream. In considering the presence of similar particles in drinking-water we must remember that the alimentary canal (mouth, stomach, intestines, etc.) is really *outside* the body, and, as long as a continuous sheet of cells clothes it, foreign matter *within the canal* cannot do much harm. If such matter be abundant enough or penetrating enough to injure the *cells of the wall*, then grave consequences may follow. We named the stonemason's lung and the knife-grinder's lung as comparable cases of injury induced by breathing impurities; but the lining-cells of the lung are more delicate than those of the bowel, and it would indeed be rare to find, in drinking-water, suspended matter as dense and irritating as that loading the air in the carrying out of certain trades.

(*e*) **Organic substances in suspension.** It will be gathered from what has been said above, that these may be *by far the most dangerous impurities in water.* As regards water used for bathing or cleansing, they are only important if such water can be the means of carrying them to some susceptible part of a living animal. Natives in India have been known to wash milk-cans with unboiled water rich in the bacterium which is the immediate cause of cholera, and to spread a jelly-bag to "air" upon sand or earth abounding in the same pathogenic forms. Fortunately, in England, the conditions which make such action fatal do not often exist; fortunately, of the many kinds of bacteria present in almost all natural waters, the majority are harmless. But, because the harmful or pathogenic forms are so powerful, everything that may indicate or allow their presence should be taken as a danger signal. Chlorides and nitrites are (as we have said) innocent in themselves: but if chlorides indicate pollution with sewage from dwellings, if nitrites show that organic matter has but lately been changed in the water, then, remembering the foulness and mixed character of sewage, and the widespread existence of disease among men, we must look on these innocent substances with suspicion.

Indeed, looking back on the list of impurities given, we may say briefly, that if asked to name those which are important before all the rest, we should say:

For **laundry-work**, those constituents which are **soap destroyers.**

For **drinking-water, bacteria.**

C. *The treatment of the impurities in natural waters.*

§ **21.** It is not given to most housewives to choose the water which shall be used for domestic purposes and then to purify it. Any water may be purified by distillation, but distillation, to be efficient, needs more than the appliances of an ordinary household. And the choice of water is usually narrow, especially to the dwellers in towns; it is not the housekeeper who organizes the water supply and plans the sanitary appliances. But, these facts notwithstanding, a grave responsibility rests on each housekeeper; she can minimize if she cannot abolish the risks of water-drinking; she can often make water harmless, if she cannot make it pure. Let us remember whence we draw our water; primarily, of course, from rain, but immediately from springs and surface wells, and such deep borings as are needed for Artesian wells; and from rivers and lakes. There is hardly any modern house in which water is not "laid on," running to taps through leaden pipes. All water, then, has fallen from the heavens, and much of it, before use, has had considerable contact with the earth. We will consider briefly which of the impurities named above is specially characteristic of each source.

Rain-water contains gases, bacteria, often suspended carbon particles, sometimes lead, and, under special conditions, nitric acid, sulphurous acid, ammonia.

Surface-well water contains gases, often bacteria and their products, sometimes foulness from the drainage of cesspools and other impurities of cultivation.

Deep-well water is often poor in bacteria and their immediate products. The earth has acted as a filter and, during the slow filtration, chemical action has gone on, breaking up the "toxines" or other matters formed by bacteria. But this slow passage through the earth has often caused much inorganic matter to go into solution; such water then, may be rich in mineral compounds.

Spring-water has much in common with the water of deep wells; both have had a long passage through the substance of the earth, both, it may be added, contain a relatively great amount of carbonic acid; the "sparkle" of some spring-water is due to the presence of this gas. And in spring-water, as in deep-well water, bacteria and their products are scanty.

River-water and **lake-water** is mixed in origin and varied in character. Bacteria are always present, and, sometimes, disease-producing bacteria; their numbers depend on the course of the water, its depth, its exposure to sunlight, the conflict of various forms, and on conditions so complex that it is difficult to make a statement which shall be true for all lakes and all rivers. But we may say, generally, that their waters are rich in organic matter, and poor in inorganic substances in solution, for on the one hand they have commonly had sewage contamination, on the other hand the "hard" waters of the springs which help to feed them are diluted with rain-water, and probably lose their calcium salts to some of the minute animals living in lakes and rivers.

How should a housekeeper deal with water which may reach her from one or from more than one of these sources?

(*a*) There is no doubt that **boiling** is the most effectual safeguard, at least for drinking-water. By boiling sufficiently all disease-producing bacteria are killed, or, if spores are present, their vitality—in other words their *virulence*—is lessened. Toxines may possibly be broken up by boiling[1], for they are unstable, but, in such amount as they might occur, they would be comparatively harmless if unsupported by the active bacteria. Boiling also drives off carbonic acid, and thus some of the carbonate of lime which was dissolved by its aid falls as a white sediment or forms a white scum. But it must be remembered that *this precipitated salt of lime should be removed* either by deposit or by straining, because if taken with the boiled water we cannot say that the softening is effectual.

[1] I do not think this has been demonstrated. It must be remembered that, e.g., the diphtheria toxine which has been injected with fatal effect was prepared from a *pure culture* of the diphtheria bacterium; now toxines which occur in drinking-waters must be very largely diluted,—that is to say, that the danger from them is negligible as compared with the danger from living bacteria.

(*b*) **Filtration** is valuable if properly carried out, but very often it is *not properly carried out.* A filter which is at all neglected becomes mainly a **nursery for bacteria**; air, water, organic matter, the bacteria themselves, are all present, and if the filter be kept in some rather warm corner, the temperature is highly favourable too. Commercial filtration and chemical filtration are efficient; domestic filtration may be efficient, but is often a mockery of purification.

(*c*) Neither boiling nor filtration will free a water from the **salts of lead.** Here a housekeeper must consider the nature of the water she uses. If it be a hard water there is little risk of lead pollution; if it be a soft water it should always be taken from the pipes for use after **considerable flow.** It is desirable that drinking water should never stay in a cistern; anyone so placed that the use of a cistern is inevitable, should insure by regular *running of the water* that there is little stagnation, either in the cistern, or in pipes.

(*d*) Finally, there are two precautions which are less obvious than the foregoing.

It has been found that when river-water is allowed to stand, the bacteria in it increase in number considerably. It is advisable then, that *drinking water should be freshly drawn.*

And it has been found further, that foreign bacteria introduced into sterilized water live better than if introduced into water from the same source, but unsterilized. Clearly then, *boiled water should not be allowed to stand uncovered if it is to be drunk.* It would, in this sterilized condition, prove a medium favourable to the life of contaminating bacteria. In fact, if standing be inevitable, as in some cases of scant water supply, it is well to place the boiled water in a covered glass vessel in the sunshine.

It may be urged that the procedure recommended here is a "counsel of perfection"; this may be so, but it is at least procedure which would serve well in times of epidemic disease, or in other specially anxious conditions; it is procedure from which each housewife can shape her own action, having regard to her individual needs. And it may be urged, further, that we have dwelt unduly on the treatment of drinking-water, and neglected the treatment of water for the laundry. It must be remembered however that specialization of work grows as the years pass. The number of households who give "washing" to professional laundries constantly increases; the problem of softening hard waters (by means other than boiling, with precautions) is transferred. But, though many persons do not wash clothes, almost everyone drinks. And it will probably be admitted that the destruction of soap, even the destruction of clothes, and the expenditure of labour, are all evils less crying than is the spread of disease which may weaken or destroy man.

CHAPTER VI.

Foodstuffs.

§ 22. We learn, from the teachings of Physiology, that all the living creatures in the world are continually undergoing loss of their substance; the living matter of which they are made up is always breaking down into less complex bodies which are no longer living. The rate at which this takes place varies in the case of different creatures; plants, for example, lose much less substance than do animals. But such an animal as a man constantly suffers loss of nitrogen-holding bodies (mainly urea) by the kidneys, loss of carbonic acid by the lungs, loss of salts of various complexity by the skin, and in each case there is also loss of water. The substances which are taken into the body to replace this loss are in the first place *the oxygen of the air*, and in the second place the *heterogeneous bodies which we call* **Food.** It is our business here to ask briefly how food acts, what part of the various articles of diet which we eat and drink daily are truly foodstuffs, and how, for good or ill, we affect various foods by one treatment of them or another before use.

The Nature of Foodstuffs.

§ 23. We cannot analyse the living substance of which a plant or an animal is made, without destroying it; even the most skilful chemist is unskilled in dealing with the delicate fabric of protoplasm[1]. Now we know that in the absence of protoplasm we do not meet with the voluntary movement, and the sensitiveness, which belong to the popular idea of life; we know that behind these characteristics, and of the first importance to a physiologist, though the world hardly realizes them, are *complex chemical processes* equally inseparable from protoplasm, equally incapable of imitation in the laboratory, and we know that when by analysis, living matter is killed (broken down) and then investigated, certain bodies are always present. This knowledge, although in one sense limited, is of the highest value, for it is our guide in examining the nature, the importance, and the fate of Foods.

The bodies which are always found when "living substance" is thus examined after death are:

(*a*) Proteins[2], which, as we know, are *nitrogen-holding*, and which contain besides the chemical elements, oxygen, hydrogen, carbon (this very abundantly), and sulphur (in varying, but small amount), often phosphorus, and sometimes iron.

(*b*) Salts. These are various in nature; common salt or chloride of sodium is a familiar example and very generally present, but it must not be forgotten that carbonates and phosphates often occur.

(*c*) Water. This is always present, forming about three-quarters of the total weight.

In the great majority of animals and plants, and in man, we find:

(*d*) Carbohydrates, holding the elements carbon, hydrogen, and oxygen.

[1] This term is used as synonymous with "*substance which lives.*"

[2] After evaporating the water from a protein the residue contains (roughly) about $\frac{1}{2}$ carbon, $\frac{1}{5}$ oxygen, $\frac{1}{6}$ nitrogen, and $\frac{1}{15}$ hydrogen by weight.

(*e*) Fats; these also hold the elements carbon, hydrogen, oxygen, but in proportions and arrangement different from those which obtain in the carbohydrates.

Of these bodies the carbohydrates, fats and proteins (notably the proteins), are highly complex in composition; they are represented in the daily waste of a man by the simpler substances named above,—urea in the urine, and carbonic acid in the breath. And, as we have seen, there is daily loss of water and of salts. If food is to repair this waste it must consist of the complex bodies thus broken down by the chemical changes of daily life, or of substance which can be built into these bodies. Now the building-up power or constructive power of living beings varies greatly[1]; a green plant yields proteins, fats, and carbohydrates upon analysis, but does not feed upon them: in the sunlight it builds them up indirectly or directly from simpler substances. But a man cannot thus build up, and the food which is supplied to him day by day must contain the more complex bodies. The last stage of construction is, however, performed by man and all living things; protoplasm (that is, living substance) given as food, is killed in the consumption; and thus converted into dead proteins with admixture of other bodies; the annexation of dead substance to make living substance is the work of living substance and of that alone. But, apart from this final step, the constructive power of man is, as we have said, slight, from a chemical point of view, and we find that he is most efficiently nourished when *proteins*, *fats*, *carbohydrates*, *salts* and *water*, form constituents of his daily food.

The **Proteins** must not be grouped together indiscriminately. There are, it is true, certain points of behaviour (or

[1] See above, § 1.

reactions) in which all proteins are alike, but there are others which divide them into groups,—not without interest to the cook or nurse. Thus, many proteins dissolve in *water* (native albumens, proteoses, peptones); others will not dissolve unless some *neutral salt* be present (globulins) or unless the solution be *acid* (acid albumen) or *alkaline* (alkali albumen). Again, many proteins are changed by the action of *heat* so as to become more insoluble,—practically more indigestible,—and among these are albumens and globulins; others can be heated *without losing digestibility*,—this is true of acid and alkali albumen, of peptones, and of proteoses. Lastly, some proteins are especially complex, being bound up with *some substance which is not a protein*; in ox-gall and in the secretion from many salivary glands a complex body of this nature is found, but not used as food; the **casein**[1] of milk, however, forms another and somewhat different example, and is, of course, highly valued for purposes of feeding. We will speak presently of the different articles of diet which are rich in one or more or many proteins; this brief statement will serve to show that different members of the group (and therefore different protein-holding foods) need different treatment if their full nutritive value is to be realized[2].

The **Carbohydrates** are familiar as starch, dextrin, and the various sugars. To these may possibly be added cellulose; it is a carbohydrate, but, for man at least, a doubtful food. If, including it, we arrange the members of this group in increasing order of solubility, the series runs thus; cellulose, starch, the dextrins, the sugars. For *solubility* we may without great inaccuracy read *digestibility*; thus, cellulose is acted upon by none of the digestive fluids of the human alimentary canal; raw starch is almost equally refractory, and boiled starch, incapable of absorption as starch, is changed to sugar by action of the saliva and pancreatic juice. Dextrin

[1] See below, footnote, p. 72.

[2] The substance *gelatine* which is allied to proteins will be treated of later. See below, § 28.

is to be regarded as on the way to sugar, and the sugars themselves are probably fit for absorption with very slight digestive change, or none.

We notice that among the carbohydrates (as in the case of the proteins) for absorption from the alimentary canal, and probably, later, for transport through the body, relatively insoluble bodies are made soluble by the action of the digestive organs. In various regions of animals and plants we meet with members of these groups which may be called insoluble,—the abundant starch of plants, the glycogen of the human liver, many of the proteins of almost all cells. But these bodies are not taken in or passed on as such, but at times of transport have been changed to allied bodies of high solubility. This is seen clearly when we recall the physiology of digestion. Of the proteins named above the *proteoses* and *peptones* are the most soluble, and they alone of proteins are diffusible[1]. And, as we know, it is proteoses and peptones which are formed abundantly by peptic digestion in the stomach and by the action of pancreatic juice in the intestine. The *metaproteins* too (this word includes acid albumen and alkali albumen) are capable of being absorbed, and they are formed in digestion. And it is clear that *dextrin* and the *sugars*—mainly the latter—form the goal of digestive change on starch.

The **Fats** of food are either (*a*) present in the tissues in which they have been laid down in life and thus enclosed in the cells of these tissues, or (*b*) they are taken out or *extracted*, running together into irregular masses of large size, or (*c*) more rarely kept apart as small, separate globules. In suet, to a certain extent in cooked meat, in most nuts (eaten raw), and in the diseased *pâté de foie gras*, the fat is in the first condition; in dripping, butter, the oils, it is extracted without

[1] It would be out of place here to lay stress upon the differences which exist between proteoses and peptones, or to distinguish other derivative proteins.

subsequent mechanical splitting up: and milk is the most familiar example of natural fine division, that is, of an *emulsion.* The chemical form in which fat is usually eaten in Europe is that of **neutral fats**, which may be compared very roughly with complex oxides. But under certain conditions (and as we know during pancreatic digestion) these change, splitting up into the substance *glycerine* and free *fatty acids.* As any acid, meeting with a base, unites with it to form a salt—and that this is true we know from the most elementary study of chemistry—so the fatty acids combine with bases when these occur suitably. But in this case the resulting salt has a special name,—it is called a *soap*, and it is soluble (e.g. sodium) or insoluble (e.g. lead) according to the nature of the base which has helped to form it. Thus we may, and in the intestine we do, deal with *neutral fats*, with *fatty acids*, and with *soaps.* The exact chemical form in which fat is best suited for absorption has not been clearly settled by experiment, but there seems evidence that *soaps* and the *fatty acids* are especially concerned. If this is so, we have (as in the case of the other foods) digestive action leading up to absorption, by chemical change.

The *variation in melting point* which characterizes different fats is among their most striking physical features. A piece of lard swallowed by a frog may be found, later, in the intestine—partially digested indeed, but with a residue of unchanged consistency. The same substance soon becomes fluid in the stomach of the warm-blooded animal, man, whereas we may gather that the wax of a bee's honeycomb passes unmelted through the human intestine, since it is solid up to a temperature of 63°C. It is, on the whole, characteristic of vegetable fats that they have lower melting points than the fats obtained from animals, and this has perhaps been associated with the use of the term *oil* in speaking of them; but a series arranged with regard to melting points, shows a certain admixture of the products of animals and plants, for animal fats differ widely among themselves. The fat of mutton is hard,—but it is fluid during the life of the sheep, and practically all fats, or mixtures of them, which are important constituents of the food of man are fluid at the temperature of the human stomach.

Not only are the fats of food melted during digestion, but they are also *emulsified.* Sometimes the natural emulsion, milk, is part of food, sometimes artificial emulsions are eaten. Among them are such sauces as *mayonnaise*, *Hollandaise*, and such prepared nutrients as *Cremor hordeatus* or some forms of *cod-liver oil.* But, in the food of the healthy, the fat (butter, cheese, fat of meat, nuts) is relatively massive, and it is the work of the pancreatic juice (in the presence of small amounts of fatty acids) to break up these massive irregular drops into minute particles, forming a sort of cream. In past years it was believed that this creamy mass of (chiefly) neutral fats was taken up as such by the mobile cells of the intestinal walls: we have said above that recent work points to chemical change before absorption,—change to fatty acids and further, to soaps. But even in this event the emulsification is of great importance, for *all chemical change is carried out more readily, more thoroughly, if the body changed is in a state of minute division.*

Saline Matters or **Salts** form part of every natural diet, and an animal, deprived of them by careful artificial treatment, dies. The term *salts* is popularly associated with mineral compounds; and indeed chloride of sodium and phosphates of lime and of sodium play especially important parts in the chemistry of the living body. Such inorganic salts are sometimes eaten uncombined with articles of food, and merely accompanying them:—we know that the great majority of dishes are served with *sodium chloride* as an ingredient or an addition. But the action of the saline matter is more effective when it forms an integral part of food. Instances of this union will be given later (§ 47), but we may here recall the fact that milk and yolk of egg are rich in *lime*—a substance all-important for the healthy growth of young animals. On the other hand peas, white of egg, and potatoes are poor in lime, but they hold much *potash*,—or at any rate combined *potassium*.

But, besides these inorganic salts[1], organic salts and organic compounds having some mineral constituent must be reckoned with. Experiment and observation have shown that they are needful, although the exact share taken by them in the chemical changes of life is yet undiscovered. Thus, *iron* is indispensable to proper nourishment, and it is most readily absorbed and assimilated in such complex combination as we find in beef, in yolk of egg, and in some vegetables. And many fresh fruits are rich in organic acids or salts.

In a certain sense, **Water** must be separated from the foodstuffs here considered, and yet, in importance, it is second to none. We must remember that the constant loss of sweat from the surface of the body is the evaporation of a watery solution, that all waste matter which leaves the human kidney is in watery solution, that the air bearing waste matters from the lungs is loaded with watery vapour, and that water is always mixed with the waste from the intestine (fæces) although its amount varies. Remembering this, we shall not wonder that water must be taken abundantly, either alone or mixed in various ways with food. Some facts concerning this admixture we shall speak of later; here it may suffice to remember that *fluids form the medium of all chemical interchange*, and that, to water falls the important task of being a first essential in the formation of such media in the human body.

[1] Note on Casein; cp. p. 68. *Caseinogen* is the name now (1910) given to the principal protein of milk, the term casein being reserved for the substance formed when caseinogen has been exposed to the action of rennet.

§ 24. TABLE OF FOODSTUFFS MENTIONED IN THE FOREGOING PARAGRAPHS.

Proteins

contain **Carbon**, **Nitrogen**, **Oxygen**, **Hydrogen**, and *Sulphur*; often *Phosphorus*. Traces of salts are commonly found with them.

I. *Native albumens.* Soluble in water, solutions coagulated by heat.

II. *Globulins.* Insoluble in water, soluble in solutions of neutral salts, such as *sodium chloride*, *magnesium sulphate*; solutions coagulated by heat.

III. *Casein*[1]. *Compound protein*, containing a substance or residue which cannot be digested in the stomach. Insoluble in water; soluble in dilute saline solutions and dilute alkalis; not coagulated by heat.

IV. *Meta-proteins.* Acid and alkali albumen; soluble respectively in dilute acid and alkaline solutions; solutions not coagulated by heat.

V. *Proteoses and Peptones.* *Diffusible, especially the peptones.* Soluble in water; solutions not coagulated by heat.

Coagulated proteins produced by the action of heat on albumens and globulins, are insoluble in water, in salt solutions, in dilute solutions of acid and alkali. Soluble in gastric juice and pancreatic juice, they are changed by these fluids to proteoses and peptones.

Of these groups of proteins I, II, III are found in the living animals or in their secretions; IV and V are formed in the course of digestion; coagulated proteins, formed artificially by heat, are the most insoluble form of protein.

Carbohydrates

contain **Carbon**, **Hydrogen**, and **Oxygen**, the two latter elements being here (and in a few substances which are not carbohydrates) in the proportions in which they exist in water.

[1] Phospho-proteins. See above, p. 68.

I. *Cellulose*, forms the cell-wall or protecting membrane of most plant cells. Insoluble in all the digestive fluids of man; dissolved and changed by action of certain bacteria and by certain ferments found by plant cells.

II. *Starch.* Insoluble in cold water; swells in boiling water to form mucilaginous fluid or jelly; changed by ferments of saliva and pancreatic juice to dextrins and sugar (maltose).

III. *Dextrin.* Soluble in cold and hot water, solution clear. Dextrins are intermediate bodies formed in change of starch to sugar. Very like the *glycogen* of the liver.

IV. *Sugar.* Very soluble in hot and cold water; solution clear and sweet. Many sugars known; they are found plentifully in nature, especially in plants.

Carbohydrates are absorbed as sugar from alimentary canal.

Fats

contain **Carbon, Hydrogen** and **Oxygen**, combined and arranged differently from the carbohydrate combinations.

I. *Neutral fats.* Insoluble in hot and cold water; solid at temperatures which vary for different fats. Form *emulsion* (a creamy liquid) when broken into minute particles, e.g. by alkali.

II. *Fatty acids.* Formed by splitting up of neutral fats with separation of glycerine. This is one action of *digestion in small intestine.*

III. *Soaps.* Formed by union of fatty acids with some base. Are salts, soluble or insoluble according to nature of base. This is one action of *digestion in small intestine.*

Fats are absorbed as fatty acids and as soaps; possibly as emulsified neutral fats.

The action of Foodstuffs in nourishing the body.

§ 25. We have thus gained some idea of the raw materials which, in the shape of food, are placed at the disposal of the body in order that this body may build itself up and repair waste. And we may now go a step further, asking the question, "How are these raw materials used by living substance?" In the body, as we have seen, *proteins*, *fats*, *carbohydrates*, *salts* and *water* are always present; do the proteins of the food form the body proteins? do the fats of food give rise to fats, and the carbohydrates to glycogen or some sugar-like substance? To answer this question fully we should have to go beyond the limits which are suitable here; we must be content (as a partial answer) to consider what is indicated by the chemical constitution of the foodstuffs, and to name some of the results of long-continued and careful experiments in physiology.

From a chemical point of view fats and carbohydrates, either alone or combined with each other, cannot give rise to protein, for they are *without the element* **nitrogen.** Proteins, on the other hand, hold all the elements which fats and carbohydrates contain; therefore they can, so far as their actual elementary composition is concerned, *act as the source of both these simpler compounds.*

The results of experiments support the conclusions which these facts lead us to draw.

(*a*) In the first place, it is found that **protein foodstuffs** can give rise within the body to proteins, carbohydrates and fats. It is easy to believe that the nitrogen of the body-proteins is derived from the nitrogen of protein food, but it has been shown also that, on protein diet, there may be storage of the starch-like glycogen of the liver and also formation of fat. A good illustration of the last-named action is found in the fact that a mother, nursing her child, gives milk richer in cream—which is mainly fat—when she is supplied with abundance of protein in her food. And in certain forms of the disease **diabetes**, in which sugar is excreted in large quantities by the urine, it has been shown that this sugar must be derived from the breaking down of some nitrogenous substance.

(*b*) In the second place, it is found that an animal dies when fed **on fats and carbohydrates without proteins.**

But **carbohydrates** can and do give rise to fat in the body, and we are familiar with the change in daily life. For potatoes (because of the large quantities of starch they contain) are one of the first articles forbidden by a doctor to a patient who is too fat; and again, bees form abundant fat (wax) from food which is chiefly sugar.

It has not been clearly shown that **food-fats** give rise to body-carbohydrates; it is proved that the fat of food undergoes or may undergo a change to form some different fat which is characteristic of the tissues of the animal consuming it. Thus, in ordinary farm feeding, the fat of oil-cake does not reappear in the milk and the tissues of the cattle fed upon it; and the fat of a man is unlike the fat of a dog, even when both are fed upon the same fatty food.

§ **26.** In shaping a diet which involves determination of quantities, there are other important experimental results to be considered besides the mere chemical changes which are possible to foodstuffs.

(*a*) In the first place, a diet in which proteins are used to the exclusion of fats and carbohydrates, is a most extravagant diet from the physiological point of view. A certain amount of carbon is demanded by the body daily to make good the daily waste of this element; in order to gain this from proteins alone, so much must be eaten and changed chemically, that at the same time far more nitrogen is eaten than is needed, and there is uncalled-for nitrogenous waste, which may even be accompanied by serious disturbance of health. Further, it is found that protein food makes the total chemical change which is constantly going on in a man's body more active; we might almost say the *living substance lives faster.* This is sometimes a change for the better; thus, great stoutness may be due to sluggish chemical processes in which *fat* is formed and laid down, rather than the more complex *protoplasmic* substance. And in such cases a healthful reduction of fat may be brought about by abundant protein in the diet, as in the system known as "Banting," or as in the more modern "Salisbury treatment." But if there is not this unhealthy stoutness; if a man is maintaining his weight, and is in good muscular and respiratory condition, then increase of the total chemical changes of his body (increased **metabolism**) is harmful rather than a benefit.

(*b*) In the second place, there can be no doubt that the fats and carbohydrates are invaluable as subsidiaries in the chemical changes of the tissues, although they cannot play the part of principals. They are rich in carbon, and we remember how much the daily waste matters of the body are carbon-holding. A tissue so characteristically nitrogenous as are the voluntary muscles, has abundant non-nitrogenous waste-products (*carbonic acid*, *lactic acid*, *water*), and it is these which are notably increased when a muscle works hard.

Further, the non-nitrogenous foodstuffs have this property, that they check or lessen the chemical changes in proteins: in other words, they spare nitrogenous waste; *the tissues, we may say, live more slowly.* And this in times of health is a valuable economy. Sometimes indeed the life of the tissues is already too sluggish, for example, in such disordered conditions of the body (referred to above) as lead to excessive stoutness. To give a diet of fats and carbohydrates here would be most unsuitable; the foodstuffs which are needed are such as will excite thorough chemical change, so that the substance of the cells makes **itself** (i.e. **protoplasm**) out of the raw material offered, and does not halt at any "half-way house" of fat-formation.

But on the whole, although, in the history of animals, the first digestion was probably protein, there can be little doubt that a diet in which nitrogenous and non-nitrogenous foodstuffs are mixed is the "happy mean" physiologically for man. When it is given, the digestive juices are taxed in fair proportion, the ferments acting upon starches, proteins, and fats, all having materials on which they can act: at the same time, no excretory organs are taxed unduly. Under certain conditions it may be most desirable to let one substance or another come to the front in diet, either because one digestive organ is weak, or because the chemical changes of the whole body (and we must remember that to these changes the formation and maintenance of the different tissues is due) have run riot in some way and need the checking which unusual food can bring about. And infancy, extreme old age, and sickness all need special arrangements of food; it must be remembered that here we are intentionally leaving aside these states, and dealing only with the healthy adult.

In speaking of the *rôle* of non-nitrogenous foodstuffs we have not discriminated between the fats and carbohydrates, and it may be asked, "Is it a matter of indifference whether either or both be introduced into diet?" Within limits, they can replace each other, and each has its special drawbacks and advantages. A given weight of fats is more useful to the body,—can be used more economically in its chemical changes than can the same weight of carbohydrates; on the other hand, fats are somewhat difficult of digestion. Carbohydrates are easier to digest and they are cheaper, commercially. We must probably look upon the most satisfactory diet as that which contains a mixture of the two.

§ 27. The question of the exact fate of the **salts** and **water** of diet is, in some ways, more difficult than that we have just been considering; it is indeed too difficult for long discussion here. But one or two points may be borne in mind.

(*a*) In the first place we must realize that all the tissues of the body are *wet*; that is to say, that water is present in varying amounts, but generally forming about three-quarters of the total weight of the tissue.

(*b*) In the second place *all foods contain water.* That this varies, and how it varies, we shall see in succeeding paragraphs, but we may mention here that in what is called *dry oatmeal*, 15 parts out of 100 are water, and that 8 parts in 100 are found in *butter*—a food which seems almost purely fatty. As we might expect, the water present in *raw meat* is more abundant; in *lean beef* there are about 74 parts in 100; in *white fish* 78 in 100 parts.

But, apart from this water, taken half unconsciously with food, much is drunk as hot or cold water, and in various made beverages. *This has important special action.* It calls forth **peristaltic movements of the intestines** (i.e. the movements which shift the contents of the bowel and pass undigested matters towards the lower opening) and thus helps digestion, while it checks constipation. It also acts as what is known as a **diuretic**, bringing about more vigorous action of the kidney, and greater flow of urine, and so helping the discharge of important waste matter. Probably the intestinal movements are quickened more by cold water than by hot water or tea,—almost any hot drink has the diuretic property—and such hot fluids also tend to the formation of sweat. We know that the temperature of a healthy man remains fairly constant, and further that all the small blood vessels of his body are in more or less close connection by means of delicate nerves. When much hot fluid is introduced into the body there is (through the action of these nerves) a flushing of the blood vessels of the skin—so that hurtful rise of the temperature of the body generally is avoided—and with this flushing there may be marked outpouring of sweat, and thus further increase in the discharge of waste matter, and further reduction of temperature by evaporation.

The action of saline drinks is aperient; it has been mentioned above, § 20.

Of the *salts* we may say briefly that, as all tissues of the body, when analysed, show saline matter among their ingredients, so we can hardly find the article of food which is absolutely salt-free. But there are certain parts of the body where the presence of salts is very marked and of great importance,—we may instance all bony matter, and the red colouring matter of the blood, which is indeed a protein compound, but is iron-holding. And to meet the special needs of such tissues, pressing above all times during growth, there must be choice of special food in which the suitable salts or elements abound. Thus a large part of the saline matter which makes bones strong and rigid is *phosphate of lime*, and milk is distinguished by its richness in lime; it is on this account, among others preeminently the food for the very young.

§ 28. There are two substances which have been merely mentioned in the foregoing pages, and upon which we should yet dwell briefly, as they are very commonly present in articles of food. The one is **Gelatine,** a body not truly a protein, but yet allied to protein, and nitrogen-holding; the other is **Cellulose,** a member of the groups of carbohydrates.

Gelatine in Food.

In its extracted form, extracted for example from calves' feet, or prepared commercially from other animal substances, **Gelatine** is familiar to most housewives; as are its properties of setting to a jelly in the cold, of becoming liquid when warmed, and of remaining uncoagulated when greatly heated. It may, by boiling, be extracted from *all connective tissue*, from *bone*, and from *cartilage*; the veal-stock or beef-tea which "sets" on cooling has been prepared from meat rich in connective tissue (*tendon* or *sinew*) or from young bone, and it is the gristly or cartilaginous character of the calves' feet which makes them a rich source of gelatine. What is the value of this gelatine in diet? Is it a true food?

Gelatine cannot act as a protein; it cannot build up tissue; indeed an animal which received all its nitrogen in the form of gelatine would first draw upon its own nitrogenous tissues, and would presently die. But, on the other hand, it has a distinct value as *an economiser of protein.* We have said above that the non-nitrogenous foodstuffs act as "sparers" of the chemical changes in protein; the action of gelatine is like theirs, but more powerful, so that an animal will thrive on a diet which does not hold much protein, when gelatine is eaten at the same time, although the protein cannot be removed altogether.

Besides having this direct value, gelatine is often the means through which some food or stimulant is given;—food such as meat-juice, fruit-juice, sugar, or cream;—stimulant such as brandy or wine, or extractives of meat.

Lastly, it may be regarded as a pleasant accompaniment to solid food in various preparations of aspic.

Cellulose in Food.

We know that, in the human alimentary canal, starch is turned to sugar by ferment action. A ferment having this power is formed by the cells of the salivary glands and then poured into the mouth, and a similar ferment is formed by the cells of the pancreas, whence it reaches the intestine. This ferment has no power on the more insoluble carbohydrate, cellulose; indeed *there is no ferment formed by the gland-cells of man which can dissolve it.* Yet cellulose is largely eaten by man. All vegetable cells, all fruit cells are clothed by cellulose or by some substance allied to it or derived from it, which may be even more difficult to dissolve. Its fate then is a matter of interest; is it, we may ask, useless matter—the inevitable but inconvenient load of true food?

(*a*) This question can be answered in the negative. In the first place some living matter is capable of forming a ferment which acts upon cellulose—the living matter of certain plant cells. The living matter of certain *bacteria*, either by means of a ferment, or directly, also has this solvent power. Now these bacteria are found in the intestines of probably all mammals, and there is evidence that to them is due the disappearance of cellulose which certainly does take place in human digestion. This disappearance is only partial at the best, and varies much in extent; the products of solution are not simply sugars but more complex, and, it is safe to say, less nutritious; still it must be remembered that not all the cellulose eaten is cast out unchanged, and that the agents which bring about change in a part of it are in one sense foreign inhabitants of the intestine.

(*b*) But in the second place the *cellulose which is not digested has a use which is probably of high importance.* It stimulates mechanically the walls of the intestine, helping those wave-like movements which we have learned to call *peristaltic*, and which shift the food that it may be thoroughly exposed to the ferments present and that, when its nutritive matter is used up, it may be passed to the exterior. The intestines of animals who feed differently have different characteristics: thus, flesh-eaters have a notably short intestine; on the other hand herbivora (grass-eaters) have a very long intestine, and to them the stimulus of cellulose is all-important. Man, intermediate in the character of his food, has an intestine of intermediate length, but the removal of cellulose from his diet has generally to be met by special treatment. It is well known that in carrying out the "Salisbury" cure (in which one aim is the digestion of protein food) some sort of aperient is often used, and equally well known to doctors is the aperient action of brown bread, porridge, and other foods rich in "indigestible" cell walls.

We have just said that many plant cells do form a ferment or ferments which dissolve cellulose. These ferments do not continue their action after such cells are eaten by animals, but before this point they have in some cases produced an effect which has especial interest for the cook. The term **pectine** has been used to indicate a substance or substances which may be yielded by ripe fruits, substances which in hot water are liquid (form a solution), but, in the cold, set to a jelly, and which form the ground-work of the true **fruit jellies** with which we are familiar. And these substances, pectine and its near allies, probably spring from change in the very insoluble carbohydrates of the cell walls of various fruits. The change is not a simple one, and to discuss its exact nature would be out of place here. But we may remember that while the gelatine of animal tissues is nearly allied to the proteins, the bodies which in plants most resemble it physically (i.e. which are liquid in the warm and set to a jelly in the cold) are **non-nitrogenous** derivatives of the abundant carbohydrates of the cell walls, and are derived from them, when the conditions are suitable, by special ferment action. We have seen that *gelatine* is of real value in itself as sparing the protein waste in the body; the exact value of *pectine* has not been found, but it is very probably valuable in the same fashion—whatever that may be—as are salts and organic acids. Therefore, in thought, we should associate it with them physiologically, rather than with the proteins, carbohydrates, or fats.

Summary.

§ 29. It may be helpful to gather together briefly the most important points which have been dealt with in the foregoing paragraphs.

(*a*) We have seen that *a diet of non-nitrogenous foodstuffs only would starve the body.* For there is a daily waste of nitrogen—a loss which they cannot repair.

(*b*) On the other hand we have seen that *protein foodstuffs can be used as the sole food of the body*, repairing both nitrogenous and non-nitrogenous waste.

(*c*) But lastly we have seen that such *a protein diet would be a physiological extravagance*—a waste of nitrogenous material for the adult who is healthy—a *régime* often accompanied by injurious consequences.

(*d*) Thus we are led to regard as best for such an adult **a mixed diet,** *a diet which is, moreover, never destitute of salts and of water, and has its due proportion of insoluble material such as cellulose and woody fibre.*

§ 30. The question which naturally follows on these conclusions is this: "How do we gain such a diet from the foods at our disposal? What foodstuffs belong to various articles of diet?" The answer to this question forms the subject of the next chapter. But before turning to deal with it we may say a word upon one of the most widespread misapprehensions which is betrayed by students of elementary dietetics. This is the ready use of the terms "tissue-formers" and "heat-producers" to indicate respectively proteins on the one hand, and fats with carbohydrates on the other.

How are tissues formed in the body? They are formed by their own activity from food; and this food, while it is necessarily protein, is faulty unless it contains carbohydrates and fats as well. Moreover the waste of muscles is very largely non-nitrogenous and, we may infer, so is the waste of other tissues which are less readily examined. Nitrogenous waste does always occur, but it would seem to be spared by supplies of non-nitrogenous food; and when muscles work especially hard the nitrogenous waste is very little increased, but there is much greater discharge of water, of carbonic acid, and of sarcolactic acid.

How is heat produced in the body? Briefly, by any kind of *metabolism* or chemical change. But the active seats of chemical change are the tissues, and the tissues are protoplasmic, i.e. nitrogenous. And protoplasm cannot be built up without proteins, though fats and carbohydrates may be most important aids. Metabolic action, chemical change, is nowhere more active than in the muscles, the glands, the nervous tissues of the body. We cannot separate from them our conception of the physiological heat producers; we cannot separate their existence and well-being from the taking in of protein food.

These statements are brief and apparently dogmatic, but almost every one could be supported by evidence drawn from the careful work of many physiologists. They may just indicate (and more than this they cannot do) the complexity which does belong to the nutrition of the body; I should be glad to think they could check the easy use of half-understood technical expressions. The division of foods into *tissue formers* and *heat producers* had a meaning to the great physiological chemist who first made the distinction; the terms have a meaning still for the expert, but a meaning which the work of recent years has tended to make more complex and less clear-cut. And it would be a great gain if their general use at the hands of those who are not chemical or physiological experts could become a thing of the past; if we were content to describe foodstuffs in terms which their constitution teaches us, and not to prejudge the hard question of their *rôle* in the chemistry of life.

CHAPTER VII.

The Constituents of Food.

§ 31. In the last chapter we learnt that certain foodstuffs must be present in the food of man if he is to live healthily; we have still to learn how food may be chosen intelligently. The knowledge which should help in this choice is really to be gathered from the information we have already acquired, together with further facts brought out in the following chapter, for we must know in the first place how the *different foodstuffs are distributed among, or contained in, different raw articles of food*, and in the second place how these *articles of food are affected by cooking or by other preparation for the table.*

Nevertheless as preliminary to both these divisions of the subject, we may say that *no one diet can be described as a perfect diet for mankind.* Bodies of similar composition have to be maintained by food in widely different regions of the world and under different conditions of wear and tear; and, partly from choice, partly from the necessities of the situation, the diet of man is now animal, now vegetable, sometimes taken in the raw state, more often prepared for eating by some process of cookery. That all these varieties of diet are of equal value we cannot pretend; their economy (in a physiological sense) is very varying, but what we shall see is that s i m i l a r c o m b i n a t i o n s o f f o o d s t u f f s m a y b e d r a w n f r o m d i f f e r e n t s o u r c e s. It may be urged further that as the same food is not appropriate to the infancy, the manhood, and the old age of a man, so, when many adult men are gathered together and fed upon similar daily rations these rations do not meet the needs of each individual with equal success. When a group of persons are clothed in ready-made clothing, those persons who diverge most widely from the mean size show a misfit most clearly, and, in the same way—though the fact is less readily appreciable—there must be many "misfits" in a common diet such as that of a prison, of an army, of an orphanage, or of a ship. These diets may be chosen with great care, but we can hardly look on them as in each case the best for each of the many individuals who share them. We would not, then, prescribe a diet, but rather give the data from which intelligent individuals may shape a diet. To this end we will here consider the foodstuffs in order, saying something about the various foods in which they are found and the condition in which they are found. For like constituents are present in different parts of plants and animals in different proportions; liver and kidney, for example, are unlike fat bacon; the seed of a pea is unlike the pod or the leaf; and, while milk is the source of cheese and butter, it differs widely from both in food contents.

PROTEINS.

A. Proteins in animal substances.

§ 32. We will take as a point of departure a well-known protein-holding animal food, namely *lean beef*, and consider its composition. It is, as we know, the flesh (that is, the muscles) of the ox, made up of bundles of muscular fibres of the variety known as striated, and each of these fibres possesses its own protoplasmic substance and nuclei, and is bounded by a delicate sheath of somewhat different composition. The separate muscular fibres, and, again, the bundles of these fibres, are held together by connective tissue which has no power of contraction; this tissue varies in amount,—thus rump-steak has very little of it, but all sinewy meat has much. Running in the connective tissue are the blood vessels and nerves of the muscle, abundant in number but not important in bulk; and we must not forget that much blood with lymph is still clinging to the muscular fibres, although much has been lost in the process of "cutting up" the ox. When fat is present it is stored between the fibres of muscle and in the connective tissue, but for the moment we are considering *lean* beef.

With this characteristic structure we find a certain characteristic chemical constitution bound up:

(*a*) About 75 parts by weight in 100 parts of uncooked beef are water.

(*b*) About 20 parts by weight are made up of nitrogenous substance. This, though nearly all protein, is not pure protein; it includes the connective tissue, of which mention has been made, and which, on heating in moist heat, yields *gelatine*; it includes also certain nitrogenous bodies which probably spring from chemical changes in the proteins and are sometimes spoken of collectively as *nitrogenous extractives.*

When we examine the composition of human muscle carefully we find that it is as follows. In 100 parts there are:

Water	73·5	parts.
Proteins	18·02	,,
Gelatine	1·99	,,
Extractives nitrogenous and non-nitrogenous	·22	,,
Inorganic salts	3·12	,,
Fat	2·27	,,

It will be seen that the error introduced by grouping the gelatine and nitrogenous extractives with the proteins proper, is not great. And we shall group them thus in the analyses of foods which follow, unless special statements to the contrary are made.

(*c*) The most important proteins in beef belong to the group of the *globulins*. It will be remembered then that they do not dissolve in pure water, but that they do *dissolve in solutions of neutral salts* (e.g. common salt), and also that they *coagulate* or become more insoluble (indigestible) on heating (§ 23).

(*d*) Salts are present, between 1 p. c. and 2 p. c.

It has been found that lean beef, eaten raw, is digested in about 2 hours, and the digestion of its proteins is almost complete. Complete digestion is hardly known in the alimentary canal of man, but, in the case of raw beef, only 2½ parts by weight in 100 are passed from the bowel unabsorbed.

Cooked beef is digested less quickly, needing from 2½ to 4 hours, but the residue need hardly be greater than with the raw substance.

Briefly, beef must be looked upon as very nutritious and very digestible; it ranks high among protein-holding foods. Eating it, we eat proteins which are for the most part made insoluble by heat, and which in the natural state do not dissolve in water but do dissolve in solutions of salts. Further, they are proteins which, in the beef, are associated or bound up with water and with very small amounts of salts.

§ 33. These characters are possessed not by beef alone but by the muscular substance of great numbers of animals, and it is on this ground that we eat animal flesh so largely. Butcher's meat, poultry, game, fish, crustacea (crabs, lobsters, prawns, etc.), molluscs (oysters, mussels, etc.) are different in small points from each other and from beef, different in the exact amount of water and proteins they contain, different now and then in the character of their proteins. But, in all, the water present amounts to between 70 and 80 parts p. c., the proteins to from about 18 to 22 parts p. c., and among these proteins *globulins* are found. The same may be said of *heart-muscle* and of *tripe* (*stomach*), in both of which the muscular fibres lack the delicate sheath which the fibres of voluntary muscle possess; and the *tongue* is another highly muscular article of diet in which the fibres (of the voluntary or striated type) are arranged in a curiously rectangular network which is, probably because of its arrangement, easy of access by the digestive fluids.

We are also in the habit of eating certain other organs of the animal body, chiefly certain of the glands: among these are the *liver* and *kidney*, the *thymus* and *pancreas* (known as sweetbreads); while the *brain*, though hardly a staple article of diet, is well known as occasional food. These are all non-muscular, but they are all distinctively **nitrogenous**—holding proteins, extractives and sometimes gelatine, and holding 70 to 80 parts by weight of water in 100 parts. Among the proteins, globulins are always found, and often a compound protein is present such as was described in § 23. Of these organs the kidney, with its dense structure, is perhaps the least easy to digest, unless its preparation for the table is carefully carried out; the liver and brain are more friable, more readily broken up, and in the pancreas a certain preparation for digestion may be bound up with traces of pancreatic juice (which moistens it), until the ferment is destroyed by cooking.

It is probable that, similarly, residues of digestive fluid increase the digestibility of those animals which, although eaten partly for their muscle, also contain a large and complex digestive gland. Such a gland is the so-called "liver" of the *crab*, in which however at the moment of eating the digestive ferments have been killed by cookery; such too is the "liver" of *molluscs*, so that we can understand the superior digestibility of uncooked oysters.

§ 34. We may now contrast with the lean beef, which formed our starting point in the consideration of animal foods rich in protein, certain foods which are the *natural products of animal life* or are prepared artificially—and in this comparison we shall regard only the amount and characters of the proteins present.

Of such foods, none is more familiar than **milk**. Milk varies a little in composition, according to the pasturing and condition of the cow, or other animal, from which it is drawn, but it is always more watery than beef (87 parts in 100 are water) and its total protein contents do not generally amount to 4 parts in 100. Further, the proteins present are unlike those of beef; we do not find globulins (or only in very small amount); the coagulable protein of milk is an *albumen* (soluble in water, and becoming changed by heat) while the protein *casein*[1]—more abundant in milk than albumen—belongs to the class of compound proteins which have been named above, and which may be described as especially rich in phosphorus. Casein is not made more insoluble by heat, but it is changed by the rennet ferment contained in the digestive fluid of the stomach, and "sets," or forms a clot which action of the pepsin dissolves. This clot, imprisoning the minute fat globules of milk, turns any quantity of milk in which it is found into an opaque jelly familiar to us as **curd**; and thus recalls the action of fibrin when it binds the red and white corpuscles into a jelly-like blood-clot.

[1] See above p. 72 footnote.

This peculiar action of the digestive fluid of the stomach upon milk lies at the root of all cheese-making, and we may look upon cheese as the rennet-clot of milk, condensed by drying under pressure, and changed by the action of certain bacteria (compare above, § 3), and by the addition of flavourings and colouring-matter. This condensation gives a richly protein food, one that contains about 30 parts by weight of protein in 100, while in 100 parts only 34 are water; it is, however, a food which, as we shall see, is not highly digestible, although it is highly nutritive.

When the clot of milk, which is destined to form cheese, shrinks or is crushed, the liquid squeezed out from it is known as *whey*. Whey holds much of the coagulable protein of milk (but not the more important casein), together with the milk-sugar and milk-salts. But another artificial splitting up of milk has been carried out in late years, and carried out in such fashion that the fat and sugar on the one hand are separated from all the proteins on the other. Thus a flour-like patent food, the *Protene* of commerce, has been prepared; a food which, it is claimed, supplies to those who eat it a very high percentage of protein substance in a digestible form. It is stated that in 100 parts by weight of protene 80 parts of protein are found; it will be seen then, that even mixed with a sufficient quantity of water, or with wheat flour, or gelatine, for purposes of cooking, it yields articles of diet which are unusually rich in nitrogen-holding matter.

We may look upon milk as a secretion of the animal body intended mainly to nourish young animals who are too helpless to find food for themselves. In **eggs** we find, not indeed the same consistency, not quite the same substances, but yet substances which are highly nourishing and which are used by immature (i.e. very young) animals during their growth. All eggs have to subserve this end, but it will be understood that they vary much in size and in structure; thus, *caviare*, the *roe of the sturgeon*, is made up of multitudes of clustering eggs; and this is true of the hard roe of all fishes, however different in appearance and flavour. In using the word egg, however, we think naturally of the eggs of birds, and especially of the hen's egg, many millions of which are used daily in England. Taking this familiar egg as an example, we may say that in eggs there is less intermixture of foods than in milk (thus, no sugar is found), but nitrogenous matter is abundant. In the white of a hen's egg about 13 parts by weight in 100 are protein and about 84 parts are water; in the same weight of egg-yolk there are 16 parts by weight of protein and about 50 of water. The protein matter of fresh eggs is different in nature according as the yolk or the white is examined; in the former, there are *globulins* much resembling the main proteins of lean beef; in the latter, *albumens* (dissolving in water as well as in salt solutions) are present. Both these classes of proteins, it will be remembered, are greatly changed by the action of heat, and we shall see later that hardly any article of diet is more affected by different methods of cooking than is the egg.

In all animals except those which are very simple—certainly in those which form staple articles of human food—**blood** is present, and must be looked on as a fluid rich in proteins, and formed by the cells of the body. The blood of the ox holds more than 7 parts of protein in 100 parts; these proteins belonging to the familiar, coagulable groups of the globulins and albumens. To the majority of Englishmen however all articles of diet prepared principally from blood are distasteful; *black pudding* or "*Blutwurst*" is largely eaten in Germany, and its main constituent is pigs' blood.

§ 35. The articles of diet of which we have thus spoken briefly, form certainly a heterogeneous group, and we shall see later that the value of each member of the group is much affected by its preparation for eating. But, assuming for the moment that all receive the same treatment, or that all are eaten raw, it is interesting to notice some of the points of difference between them, as on the other hand we have noticed the presence of proteins—their point of likeness.

(*a*) In the first place we notice a very *varying admixture of the other foodstuffs with protein matter.* We have seen that there is now one percentage of **water** and now another (compare above, § 27), and examination shows that the **salts** present vary, but within narrower limits. In *butcher's meat*, in *poultry* and *game*, we may fairly say that slightly over 1 per cent. of saline matter is present; taking this as a standard, we may add that in *tripe* and in *milk* the percentage is rather low (although the importance of the lime-salts in milk is great), while the percentage is somewhat high in *fish* and in *molluscs* (oyster). In *cheese*, saline matter is abundant.

But the admixture with **carbohydrates** and **fats** varies still more. It has been estimated that the daily diet of a healthy man should contain 100 grms. ($3\frac{1}{2}$ ozs.) of protein matter; if we suppose for a moment that we wish to gain this quantity of protein from the one description of food, and choose this from the list of foodstuffs named above, this variation in admixture shows very clearly. Thus, in eating 100 grms. protein from *white of egg*, we need eat no carbohydrates and only 2 grms. of fat; if the source of the proteid is *yolk of egg*, carbohydrates are absent as before, but the necessary quantity of egg-yolk contains 200 grms. fats. A quantity of *lean beef* yielding 100 grms. proteins holds no carbohydrates, and may hold as little as 7 grms. of fats; from *cow's milk*, on the other hand, we can only gain 100 grms. protein if we eat 107 grms. fats and 140 grms. carbohydrates as well.

(*b*) In the second place, there are *differences in digestibility among the animal substances rich in protein.* Sometimes differences in texture, or density, make it easy to understand that this should be the case: thus the muscular fibres of the heart, although they are naked (i.e. without enclosing membrane), are packed very firmly together, and so are the cells of which the kidney is made up. On the other hand, as we have said, the muscular fibres of the tongue (which have enclosing membranes) cross each other loosely, forming a right-angled network, easy of digestion, and the muscle of tripe is unstriped, i.e. made up of naked cells, relatively small, and bound up into thin sheets. This structure and arrangement seem to be in harmony with what we know practically of the ready digestibility of tripe, and in the case of this tissue it is probable also that the cells of the stomach have some digestive action after the animal has been slaughtered, but before the ferment they contain is killed by cooking. Again, the substance of cheese is very dense, and it is easily comprehensible that the digestive juices penetrate it with difficulty, and the same may be said of the glairy mass which we know as raw white of egg. To make cheese more digestible, we "grate" it; by "frothing" white of egg, or beating it well with yolk, the same end is reached.

When the muscular fibres eaten are large, or buried in much tenacious wrapping, their solution may be difficult; and, when fat is closely mixed with protein matter, *two* kinds of digestive action must be vigorous (i.e. the digestion of protein and the digestion of fat) if the mixed food is to be satisfactorily dissolved. Probably for this reason some "rich" fish, such as the salmon (12 parts of fat in 100 parts), or the eel (27 parts of fat in 100 parts) are less digestible than the whiting or the sole.

There are, however, differences in digestibility which can hardly be accounted for by tangible differences in the composition and "build" of the foods concerned. It may be that such differences are introduced by what might be called accidental mixture of "foreign" substances with tissues which are eaten, and that mixture of this kind is responsible, at least in part, for the indigestion which sometimes follows the eating of crab and lobster. But, in other cases, the causes of difference are more subtle still: it is found that the rates of digestion of raw beef and raw mutton are practically the same; but medical experience has pronounced mutton more digestible than beef.

(*c*) Lastly, we must remember that *individual differences abound in the eaters*, and that idiosyncrasy defies explanation. Experiments have shown (as we saw in § 32) that, when lean beef is eaten by a healthy human being, only 2½ parts in 100 of proteins are rejected from the bowel unabsorbed, and we may add that about 3 parts per cent. are thus lost from the proteins of egg, and 8 parts per cent. from the proteins of milk. But there can be little doubt that these figures would vary much, were the human beings examined to be increased in number. The healthy persons who cannot, when adult, take milk or eggs form an important group, and cases have been known in which there was (in health) inability to digest the flesh of poultry—a food which is so commonly regarded as suitable for the feeble digestion of the convalescent.

B. Proteins in vegetable substances.

§ 36. It is a popular belief that proteins belong characteristically to animal substances, and carbohydrates to plants and their products. And the composition of muscle on the one hand, and, on the other, the poverty of animal tissues in carbohydrates do give some foundation to the belief. Nevertheless it is a belief partly founded on misapprehension. From plants alone, any animal may obtain and many animals do obtain proteins and all the other foodstuffs necessary for healthy life.

Let us consider for a moment, setting aside the habits and nutrition of parasites, the scheme of plant life. We recognize in the familiar green plant such parts as are commonly *her-*

baceous; leaves, young shoots, and (in a somewhat modified sense) flowers. These are regions where the chemical changes which belong to life are especially active, but they are regions which for their well-being are closely dependent upon daily food—upon supplies of oxygen and carbonic acid from the air, upon water, and saline matters drawn from the soil. Cut off from such supplies, they wither and, speedily, they die. But there are other parts of plants in which there is storing up of what are known as **reserve materials**; these are substances which are food or can be turned into food independently of daily supplies from the external world, and they serve to support young plants or young shoots when daily food is scanty or lacking. This storage may take place in many different organs of the plant, such organs being usually modified in connection with it; thus the *potato* of commerce is an altered stem, rich in foodstuffs; in the *onion*, food is stored in the closely-wrapped leaves of the *bulb*; while in the *parsnip*, the *carrot*, and the *beet* we deal with *roots*. But the plant-organ *par excellence* into which foodstuffs are stored is the **seed**, and this, with certain wrappings or coats of very various structure, forms the *fruit*. The grains of wheat, of barley and maize, the almond, the nutmeg, the cardamom, the date-stone—these are all seeds, seeds which have within them such concentrated materials that the young plant may draw upon them for food in the early stages of its growth; they play a part much like that played by the foodstuffs in milk and animal eggs.

Now when we look at plants, not as members of a great group of living beings, but as the food of man, we realise (and it is a truth often forgotten) that *every living vegetable cell that is eaten must contain some amount of protein*; for nothing can be living which does not hold some protoplasmic constituent however slight, and proteins, as we know, form the basis of protoplasm. In lettuce, in the fruit of the grape or the tomato, in the leaf-stalk of rhubarb, there is a protein element, and, when these succulent parts of plants are eaten raw, it is probable that the protein matter they contain is especially soluble, although it is shielded by indigestible cellulose cell walls. The amount present is *very small*, greater in young green things than in older tissues in which the quantity of water has increased: thus, *asparagus*, which is the young shoot and tightly packed buds of the plant, holds 3 parts of nitrogenous matter in 100 parts; while rhubarb, which is an adult stem, has hardly 1 part in 100. And it must not be thought that on such fresh, green substances *alone*, a man could live healthily. The "grass-eating" animals form a large group, but their teeth, stomach and intestines have special characters and arrangement, fitted for dealing with this food. Man has neither these special characters, nor those which belong to the "eaters of flesh" (e.g. the cat, the lion); he has much more in common with the apes and monkeys who are fruit-eaters by nature. It is the storage organs of plants that must be eaten if nourishment from vegetables is to be sufficient for man; and it is in them that, as reserve materials, the protein substances of plants are chiefly found.

Even among these organs great differences of composition exist: the turnip, the carrot, the beet, and the onion are all poor in proteins, and contain much water—the turnip 92 parts, the onion 91 parts, the carrot 89 parts, the beet 82 parts, all in 100 parts of substance—even the potato, although more substantial than they, has 75 parts of water in 100 parts. The grains which are sometimes grouped together and spoken of as "cereals" (the seeds of the Gramineae) show a very different proportion, but yet cannot be counted actually rich in proteins; thus 800 grms. of wheat, or 1000 grms. of maize or 1200 grms. of rice must be taken in order that, in each case, 100 grms. of proteins may be obtained. It is in the seeds of plants which belong to the natural order Leguminosae and are sometimes collectively named "pulse" that proteins are most abundant, and, holding but little water, these seeds are, as we shall see, rich in other foodstuffs also. In the ripe pea, 22 parts by weight p. c. are proteins, and the bean and the lentil have respectively 23 parts and 25 parts p. c. And while we must consume 3000 grms. (five pints) of cow's milk or 5000 grms. (eleven pounds) of potatoes to obtain 100 grms. of proteins, the same quantity of protein is yielded by 430 grms. of peas—fifteen ounces only[1].

§ 37. Thus we see that from all herbaceous vegetable tissue which we eat, we obtain a small but an exceedingly small amount of protein, that from certain organs of plants which are reserves of plant food, but yet watery, we may obtain more, and that, among vegetable foods, edible seeds are the richest in proteins. This is true of the seeds which we know as cereals (in which the percentage of proteins is roughly 10), or the seeds of peas, beans and their allies (in which the percentage of proteins is roughly 25).

We may now ask, can any general statements be made concerning these vegetable proteins?

(*a*) *Globulins* are by far the most abundant of the plant proteins. *Albumens* are found but in small quantities and rarely, especially in the plants most used as food. *Proteoses*, which it will be remembered are very soluble, occur in the milky juice or "latex" of certain foreign plants, and they are described in some flowers. Their presence here probably means that the proteins, which were stored in the seed in some form less easy to dissolve, are beginning to undergo change under the action of some ferment, and to be prepared for the use of the young plant.

(*b*) The plant proteins as they occur in nature are, on the whole, more *mixed with other foodstuffs* than are the proteins which are found in animal foods, and this is true

[1] Various fungi and algae have a considerable amount of protein in their composition, but they do not usually form *pièces de resistance* in diet.

especially of admixture with the carbohydrates or fats. We have seen that 100 grms. of proteins may be eaten from white of egg, with admixture of no carbohydrates and only 2 grms. of fats; and further that the same weight of protein may be taken from lean beef, with 7 grms. of fats and no carbohydrates. But if we consider peas—and they are a vegetable food rich in proteins—we find that to eat 100 grms. of *proteins* from them demands that 7 grms. of *fats* and 230 grms. of *carbohydrates* shall be eaten too, while in the case of corn, 14 grms. of *fats* and 580 grms. of *carbohydrates* accompany 100 grms. of proteins.

(*c*) As among the food proteins of animals, so among those which are obtained from plants, there are differences in **digestibility.** But, taken as a whole, the vegetable proteins are less completely absorbed when eaten by man. We find that of peas, shelled and well boiled, from 17—27 parts per cent. by weight of the proteins present are passed from the bowel unabsorbed; the corresponding loss in the case of white bread is 20—25 parts per cent. by weight of proteins; and as much as 40 per cent. of the proteins of lentils may be thus rejected. It must be remembered that all these proteins lie in cells which have walls of indigestible cellulose, and it is probable that the action of the digestive juices may be hindered by penetration of this substance—which they leave undissolved. It has been found that a flour made from pulse and cereals has unabsorbed remains of about 9 parts per cent. of proteins; here it may be that grinding up the cells with their contents necessarily breaks the walls, and so makes it easier to dissolve what lies within.

CARBOHYDRATES.

A. Carbohydrates in animal substances.

§ 38. It is, probably, the distribution of carbohydrates in foods which has led to the belief that proteins belong characteristically to animal substances, and carbohydrates to plants and their products. The belief is, as we have said, partly founded on misapprehension, for all plants when living have a protein constituent, while the protein content of some edible fungi is large; but the carbohydrates are, certainly, very unequally distributed. We may say that, with the great exception of milk, there is no animal food in which they abound. They do play a most important part in animal life, and the starch-like body glycogen is plentiful in the liver sometimes, and, in very early stages of life, it occurs in the muscles and in other tissues. Yet liver and muscular tissue, as used in the kitchen, have no carbohydrate constituent sufficiently important to be taken into account. Glycogen only accumulates after abundant nourishment of a particular kind has been taken, and animals are not usually slaughtered in full digestion; thus glycogen is absent, nor can we expect to find sugar, which springs from glycogen in animals by *post mortem* change. Milk, as we have said, has much carbohydrate material; in 100 parts[1] of cow's milk 87 are water, but of the remaining 13 parts, 5 are milk sugar, or lactose. Indeed we may say that the only animal carbohydrate of importance from a dietetic point of view is the soluble carbohydrate, *sugar of milk;* and the fact that it is **soluble** (and therefore at the disposal of the absorbing cells of the

[1] Throughout this section the term "parts," when used of the quantitative composition of foods, expresses parts by weight.

intestine without much preparation), is in harmony with the fact that milk is the natural food of all young sucking animals. When very young, these animals have either scanty saliva, or saliva with weak digestive action.

B. Carbohydrates in vegetable substances.

§ 39. Green plants are the great builders-up of carbohydrate substances. Formed chiefly in the leaves, these substances are used for the nutrition both of the plant which forms them and of the young plant which shall succeed it. For the latter purpose they are stored, generally in some insoluble form, as in the date-seed, which contains much cellulose, or in the potato, which has almost 20 parts per cent. of starch. But the more soluble bodies, dextrin and sugar, do occur,—for example in the chestnut, in the flesh of the date, and in the grape.

It is, then, the *storage organs of plants* which we must examine if we wish to examine vegetable foods which afford carbohydrate food-stuffs. We will consider certain of these organs which may be looked on as types, noting those points about their structure and constituents which are important in the shaping of a diet.

A *grain of wheat* is a familiar storehouse of vegetable carbohydrates, and there are three points about it which concern us here. *First*, it is a mass of small, closely-fitting compartments or cells, the protoplasmic substance of each cell being bounded by walls of cellulose: *second*, the contents of the cells are not of the same nature throughout the grain: *third*, the contents of the cells vary somewhat with the age and condition of the grain.

The first point is of importance because cellulose is practically indigestible to man. If a grain of wheat were eaten whole (except for such crushing and breaking as the teeth bring about in chewing) the digestive fluids—saliva and pancreatic juice—would have to penetrate the indigestible walls before reaching the nutritious carbohydrates which lie within; if the grain be very finely ground before eating, the mixing of digestive juices is more ready, their action easier and more nearly complete. Thus the nutritious matter of a very fine flour can be acted upon more thoroughly than can that which is made up of coarser particles[1].

In the second place, the contents of the cells of the wheat grain are not alike throughout the grain. The contents of the cells may be generally described as starch grains and stored protein, with a small amount of protoplasmic (i.e. living protein) substance; in the cells towards the centre of the grain the starch is most abundant; towards the exterior there is a relative increase of proteins. Further, the walls are unlike in composition; delicate cellulose walls mark the central cells; towards the outside the walls are thicker, and some of them are very dense, so that they form a protective covering. Thus flour prepared from the whole grain of wheat may differ considerably from preparations which contain only the central or the outside (cortical) parts of the grain; moreover, flours made from the central cells alone can never be rich in proteins, since the protein-rich layer is cortical.

In the third place, the contents of the cells of the wheat-grain vary somewhat with the age and condition of the grain, and with the degree of ripening. There are variations in the amount of protein matter present, and variations in the character of the carbohydrate. A diastatic ferment is present in wheat, and, by its action, some of the stored starch is changed to sugar when the grains are of suitable age and placed under suitable conditions (as in malting for beer-making). This variation is not of great importance in ordinary diet, but some fancy flours owe certain of their peculiarities to the state

[1] See above, § 37.

of the grain from which they are made. For the most part we may say that the carbohydrate of wheat is **starch**, with **dextrin** and **sugar.** About 70 parts by weight in 100 of English wheat are made up of starch; about 2 parts are cellulose; about 11 or 12 parts are protein and other nitrogenous matter; and mineral matters or salts make up 1 to 2 per cent., and are, roughly, equal to the amount of fats present.

The salient points about the carbohydrate food-stuffs in wheat then, are the following:

(*a*) The main carbohydrate **starch** (of which there are about 70 parts per cent.) is indigestible in the raw state: cooked, it needs change to bodies which can be absorbed,—a change which is readily brought about by the ferments of saliva and of pancreatic juice.

(*b*) The starch is mixed with food-stuffs of the other classes; thus when we eat 100 grammes of starch from wheat, we eat with it 17 grammes of proteins and 2½ grammes of fats. In this respect the wheat contrasts with lean beef (which we took as an example of animal, protein, food); *there is in the beef greater preponderance of its main constituent*, **protein.**

(*c*) Salts are present; rather more than 1½ parts in 100.

The whole groups of "cereals," as they are popularly termed, show a strong likeness to wheat in these salient points. The cereals are the familiar edible fruits of the Gramineae, and although there are variations in their constitution—excess of starch and especial deficiency of fat in *rice*; relatively large admixture of fat in *oats*—yet they all hold **starch** as the predominant food-stuff; in all, the starch is enclosed by cellulose walls; in all, nitrogenous matters (§ 37), water, and salts are present too.

In 100 parts of *rice* there are about 76 parts of starch, and there are 63 parts in *oatmeal*, 66 parts in *maize*, 63 parts in *buckwheat* (all in 100 parts of the grain). Fat is almost absent from rice: in oats it may amount to 8 or 10 parts in 100.

In the *chestnut* we have a seed which, though different from a cereal grain in the eye of a botanist, is almost as rich in carbohydrates. When the nut is ground into flour, the cells holding these carbohydrates are broken down, at least in part, and the carbohydrates are set free; they form, with the remnants of cell-walls, a flour—chestnut flour. Analysis of this flour shows that the digestible carbohydrates present are mixed: there are **sugar** and **dextrin** as well as starch.

The digestible carbohydrates amount to:—*starch* about 30 parts, *dextrin* about 23 parts, *sugar* about 17 parts, all in 100 parts of chestnut flour.

We may contrast with these storage organs *the seed of such a legume as the pea.* This seed is like the wheat grain in that carbohydrates abound, and in that the important carbohydrate is **starch**. But less starch is found than in wheat or in the other cereals and, as we know, more protein matter occurs (§ 36). Cellulose walls enclose the stored up foodstuffs, and salts are relatively abundant, that is, they generally amount to more than 2 parts in 100. The same characters that mark the pea are distinctive also of *beans*, *lentils*, and the other seeds which are popularly known as "pulse."

The actual percentage of starch in "pulse" is between 50 and 60. The amount of fat in *haricot-beans*, *peas*, and *lentils* is small (about 2 parts per cent.) but in the less familiar "pulses," *pea-nuts* and *soy beans*, there is much more; 50 parts and about 18 parts per cent. respectively.

A further contrast to the wheat grain, and indeed to all the seeds we have yet considered, we find in the *sugary fruits*, of which the *grape* may be taken as a type. Here the little hard pip or seed corresponds to the cleaned grain of wheat, and we eat the soft, ripe, fruit-wall, which encloses the seeds. This is cellular, but the cells are for the most part large and very thin-walled; their contents are watery, and we find **pectic bodies**[1] and **gum**, substances which there is reason to regard as produced from carbohydrates by some chemical change. The water in a grape makes up 80 parts in 100; about 13 parts are **sugar**, and 3 parts are the **pectic bodies**. With the grape we may group most of the familiar "berries" (including the *orange* and *lemon*), "stone fruit," such as the *cherry*, the *peach*, the *plum;* and *apples*, and *pears*. The relative amounts of sugar and of the pectic bodies vary, and different organic acids are found in different fruits (malic acid in apples and pears; citric acid in gooseberries, lemons, and oranges; tartaric acid in grapes); still, there is strong likeness. In all, we find the large thin-walled cells, with their watery, sugary, contents[2]; in all, some bodies which if not carbohydrates are closely allied to them. The *banana* differs, in that it is especially rich in sugar and the pectic bodies, and lacks organic acid; and in the pod of the *carob-* or *locust-bean* (used as food by some Europeans, though not by Englishmen), we find nearly 70 parts in every 100 made up of sugar, pectine, and gum. The flesh of the *date* is also rich in soluble carbohydrates and their allies (sugar, pectine, gum), and the same is true of *dried figs;* but it must be remembered that the date, the carob-pods and the fig have lost water since they were fresh and ripe. *Tomatoes*, *melons*, *marrows and cucumbers*—all of them fruits which may be considered in this group, can hardly be looked upon as containing stores of carbohydrates; for even the tomato has only 6 parts per cent. of sugar, and the others, poorer still in this, their only digestible carbohydrate, are not eaten for their nutritive value.

[1] In § 28 brief mention has been made of the characters of pectine. It is probable that this name has been used to denote a group of substances rather than one chemical substance, and to indicate this the term *pectic bodies* has been used in this paragraph.

[2] Certain of the cells, e.g. in the pear, are quite different and practically indigestible: they are the "scleroblasts" of botanists and have greatly thickened, woody cell-walls.

It may be of interest to arrange the chief members of the group of fruits here described (and the group is of course purely artificial and formed for present needs) in series, indicating their richness in carbohydrates and their richness in water. The order is, naturally, nearly inverse.

Fruit.	Carbohydrate in 100 parts.	Water in 100 parts.
Dried figs	60	17
Dates (dried)	55	21
Carob pods (dried)	51	15
Bananas	19	74
Grapes	13	80
Oranges	8	86
Pears	7	84
Apples	7	83
Tomatoes	6	90
Peaches, cucumbers, and Vegetable marrows	2	94

These percentages are approximate, and bodies of the *pectic group* are not here included in the carbohydrates.

§ 40. It is not only in seeds and fruits that we find abundant vegetable carbohydrates: there are storage places for them, as we have said, in other organs of the plant; in stems, leaves, roots. These organs are often changed or modified, so that the leaves are not like typical green foliage leaves, and the stems not like the familiar upright, green, plant-stems. The *potato* may be taken as a well-known example. It is a stem, changed and swollen, a mass of cells whose cellulose walls with their thin lining of protoplasm enclose watery contents (75 parts in 100 parts are water), and contain abundant starch (about 18 parts per cent.) with a small amount of other carbohydrates and of pectic bodies. That is to say, the potato is watery, but yields a starchy food. And, resembling it in general plan, although differing from it in some details, we have almost all those vegetables that are popularly known as "root vegetables": these may be true roots, as the *carrot*, the *beet*; stems, as the *Jerusalem artichoke*; inconspicuous stems bearing prominent leaves, as the *onion*, and the *true artichoke*. For the most part their stored carbohydrate is a **sugar**,—this is so in the beet, the parsnip, the carrot, and the onion: in the parsnip and the sweet potato[1] starch is present too. The pectic group of bodies is always found; indeed in the turnip they seem to replace stored carbohydrate; for pectine and its allies form 3 parts in 100, while starch, dextrin, and sugar are absent.

All the organs which we have just considered have more than 75 parts per cent. of water, and in onions and turnips the percentage of water is over 90. Their carbohydrate content is, approximately, as follows:

	Starch in 100 parts.	Sugar in 100 parts.	Pectic bodies in 100 parts.
Potatoes	18	—	2 (with some dextrin).
Sweet potato	15	1½	3 (with some dextrin).
Parsnip	3·5	5	nearly 4 (with some dextrin).
Beetroot	—	10	2½
Carrot	—	4½	2½
Turnip	—	—	3
Onion	—	about 5	about 5

From the list just given it will be realized, that the carrot, the turnip, and the onion have no claim to be regarded as foods rich in carbohydrates; and the same is true of the various salad plants (*lettuce*, *watercress*, *mustard*, *endive*) and of the many leaves and herbaceous stems that are used as "vegetables" or "fruits." Celery contains a little sugar (2 parts per cent.); watercress, between 3 and 4 parts per cent. of starch and its "gum" derivatives; rhubarb a little sugar with "gum"; but the value of these and other green foods depends on other characteristics (see below, § 46).

[1] This is *Convolvulus Batatas*, and not related to the true potato, *Solanum tuberosum*.

Carbohydrate food-stuffs in plants.
Summary.

§ 41. From the facts given in the foregoing paragraphs we gather one or two general statements easier to remember, perhaps, than actual statistical details.

A. **Starch** is the carbohydrate most generally found and most abundantly found in plants. Dextrin and sugar occur sometimes, but in much smaller quantities: in certain parts of certain plants the imperfectly understood **pectic bodies** are found, and they are probably to be looked upon as derivatives of carbohydrates. The carbohydrate (**starch**) in which plants are the richest, is one which must be changed before it can be absorbed by the digestive cells of animals.

B. The **Cereals**, as they are popularly termed, hold the richest stores of starchy food; they include most of the grains which are commonly ground to form meal or flour, and which are the main sources of bread and cakes.

C. **Pulse** is the name given to a group of seeds not quite so rich in starch as are the cereals, but more widely nutritious, since they (for the most part) contain larger store. of protein. These seeds may be ground to meal (pea-meal, bean-meal, lentil flour), but are not adapted for bread making.

D. A group of sugary fruits may be next distinguished, they all contain much more water than do the cereals or the "pulses," and **sugar** takes the place of starch: in most cases the **pectic bodies** appear too. The fruits which may be placed in this group are varied in character; dried figs have abundant sugar; dates and bananas a considerable amount; while the peach can hardly be looked on as a storehouse of any carbohydrate.

E. Another rather heterogeneous group is formed by *stems*, *roots*, or *leaves*, in which the function of storing up reserves is added to, or replaces their usual function. In these there is sometimes a considerable amount of starch (as in the potato); sometimes only sugar, and that in small amount (the carrot); sometimes mainly the pectic bodies (the turnip).

F. The edible green leaves (cabbage), stems (asparagus), or whole plants (cress seedlings), which have great dietary value in some ways, are unimportant as sources of carbohydrate food-stuffs.

G. There are certain seeds, fruits, or other parts of plants which have marked characters, but are not easily included in the foregoing groups. Thus the **chestnut** is rich in starch, sugar, and dextrin; the **filbert** has a fair amount of carbohydrates; and **Iceland moss** is very rich if not in starch, in a body which resembles it closely.

FATS.

A. Fats in animal substances.

§ 42. When fat is formed in the animal body it is formed as the work of **living cells.** These cells, fed by the lymph and blood,—which carry nourishment throughout the animal,—deposit in their substance minute oil-drops. And when this particular activity is carried very far, the oil-drops run together, growing at the expense of the substance of the cell, so that this substance remains as a very delicate case for the fat which it holds.

Suet is a mass of fat formed in this way by the joint action of thousands of cells; so too is the *fat* of *beef, mutton, pork, goose, salmon,* the *eel* and of all *fatty fishes and meats.*

And *marrow* (that is to say *yellow marrow*) is nearly pure fatty tissue.

In the *nerves* and in *brain* we find fatty substance of a special kind—the medulla or myelin sheath of the nerves. The nerves in general do not form a food by themselves, for, as we know, they are scattered through the tissues of the body. But brains are eaten, though they are a delicacy or adjunct to food rather than a staple food: they are nutritious and digestible, and fat is one of the food-stuffs they yield.

Liver we have placed among the protein-holding foods, and its main value is as a source of protein. But a little fat is almost always found in liver and sometimes, as in certain fish and in the diseased geese which furnish *pâté de foie gras,* the amount is considerable.

Thus we see that the **fat-laden tissues** of animals form one great source of fatty food—fat meat, fat fish, marrow, brain, liver. In fat meat and fish and in marrow the fat drops are formed within connective-tissue cells; in the brain it is the nerve fibres which have a fatty constituent; in the liver the liver cells are changed and come to contain fat, and in many cases the connective tissue of the liver is loaded too.

But the activity of the cells which form fat does not always end in the production of such a mass of fat-cells as we find in suet. Let us consider, for a moment, the **yolk of an egg**; chemically it holds about 30 parts per cent. of fats and 15 parts per cent. of proteins; histologically it is a gigantic cell, with very, very little protoplasm, and a large quantity of reserve-material destined to nourish the growing bird. The fat of the reserve-material is for the most part in tiny drops which do not run together: *yolk of egg is in fact an emulsion, though not quite a typical emulsion.*

Now let us turn to consider **milk.** The cells of the mammary gland form fat-drops within themselves, but do not end by becoming mere fat-cells. They cast off the small droplets of fat which they have formed, into the duct or gland-passage which leads to the exterior, and here the fat-drops remain separate from each other, by reason of the other constituents of milk which are also formed and turned out by the gland-cells. *The fat of milk is very finely divided; it forms a true emulsion.*

Thus we see that fat formed by living cells, but set free from those cells (milk), or loosely held in the substance of a vastly extended cell (yolk), and remaining in a state of fine division, is important as fatty food.

Lastly, we may have foods containing a very high percentage of fat **prepared from the various fatty tissues** or from milk. Familiar examples are butter, dripping, lard, together with the different imitations of butter. Here the fat *is not within cells and not emulsified:* in lard and dripping it is pressed or drawn out of the cells which formed it; in butter, the shaking and stirring of the churn have destroyed the emulsion of milk. Cheese may claim to be a fatty food, but has an equal quantity of protein—about 30 parts per cent. In cheese-making, the protein is precipitated and the milk fat clings to it; then, by pressure, a very dense food is formed.

We may arrange examples of the groups of foods just mentioned, in a descending series, beginning with those in which the percentage of fat is the highest, and giving approximately the percentage composition in fat.

Article of food		Fat in 100 parts by weight
Marrow of bones	about	95 parts
Butter	,,	87 ,,
Bacon	,,	65 ,,
Fat mutton	,,	35 ,,
Cheese	,,	30 ,,
Yolk of egg	,,	30 ,,
Salmon	,,	12 ,,
Brain	,,	8 ,,
Milk	,,	4 ,,

It is interesting to note that milk—the food which is in itself a complete and satisfactory food for the early months of human life—comes low in the list. Indeed the foods which have a very high percentage of fat are not suitable for digestion alone, at least in temperate climates: we eat bread with butter or dripping, and beans with fat bacon.

§ 43. Looking at animal fats as forming a group, can we make any statement about them which is important from a dietetic point of view? We can do little more than recall the statements made in § 23.

A. They are as a rule **mixtures of fats.** And this fact is of importance; for different fats have different melting points, and thus, mixtures which contain the fats in varying proportion will also vary in melting points. Speaking of animal fats generally, we may say their *melting points are high;* they are not liquid at the ordinary temperature of the air in England, but there are distinct differences among them, so that we come to have what are called *hard fats* and *soft fats*. Thus mutton fat is particularly hard (melting point high); pork fat, and goose grease are especially soft (melting point low).

B. But, further, the animal fats, as eaten in England at least, are **neutral fats.** A very small amount of fatty acid may be present; when its amount increases we say the fat is *rancid*, and rancid fats are usually rejected as food.

C. And lastly, with the exception of the fats in milk and in yolk of egg, the animal fats of food are **not emulsified.** Freed from the tissue cells in which they lie, by digestion, or by previous treatment, the fat-drops run together into larger drops and irregular masses.

Thus a good deal of physical change and chemical change is called for by the fats of food before they can be absorbed by the cells of the intestinal wall. They must, as a rule, be melted; they must be **emulsified**; and, in part at least, they must be split up into fatty acids and glycerine.

As we have said, **milk offers fat which is already emulsified**: we have seen, earlier, that its protein is a soluble protein and that its carbohydrate is sugar of milk; the constitution of milk is admirably adapted for the nourishment of the young animal.

B. Fats in vegetable substances.

§ 44. Changing only a few words here and there, much that has been said above in § 39 about the occurrence of carbohydrates in plants might here be said touching the occurrence of fats. Like carbohydrates, the fats are mainly stored in *seeds* and *fruits*, like carbohydrates they are found, but less abundantly, in stems and leaves. A fatty seed is a closely grouped mass of little cells, as is a starchy seed; the cell-walls are of indigestible cellulose, some delicate sheet of living substance lines them, a mineral residue (i.e. some form of "salt") is always present.

But, changing the point of view a little, we might with equal justice draw a parallel between the occurrence of fats in plants and their occurrence in the tissues of animals. We do not, indeed, use commonly any fatty vegetable secretion which is comparable with milk (although the "milk" of the cocoanut has resemblances in more than name), but we must distinguish vegetable fats as (*a*) *Fats laid down in the tissues* and eaten with them, or (*b*) *Fats expressed or prepared from these tissues.*

(*a*) The **fats laid down in tissues** are comparable with those eaten in fatty meat (adipose tissue), but, whereas the residue of cell-substance which encloses fat in animal tissues is digestible, there is in plant-cells an additional, indigestible cell-wall. A seed such as the almond holds more than 50 parts per cent. of fats, and the cocoanut, the brazil nut, the walnut, varying somewhat in percentage composition, are all richly fatty. In the olive, it is not only the seed (kernel) but also the fleshy fruit wall that is laden with fat (much as the date-flesh is laden with sugar), and as an example of fat in plant stems we may take the whole natural order to which belong *Angelica*, *Chervil*, and *Fennel* (the *Umbelliferae*). Here we cannot perhaps speak of concentrated stores, but in both stems and leaves there is a volatile oil which, at least in the fennel, is sometimes combined with bread to make a palatable and nutritious food.

(*b*) **Fats prepared by chemical or mechanical means** from the plant substance which formed them are among the most familiar in domestic and commercial life. **Olive oil** alone must rank very high in popularity as a food-stuff, especially in southern Europe, and the oils prepared

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respectively from walnuts and almonds and from linseed are eaten, though less generally, and less abundantly.

A list of typical fat-yielding vegetable foods, arranged according to the percentage of fat they contain, forms an interesting pendant to the list of fatty animal foods given in § 42.

Article of food		Amount of fat in 100 parts by weight
Brazil nut	about	65 parts
Almond	,,	55 ,,
Olive	,,	40 ,,
Linseed	,,	38 ,,
Cocoanut	,,	35 ,,
Walnut	,,	30 ,,
Oatmeal	,,	10 ,,

We meet with the grains of oats once more in this place; in earlier paragraphs we recognized them as valuable for their starch (63 p.c.) and their proteins (16 p.c.).

Can we group together these vegetable fats and make any general statements about them?

§ 45. (A) They are in the main **neutral fats.** Decomposition into fatty acids and glycerine is easily brought about, especially in the case of non-purified fats; when this decomposition is vigorous we have (v. *supra*, § 43) the condition of rancidity.

(B) In the cells of fruits and (especially) of seeds, fats are often **associated with nitrogenous food-stuffs.** It is rare to find starch and fat in the same seed at the same time (both are present, however, in the filbert kernel): but the almond, the pistachio nut, the pea-nut, have all more than 20 parts per cent. of proteins and related bodies. Thus many of these seeds are highly nutritious; but on the other hand they are **difficult of digestion,** for both proteins and fats are shielded by the indigestible cellulose walls within which they lie. Indeed the digestive organs of civilized man—so often weakened by hereditary and present habits—make no great use of highly fatty seeds.

The case is different with the pressed out or prepared oils; here nothing stands between the fatty food-stuff and the digestive organs, but the oils are *not native emulsions*, but are massive, and therefore a first action in digestion is their emulsification.

(C) The vegetable fats have as a rule **low melting points.** It is perhaps because we are accustomed to see them in the liquid (or melted) state that we instinctively speak of them as *oils.* Oils are fats; and the fats characteristic of the olive, the almond, the rapeseed, the linseed, the walnut, and other seeds and fruits are liquid at ordinary temperatures. But the fats of the palm and the cocoanut are solid at these temperatures, and in this property they recall the groups of the animal fats.

SALTS AND WATER.

In discussing the nature of food-stuffs in Chapter VI. we pointed out that in one sense proteins, fats, and carbohydrates, by complex chemical change, upheld and formed anew the living substance of the animal body. But in a wider sense inorganic and organic salts and water share in the labour; without them an animal would die. We will dwell briefly on the distribution of (1) salts, (2) water, in animal and vegetable foods considered together.

1. Salts in animal and vegetable substances.

§ 46. It is open to us to eat various salts, inorganic and organic, either in a pure state or mixed with food, and one inorganic salt—chloride of sodium—is largely eaten in the latter fashion. But though the behaviour of salts within the body, i.e. the part they play in physiology, is obscure, one thing we can say—that that part is better played when they are eaten as constituents of food than when they are eaten alone, or as adjuncts to food, or drunk in solution. In the latter case, indeed, they seem to have the character of drugs—their use belongs rather to disordered conditions than to healthy life. But a discussion of the mode of action of saline matters is beside the point here; accepting the facts that they are important qualitatively in food, although the amount present is always small compared with the total amount of food, we have to consider briefly *what is their distribution among foods.*

We will take first a group of animal foods, including in it all organs of animals which are commonly eaten.

In **butcher's meat** we find rather more than 1 part of mineral matter in 100, but in fat meat (unsalted) there is sometimes only ½ part p.c.

Poultry and **game** have also from 1 to 1½ parts p.c.

Fish for the most part contain more, varying from 1 part in the eel, to 3 parts in the flounder.

Eggs have about 1·3 parts p.c., and the yolk is slightly richer in salts than the white.

Milk and **cream** have less than 1 part p.c.; there are ⅘ in cow's milk, ⅓ in human milk, and nearly ½ p.c. in a fairly typical cream.

The **cereals** generally hold more mineral matter than the meats when the whole grain is examined. (*Oats* 2 parts, *maize* 2 parts, *rye* 1½ parts p.c.) Removal of the outside layers of the grains lessens the content in saline matters; *rice* has only ½ part p.c., a fine *white flour* hardly more than ½ p.c., while a fairly coarse *bran* (bran representing the part of wheat rejected in making white flour) has 6 parts p.c.

The seeds known as **pulse** have still more mineral matter; in *peas* there are 3 parts, in *lentils* 2½ parts, in *haricot beans* nearly 3 parts p.c.; and the oily seeds which are commonly called **nuts** are in many cases as rich (*almonds* contain more than 3 parts p.c.). The storage organs which are popularly known as **root vegetables** may rank nearly on a level with butcher's meat in regard to saline matters, but they are slightly poorer (*potatoes* 1 part, *carrots* 1 part, *turnips* less than 1 part p.c.).

Among **green vegetables** we find that *sea-kale* and *celery* have less than 1 part p.c. of salts; *cabbage*, *lettuce*, *watercress* have 1 part p.c. or slightly more, and *spinach* heads the list with 2 parts p.c.

The **sugary fruits** are poor in inorganic salts; apples, pears, grapes, peaches, oranges, have all ½ p.c. or less; but in these fruits *important organic salts occur*—the salts of malic acid, of tartaric acid, of citric acid, or the acids themselves. The lemon stands out conspicuously among these fruits: it holds about $1\frac{1}{2}$ parts p.c. of mineral matter, and 5 parts p.c. of citric acid.

Briefly, we may say that to have 2 to 3 parts of saline matter in 100 parts of a natural food is to be rich in saline matter, and that the pulses and some of the nuts answer to this definition. Cereals must be placed next, to be followed in order by fish, eggs, game and poultry, butcher's meat. About on a level with butcher's meat we place green vegetables; the root vegetables come rather lower in the list. We place milk next, and last, the groups of sugary fruits—which are however rich in organic acids.

§ 47. We have drawn up this list having regard only to the saline constituents of the various foods and looking upon them in each case as forming *one* item. *But the saline constituents of different foods are not alike.* In the most important foods we find iron, magnesium, potassium, chlorine, sodium, phosphorus, calcium (lime), but these are present in varying proportions. Further, what is called the *acid radicle* may vary; thus one food may hold chiefly chlorides; another, phosphates; another, silicates. And, lastly, the "mineral" element may exist not as a familiar inorganic salt such as sulphate of iron or sulphate of lime, but linked to or chemically hidden in some complex organic substance probably very important in the chemistry of life.

These facts show that the simple terms *salt*, *saline matters*, *mineral matters*, cover wide variety; we cannot pretend here to enter minutely into their meanings even for the chief forms of food; but one or two points are not only especially interesting, but are charged with significance to anyone who shapes a diet. We will consider briefly the presence of calcium, iron and phosphorus-holding bodies in the mineral matter of some of the more familiar foods.

But in connection with the consideration, two points must be borne in mind. To examine the mineral constituents of complicated foods, the foods are usually *dried and burnt.* Thus all organic matter is broken up and dispersed, as various volatile substances, and an **ash** remains which is the mineral residue; all the metals which were present in the original foods are present still, but we may be almost certain that they existed originally in different combinations,—complex combinations which have been split up by the necessary process of analysis.

In the second place, the total amount of mineral matter is so small that only very minute fractions of its constituents are present in 100 parts of food in the raw state. It is slightly easier then to consider 1000 or 10,000 parts of food: we will speak of the content of 10,000 parts, but it must not be forgotten that this is so, and the figures must not be compared with percentages.

Lime.

(Foods arranged in descending series)	Calcium as oxide in 10,000 parts raw food
cow's milk	20
yolk of egg	18
peas	12
wheat	6
human milk	3
potato	$2\frac{1}{2}$
white of egg	2
beef	1

Iron.

	(Foods arranged in descending series)	Iron as oxide in 10,000 parts raw food
equal	yolk of egg	2
	peas	2
	wheat	2
equal	beef	1
	potato	1
	white of egg	$\frac{1}{2}$
equal	human milk	$\frac{1}{25}$
	cow's milk	$\frac{1}{20}$

Phosphorus.

(Foods arranged in descending series)	Phosphoric acid in 10,000 parts
yolk of egg	92
peas	85
wheat	80
beef	56
cow's milk	24
potato	16
human milk	5
white of egg	3

We have chosen these mineral constituents because each has an importance of its own in the animal body. **Phosphorus** is an integral part of calcium phosphate, and calcium phosphate forms more than 30 parts p.c. of bone. And in all nervous tissue (nerve-cells, nerve-fibres) complex phosphorus-holding substances are present. The importance of healthy bones and healthy brains can hardly be rated too high.

Calcium shares with phosphorus in the composition of bone, and is present not only as the phosphate but as the carbonate.

Iron is always present in the red colouring matter of the blood (haemoglobin), and we know that this is the great oxygen-carrier of the mammalian body. And the recent work of physiologists shows that iron is also hidden away in combination with the living substance which forms the nuclei of cells.

It is clear however that the importance of these substances is not the same at all periods of life; the building up of healthy bones and teeth belongs especially to childhood: it is only their maintenance which is important when growth has ceased. Thus organic foods rich in lime-compounds are especially valuable for the young. In old age their value is less determinate, for an undue laying down of lime-compounds, as for example in cartilage and in the walls of blood-vessels, is one of the physiological dangers in age. Phosphates (or some more complex phosphorus-holding bodies) are also doubtless of great importance to children; but if, as seems probable, we must associate them with chemical change in all nervous matter, then they are of importance in all phases of life.

The demand for iron also runs through life, but is especially urgent in such conditions of poverty of blood as have been named anaemic: it is probable that very minute quantities of iron satisfy the needs of the body, and probable, too, that the smallness of the quantity in milk is bound up with the fact that the young animal which is nourished by milk after birth, receives iron from its mother before birth.

2. Water in animal and vegetable substances.

§ 48. When we remember that about three-fourths of the living body are made up of water; that all the nitrogenous waste of the body is discharged in watery solution; that the undigested residues of food are always moist when they are ejected; that every breath expired, is loaded with watery vapour, we realize easily that **water** must be an important constituent of diet. In the foregoing paragraphs, we have seen incidentally how different an amount of water is contained in different raw foods, and what must be said now is hardly more than a recapitulation of what has been said, but with a new emphasis.

If we arrange the groups of foods which we have been considering, in a descending series, having regard only to the amount of water they contain, we must head the list with **green vegetables**, the salad plants, green stems (for example rhubarb), and the herbaceous parts of plants generally. *The percentage of water in this group is over* 90 *and often over* 95 *parts.*

Most edible **fungi** have 90 parts p.c.; but the truffle is exceptionally solid, and contains slightly less water than the potato.

The **sugary fruits**, and "**root vegetables**" (as they are called), have as a rule more than 80 p.c. **Milk, game** and **poultry, butcher's meat, eggs**, and some **fish** have all as much as or more than 70 parts p.c.

"**Nuts**," **cream**, and **cheese** have considerably less, and may be looked upon as intermediate between the foods which we call "watery" (roughly speaking three-fourths water) and those in which the water is less than one-fourth of the total weight. Such are **bacon**, the **cereals**, the **pulses**, **butter**, and **oatmeal.**

In the following series the percentage composition is approximate:

Food (raw)	Water in 100 parts
Green vegetables	95
Fungi (mushroom)	90
Milk	86
Sugary fruits	80 to 85
"Root" vegetables	75 to 80
Game and poultry	75
Eggs	71
Butcher's meat	70
Fish	60 to 80
"Nuts"	40 to 50
Cheese	34
Bacon	22
Cereals (usually)	14
Pulses	12 to 14
Butter	9 to 10
Oatmeal	5

It must be remembered that the amount of water in **raw foods** by no means represents the amount in foods as they are eaten. Mutton has more than 12 times as much as freshly ground oatmeal, but mutton, when it is roasted, loses water in the process, while oatmeal, made into porridge, must often be eaten with 10 times its bulk of water.

In fact, if water is not found in foods it is taken with them; salads, apples, tomatoes, are eaten with no sensation of thirst, and the Neapolitans have a saying that in the melon there is "something to eat and something to drink and quite enough for washing." But dry flour or meal is not thought of as a finished article of diet.

The question may be asked: Do we lose by taking water *in addition* to foods instead of *as a part* of them? If we dry an apricot and, after the lapse of years, cook it in water, is it like a fresh apricot, from a dietetic point of view? This question cannot be answered positively; in drinking water, we usually face the possibility of bacterial contamination—less serious if the water is boiled or heated in cooking—and any large dilution of food may bring about slackening of digestive action in the stomach of the healthy adult. But apart from these considerations, the intimate admixture of water in living cells, which belongs to growth, commends itself to us as likely to provide a fair field for digestion. It cannot be said that observation or experiment has settled the point; we know far less about it than even about the dietetic importance of inorganic and organic saline compounds.

CHAPTER VIII.

The Preparation and Cooking of Food.

§ 49. In the preceding chapters we have considered certain questions:

(1) What are those **foodstuffs** which are essential to the well-being of the human body?

(2) What is the **action of these foodstuffs** in nourishing the body?

(3) What is the **distribution of these foodstuffs** in different raw articles of food?

It remains for us to discuss here the effect which cooking and other preparation of food for the table have upon the nutritive value of the foodstuffs present. In discussing this we are concerned with the physiological side of digestion and with its chemical side. For the action of the saliva, the gastric juice, and the pancreatic juice is a *chemical action*, and these juices, removed from the body, will (under suitable conditions) digest in a cup or glass. But the pouring forth of these juices is a *physiological action* (*secretion*): they are made by the living cells, and poured out by them into the mouth, the stomach, the intestine; and this action can only be performed by **living substance.** Thus we have to ask, A. How is food affected by preparation as regards the chemical action of the juices upon it? B. How is the exciting or stimulating effect of food on the digestive organs affected by processes of preparation? Does food treated in the various ways call forth an abundant flow of secretion? We will make these questions the main divisions of the chapter.

A.

1. We will consider first, *the relation between the chemical action of the digestive juices and the food as it is variously prepared.*

The fine division of food.

§ 50. Under this heading we may place:

(1) **Chewing,** with such knife and fork action as is supplementary among many European nations.

(2) **Mincing,** with which we may associate braying (or pounding) in a mortar, and rubbing through a sieve.

(3) **Grating.**

(4) **Whisking** or beating.

(5) **Emulsification.**

(6) **Dilution.**

Now we may say that all chemical action, at least *all solution, goes on more rapidly and more thoroughly when the bodies concerned are finely divided.* And this is true of the solution which accompanies digestion. If we take a piece of beef, 1 inch cube, and take the same amount cut into 1000 *cubes,* it is clear (cp. above, § 10) that the fragments offer ten times as great a surface,—the gastric juice can get at them better,—and the conditions, in this respect, are highly favourable for thorough and rapid digestion. *Thus, all fine division is an* aid *to digestion.*

(1) Chewing.

This is really all-sufficient to the primitive ancestors of man, and the use of the knife and fork and all the artificial modes of division which are before us belong to civilization, and probably to artificial diet, and slightly weakened digestion. But we cannot return to the condition of our tree-inhabiting ancestors, and thus, with advantage, we supplement the chewing of food. Nevertheless it is desirable to chew very thoroughly; the slow admixture of saliva aids in the digestion of any cooked starch or dextrin in the food, and even when the food is protein, thorough mastication is the natural action which prepares the way for digestion by the gastric juice. A case of death is recorded in which death was attributed to the action of very large lumps of beefsteak, found *post mortem* in the stomach. Here absence of chewing proved fatal, although the food concerned was protein.

(2) Mincing.

By this process the work of chewing is forestalled; we can see, then, that it is a process to which the food of the very young, the very old, and the weakly may be subjected with advantage. *Pounding in a mortar* and *rubbing through a wire sieve* may be looked on as extreme forms of mincing: in the latter, some fibre of meat is necessarily left behind, and this is not always a gain—indeed rubbing through a sieve belongs to aesthetic rather than to physiological cookery; it is wasteful, but gives a velvety texture to the purée which passes through, that is much prized in the ingredients of certain dishes. Mincing and pounding are however invaluable: *Scotch collops*, *boudin of rabbit*, *chicken panada*[1],—in the case of all these, digestion is easier than if roast beef, stewed rabbit, boiled chicken, were offered.

[1] To prepare these dishes with finish, it is needful to rub through the sieve.

(3) Grating.

With this we may associate **grinding**—the production of flour and meal—: it takes the place of mincing, when foods of suitable texture are used. Here again the difference of digestibility is marked; coarse flour or meal is more digestible than the whole grain (it has been found by experiment that more of the proteins of peasmeal is absorbed than of the proteins of peas[1]), and a fine flour is more digestible than a coarse flour. Grated almonds are, in the same way, more open to the attack of the digestive fluids than almonds simply broken up by mastication: and grated cheese is far more digestible than the fatty, compressed, mass of raw cheese. To lunch satisfactorily on bread and cheese needs fairly good teeth and good digestion; a cheese *soufflé*, or *fondu* has less compressed nutriment, but is far more digestible. Again, a hard boiled egg is a recognised tax on the civilized stomach, but in an omelette the yolk and white of the eggs are so intermixed that no large mass of either remains. This intermixture however can hardly be properly included under the heading "grating"; it is rather transitional to

(4) Whisking, beating, and aeration.

We may indeed almost regard this as a special form of grating or mincing. Instead of having solids separated into tiny fragments which form a powder or flour, we have glairy or viscid fluids beaten up into what is practically a sponge, holding air. Thus the substance beaten is formed into little compartments or artificial cells, all having but thin walls and all easy of access by the digestive fluids. We may have gelatine thus broken up (as in *lemon sponge*), and carrying with it some nutritious or stimulating matter; we may have frothy *white of egg* (raw white of egg is difficult of digestion although rich in nourishment); we may have cream as in any of the familiar *whips*. The warmth of the stomach must alter

[1] See above, § 37.

the condition of the cream and gelatine soon after they have been swallowed; still it is a frothy, permeable mass which the gastric juice encounters, not an unbroken block of solid or liquid. And because the white of egg is more glairy and tenacious, more susceptible of this "whisking" than is the yolk, therefore in *soufflés*, in *invalid puddings*, in delicate *cakes*, in an *omelette soufflée*, the white is whisked alone, and mixed only at the last moment with the other ingredients which it is to support and make "light." It is really whisking "with a difference" that gives us the proper effect in *bread*, *cakes*, *pastry*, of all kinds. Either air—as in puff pastry—or some gas—carbonic acid gas, as in short pastry, in cakes, and in bread—is introduced, and what would, without this aeration, be a dense mass, hard of penetration, becomes a porous substance into which the digestive fluids can make their way.

(5) Emulsification.

This is the *fine division of fatty particles* and therefore is related to the results of beating or whisking which we have just considered; the nature of oil is such that we cannot readily "froth" it as we do the tenacious white of egg[1], but we can beat it into minute particles, separated by air—as in the case of butter beaten to a cream—or by some non-mixing fluid. *Milk* is an example of the latter form of emulsion, and *cream* is milk containing a disproportionally large amount of milk fat; *cod liver oil* is often emulsified before it is given to invalids; *Cremor hordeatus* and other preparations have, as their basis, fat, thus made easy for digestion. *Salad oil*, if drunk without preparation, would run into irregular masses in the stomach, and be emulsified later by the pancreatic juice; in the sauces *mayonnaise*, *hollandaise*, and their derivatives, some of this emulsification is done in the kitchen[2].

[1] It will be remembered that in cream we do not deal with pure oil.

[2] See above, § 24.

(6) **Dilution.**

It is really chiefly in connection with the natural food, milk, that this process is important. Cow's milk is clotted by the rennet of the stomach, and forms the jelly which we know as curds. But the firmness of the jelly depends (with rennet of a given power) on the concentration of the milk, and *diluted milk does not clot firmly.* Now the massive clot is not easily digested, therefore to avoid its formation is sometimes desirable in the case of invalids and infants. To dilute milk for a baby with boiled water or thin barley-water, is a very general practice, and many invalids take diluted milk.

There are, further, certain processes which are almost a mixture of dilution and whisking, the processes by which a *syllabub* and *koumiss* are made. A syllabub is really milk, frothed up with wine or spirit and flavouring; koumiss is, in like manner, highly frothy milk, but here alcohol and carbonic acid have been introduced by the action of yeast upon sugar. No solid clot is formed from milk taken after this treatment; koumiss and syllabub are related to fresh milk much as is beaten white of egg to the native "white." We can see that syllabub must be a more digestible food than raw milk or than junket, and koumiss—a stimulant as well as a food—has been used to support life in certain cases of great exhaustion.

We repeat that in itself, the fine division of foods is an aid to digestion; it furthers the chemical action of the digestive fluids.

2. *The effect of heat upon foods.*

§ 51. All digestion of food by man is best carried out at the temperature of the human body (36·9° C.); such moderate warmth is wholly beneficial both to the chemical action of

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solution, and, as we shall see later, to the pouring out of the digestive juices. What concerns us now is the effect upon subsequent digestion of a much greater degree of heat, applied to foods. We shall find that this effect varies; in the case of some foods heat aids digestion; in the case of other foods, digestion is hindered; occasionally, foods are deprived of, or made poor in, certain of their constituents when they are cooked. And there is one action of heat which is not directly related to digestion, but which has so important a bearing on nutrition that it must be named here. This is **sterilization.** The meaning of the term has been explained at length in chapter II., but we repeat, that in sterilized tissue or fluid all life is destroyed; therefore any bacteria which might have been present before heating are killed. The risk of infection from any disease-producing bacteria is thus much reduced; **thorough cooking** is one great **safeguard** against the *spread of disease by means of food.*

(1) *Heat as an aid to digestion.*

All foods containing raw **starch** are made digestible by the action of heat. Raw starch is digested very slowly by human saliva or pancreatic juice; starch paste (or cooked starch) is rapidly digested, and dextrin is a bye-product or an intermediate product in the change from starch to sugar. When starch is boiled, stewed for a long time, fried or baked, the change to starch paste, or to cooked starch, takes place. When dry heat is used there is often a change to dextrin (see above, § 23) as well: this is the case in the crust of well-baked bread, of cakes, and probably in that of pies; in pulled bread, in toast, and in many biscuits.

From this point alone, we can hardly over-estimate the importance of thorough cooking of starchy foods; potatoes, porridge, all breads, all milk puddings, all pastry, and preparations such as cornflour, arrowroot, revalenta, lose greatly in nutritive value if any starch is left in the raw state. Thorough boiling, baking, or frying, or long-continued cooking at a lower temperature is essential. When digestion is very delicate, then the further change to dextrin is desirable, and it is mainly to ensure this change that doctors recommend to dyspeptic patients thin toast, slices of dry bread "pulled" or browned, rusks and other highly cooked foods. It is a change to dextrin too, that is brought about in baking flour after the fashion recommended for babies' food. Prolonged heating not only cooks the starch in flour, but turns some of it to dextrin, and the flour in its altered state may be mixed with a baby's milk at such time (say 6 months) as supplementary starchy food has become desirable.

The beneficial action of heat upon the **cellulose** of foods is less well-established, but the point is worth brief consideration. We have seen in § 28 that the digestive fluids of man do not dissolve cellulose, but that a portion of what is present in food is broken up by some of the bacteria which always inhabit the human intestine. Probably this action is not of great nutritional importance and there is no direct proof that it is furthered by the previous cooking of cellulose. What this cooking certainly does, however, is to *make limp and flaccid* the cells which, in uncooked fruit and vegetables, were tense—or in the words of botanists, turgid,—to rupture the walls very generally, and to kill and coagulate the protoplasmic contents, and to make digestible any starch which may be present. And here we have both a gain and a loss: the rupture of the cells, and death of the cell-contents makes it easier for all fluids and thus for the digestive secretions to attack them, but, on the other hand, coagulated protein is, as we have said, hard to dissolve. And an amoeba sends its digestive fluid readily through the wall of a swallowed vegetable cell, and readily dissolves the cell substance which lies within.

The point is a little obscure, but practically we know that tomatoes, apples, pears, plums, are far easier of digestion after they have been cooked, and none of these contain starch when ripe. Thus the increase in digestibility must be connected with action on the cellulose walls or their watery contents. And of one thing we are sure; the disintegrating and softening effect is *very important indirectly*. The flesh of chicken or the flesh of fish is soft enough to be rubbed and pounded to a *purée* in the fresh state; but hardly any vegetable can be treated thus. It is only after long stewing or boiling that carrots, haricot-beans, artichokes, chestnuts, and many other "vegetables" are sufficiently soft to be pounded into their respective *purées*.

It cannot be claimed that the action of heat upon **fats** furthers their digestion importantly. It is true that the work of melting the harder fats may, by preliminary heating, be spared to the alimentary canal, but this is no great gain as compared with the gain of previous emulsification. And it is discounted, when digestion as a whole is regarded, by the fact that melted fat, penetrating the particles of accompanying foods, makes them difficult to digest. Hot buttered toast and cakes are, as we know, unsuitable for the dyspeptic.

Lastly, we must speak of the action of heat which is not all a gain,—the action by which **solutions, infusions,** and **decoctions** of food are made. This is helpful up to a certain point, for *liquids are easier to digest than solids*,—the digesting fluids can mix with them and act on them more easily;—but, if the heat applied is great, then the action on **proteins** which we are about to discuss takes place, they do **not** go into solution, or if in solution they are thrown down as insoluble substance. This loss or precipitation of proteins is a serious loss from the point of view of nutrition, but other constituents do remain in a fluid which has been boiled; thus in a decoction of meat the **salts** of meat are there, often **gelatine** has been formed in the boiling from its precursor connective tissue (cp. above, § 28), and there are members of that group of substances known as the "**extractives**" of muscle[1]. Of the importance of saline matter we have already spoken, and we saw in § 28 that gelatine, if it cannot be regarded as a food, is at least important in affecting the chemical changes of the body; it is a proteid-sparer. The extractives *kreatin*, *xanthin*, *inosite*, *lactic acid* and other complex, soluble, organic bodies, are not foods, but they have a stimulating action on the body, comparable rather to that of tea. Briefly, we may say that solutions or infusions made from *slightly warmed meat* are both nutritious and digestible; that decoctions (and to them the various **broths** belong) are very poor in dissolved proteins but are still stimulating, and are not without their importance in nutrition. And in all these cases the body can readily avail itself of what the liquid concerned has to offer because of its existence in solution. If precipitated proteins are present (as in the brown sediment common in beef-tea) then, although not readily soluble, their solution is aided by fine division.

A word may be added touching infusions and decoctions of vegetable matter. Many of these are in no sense food, but are valued for their stimulating or medicinal qualities; we may instance *tea*, *senna-tea*, *bran-tea*, &c. Others are dilute starchy foods, and for them, thorough cooking is wholly a gain; in this group we may include the various gruels, barley-water, arrowroot-water and rice-water. Others again contain salts, soluble organic substances and potent flavouring, often due to some essential oil. In none do we find any important amount of protein; we have seen earlier that although small amounts of proteins are present in all parts of all plants it is only in certain reserve organs that the percentage is high, and, whether the amount is small or great in the fresh state, the proteins are made insoluble (see below) by that long-continued cooking which is requisite to carry into solution the ingredients for which most vegetable extracts are valued.

[1] See above, § 32.

(2) *Heat as a hindrance to digestion*[1].

With the exceptions of proteoses, peptones, and derived albumens, all proteins are **changed by the action of heat.** At varying temperatures they are precipitated from their solutions and in an especially insoluble form as **coagulated proteins.** But proteoses, peptones and derived albumens are but rarely met with in ordinary food—they belong rather to the products of digestion—so we may safely say that *the great mass of protein food taken by man is made less readily digestible by cooking.* This is true of proteins whether **boiled, steamed, baked, braised,** or **fried**; and even **stewing** is rarely if ever carried out at a temperature below the coagulating point of albumens and globulins. It must not be supposed that protein food is made actually indigestible by cooking; the healthy human gastric and intestinal juices can still cope with it successfully; but, when the most readily digestible protein nutriment is necessary, then we give *meat-juice*, *raw-beef tea*, or *raw scraped* and *pounded meat*, spread into sandwiches. And it is advantageous that at all times **protein matter should not be overcooked.** To this end stewing and braising are at their best carried out at a temperature below the boiling point of water; "boiled" eggs if treated with real care are also kept below the boiling point of water, for all the proteins in egg coagulate at or under 70° C. In roasting, baking, and grilling, the heat applied *at first* is great, so that a dense, coagulated, outer layer or shell is formed; then, at a *lowered temperature*, that gradual cooking—we might almost call it internal stewing—goes on which shall make tender all the flesh bounded by this dense layer. And carefully-made beef-tea *is very lightly cooked* (cp. above).

[1] The understanding of this paragraph will be clearer if § 23 be re-read here.

(3) *Heat as an agent in depriving foods of various of their constituents.*

Loss of **water.** This takes place in all dry cooking; the "steaming" of toast as it is made, is familiar and the drying of meat and bread; and besides water which escapes into the air, we have water which helps to form gravies.

Loss of **fat.** All dripping is fat, lost to meat in process of cooking. The fat is melted by the heat, and exudes in drops, from its containing cells. In an analysis given by Church, the composition of a cooked mutton-chop with and without its own gravy and dripping are recorded, and in this it appears that 6 parts p. c. of fat are lost in cooking. The amount must vary with the nature of the meat and the thoroughness of the cooking, but the quantity of dripping which accumulates in an average household testifies to its importance.

Loss of **salts**, organic and inorganic, and of other **soluble organic bodies.** All those ingredients which we named as a gain to infusions or decoctions are a loss if we consider, not the broth, but the meat or vegetables. In fact what the *bouilli* yields to the *bouillon*, it yields at its own cost. And for the most part, we do not eat meat or vegetables which have been made to yield largely of their substance to fluid, but some loss is inevitable in the case of all boiled food.

Burning. When food is exposed to very great heat it is burnt, and volatile compounds, products of combustion, escape into the air. When the heat is still great but insufficient to burn completely we get *charring of organic matter.* "Burnt" toast, "burnt" crust, grilled steak that bears the "marks of the fire"; all these have lost some of the constituents of their organic compounds with partial setting free of the carbon. And short of this point, we have the formation of those brown compounds, rich in flavour, which belong to the "outside" of browned meats or vegetables. So little is known of these that we cannot say definitely that their formation is associated with loss of substance, but it is highly probable that this is so.

Loss of **ferments.** Any ferments present in food are killed by the action of heat in cooking, although their death may not be accompanied by any actual loss of substance. Tripe, sweetbreads, oysters—and with them all animals not deprived of digestive glands—contain digestive ferments when they are fresh; these are killed by cooking, and the same fate attends such vegetable ferments as diastase or the peptic ferment found in the juice of the papaw-tree (*Carica papaya*).

We see, then, that the *relation of heat to the digestion of foods is complex.* At a gentle heat, i.e. at the temperature of the human body, all the processes of human digestion go on best, and the same temperature is most favourable for making solutions (watery or saline) of meat. But while great heat (prolonged boiling or "simmering") is all a gain as regards the digestion of starch (for it makes starch digestible, or turns it to bodies still more soluble, dextrin and sugar), there are few proteins found in foods which are not made less easy of digestion by heating.

3. *The effect of cold upon the digestion of foods.*

§ 52. This is really only important inasmuch as it lowers the temperature far beneath that at which digestion goes on best. Thus, the labour of warming food which has been eaten, falls upon the digestive organs and the blood circulating within their walls. If a cream ice be taken, the ice is soon melted, but melted to a very cold fluid, and though digestion does go on slowly in the cold, it does not become energetic until the temperature is raised. It is, then, inadvisable to eat ices when full digestion holds sway, e.g. at the end of dinner; and large draughts of cold fluid—water, milk, alcohol—should not be taken with food.

4. *The effect of mixture upon the digestion of foods.*

§ 53. We can see that if, by mixing, one food is hidden away in, or coated by another, its digestion is hindered until such time as, by digestion, or some removal of the former, the latter is set free. This sort of mixing does occur in frying, when particles of (usually) starchy food are coated with fat; and we cannot doubt that, making a dish more nutritious, such treatment does also make it more difficult of digestion. Some difficulty in digestion is no great drawback where the food of the healthy is concerned, but fried dishes are unsuitable for invalids' diet. A mixing of foods which is less intimate occurs when beef and potatoes, beans and bacon, and a thousand other dietetic combinations are eaten, and this mixing is advantageous. The earliest natural food of infant man is a mixture, and since all food eaten excites the flow of all the digestive juices, it seems that only special reasons can make it desirable not to tax them all.

5. *The effect of food preservatives upon the digestion of foods.*

§ 54. This varies with the method of preservation: sometimes a large quantity of one form of food is the preservative; this is the case with **condensed milk**, to which much sugar is added. Sometimes **salt** is in excess; sometimes the meat, fruits or vegetables are preserved by **drying**, or drying with **smoking**; sometimes by excluding the air after much heating; sometimes by the injection of **antiseptics**. There is no doubt that salting and drying render food less digestible, and that antiseptics do not form a desirable ingredient in food; the various tinned meats, vegetables and fruits, *considered solely from the point of view of their preservation*, stand in much the same relation to digestive activity as do other somewhat over-cooked foods, the cooking being that of moist heat.

In the preceding paragraphs we have attempted to group, as general statements, the most important facts established touching the relationship of cooking to digestion. We will now, as a recapitulation, treat the facts from the opposite point of view, and summarize the changes which belong to the more familiar processes of cookery.

Boiling and Steaming.

§ 55. Here, the outer layers of **protein** food are **coagulated** by contact with the boiling water or steam[1]. The inner part of the food is cooked more slowly (but still coagulated), protected from the loss of its fluid constituents by the hardened outer layers. There is a certain escape of salts and soluble organic matter into the surrounding water in boiling; in steaming this loss is minimized. Long-continued boiling forms **gelatine** in the connective (gelatiniferous) tissue of meat: and then dissolves it in the surrounding water.

Fats are melted and in part set free if boiling water surrounds the food.

Starch is burst and made **digestible**; in prolonged boiling some starch becomes dextrin.

Cellulose is softened, and partially broken down, so that it no longer forms intact cell-walls.

[1] The reference here is to the cooking of fresh meat; salted meat—already hardened by salting—is placed in cold water and heated gradually as the temperature rises to the boiling point.

Stewing and Braising.

Here the **proteins** are coagulated, **fats** are melted, **starch** grains are burst and made digestible, **gelatine** is extracted. The processes differ from boiling and steaming however, in that a gentle heat is applied throughout, and no effort is made to form any outside layer of quickly coagulated protein. Occasionally, flavour and aroma are developed by a very light frying which precedes stewing (in jugged hare, stewed rabbit, various meat stews), but this is solely for the development of flavour: the gravy which forms in stewing is eaten with the meat, and therefore no nourishment which passes into the gravy is lost; there is no need to imprison it within the meat. In braising, distinct flavour is given to the meat by the fact that it is *steam rising through vegetables* which is the cooking agent. As meat, before it is stewed, is lightly fried, so meat, after it is braised, is crisped by dry heat; but before this happens there has been no effort to imprison the "juices" of meat.

Roasting and Baking.

These are brought about by dry heat either in the oven or before a fire; as in boiling, a crust of coagulated substance is formed on the outside, and the inner portions are stewed more slowly within this; **proteins** are coagulated, **fat** is melted and partially escapes, **gelatine** is formed, and alsc partially escapes. And there is, further, a surface change which we call "browning," which carried far enough is "burning." This produces savoury but probably indigestible compounds from the meats, sweets, and vegetables concerned; and makes food cooked in this way more appetizing, but, on other grounds, less suitable for weak digestions. **Starch** is made soluble by roasting and baking and is partly turned to dextrin.

Grilling and Broiling.

These are practically the same process, and are closely related to roasting. The formation of the outer coagulated shell is more complete, the escape of "gravy" is minimized,—for the heat applied is fierce, and the pieces of food to be cooked (usually fish or meat) are relatively small, and therefore easily penetrated by heat.

Making of Soups and Broths.

We may say that this is the converse of boiling; in boiling meat, we seek to prevent the escape of its constituents into the surrounding water; in making soup or "stock" we seek to get as much as possible out of the meat or vegetables and into the fluid. Thus the meat and vegetables are cut into small pieces, are placed in cold water (usually with salt), and are slowly brought to the boil. This is in order that a warm, saline extract (which dissolves all that water dissolves and more besides) may be formed, that as much as possible may be dissolved of the various proteins before their coagulation point is reached. When this is reached they are precipitated it is true, but precipitated in small fragments[1] in the soup and not coagulated *in situ* in the meat. This coagulation is inevitable if any starch present is to be cooked, and if vegetable cell-walls are to be softened and disintegrated, and the long-continued boiling or simmering which does this, also carries on the extraction of gelatine.

[1] It is noticeable that in clear soup all these proteid particles are deliberately removed by "clearing"; only salts, soluble organic substances, flavouring and an insignificant amount of gelatine remain; of all soups, it is the least nourishing.

Fluids that "jelly" have always been subjected to long cooking, and rarely contain protein food.

In a *purée*, more than the liquid extract is present; the liquid is thick with **suspended particles**—the solids of the soup rubbed through a sieve.

B.

2. We will turn now to the second of the main divisions of the chapter, and consider the relation of the cooking of food to the **physiological** side of digestion, asking, *How does the cooking, or other preparation of food affect the flow of the digestive juices?*

§ 56. Food is the most powerful agent in calling forth a flow of digestive secretion; the sight, smell, or thought of food often makes the saliva flow abundantly—the "mouth waters"; the chewing of savoury food calls forth not only saliva but gastric juice, and that before any food has been swallowed; the entrance of food into the stomach arouses a flow not only of gastric juice but of pancreatic juice, although the pancreatic juice acts in and belongs to the intestine and not to the stomach. In fact the living constituents—the cells—of all the digestive glands are governed by the nervous system; they pour forth their secretion as a result of impulses travelling along nerves. But if we recall for a moment such a nervous impulse as that which makes a striated muscle contract, we remember that it may be started *directly*, as by electrical excitation of the nerve (motor) going to the muscle; or *reflexly*, as when some nerve going to the brain from an appropriate sensitive surface (say the retina) is disturbed. The disturbance of such a "sensory" nerve sets up action in the central nervous system (brain, spinal cord), one result of which is a further disturbance set up in the particular "motor" nerve we are considering (say the nerve to the eyelid), a disturbance which travels down the nerve and makes the attached muscle contract,—as in winking. In a similar way the nerves which bring about, not movement of muscles but **secretion by glands**, may be excited directly but are also called into action **reflexly.** And it is this reflex action that the taste, smell, or sight of food brings about; nervous impulses or disturbances started in the mouth, in the nose, in the eyes, travel up to the central nervous system and then start other nervous impulses which travel down to the digestive organs and rouse the secreting cells. These cells are further and similarly roused when food is actually in that part of the alimentary canal to which they belong, and digestible food is more effective—more powerful—as a disturbance, than substance that cannot be digested.

These facts are of importance because they may be made the text of a sermon upon dainty, well-finished, and appetizing cookery. We cannot doubt that food which is pleasant to the sight, to smell and to the taste is a stronger indirect excitant of all the nerves which can bring about flow of digestive fluids than is raw or ill-dressed food. Of course the term "appetizing" has no absolute meaning for all men and all times; the food that is eaten with relish by the Patagonians and the Esquimaux could not be set upon an English dinner-table; but its meaning for our own race and day needs little explanation. It is to produce this quality that frying, grilling, roasting are used so widely; there is no doubt that raw protein food, minced, or extracted, would be the most digestible form of protein food[1]; that fats—to this end—should be warmed and emulsified; that starches should be cooked by thorough boiling. But we sacrifice something of digestibility to the pleasures of the palate, and this, within limits, rightly, so long as we deal with digestion that is not

[1] Raw meat is digestible, but dangerous unless it is chosen with care; it may contain disease-producing bacteria and other noxious parasites.

specially weakened. That pleasurable sensations of smell and taste should lead to a generous outpouring of digestive secretions is more important than that all food should be submitted to the action of those secretions in its most digestible form. It is no hardship for the healthy to deal with food that is somewhat hard of digestion, and even insoluble residues are valuable up to a certain point, in aiding the wave-like peristaltic movements of the intestines[1].

With the food of the very young, the very old, and the sick, the case is different; we deal with digestion by cells which have not yet grown strong, or, having been strong, are now weakened. Hence that they should be provided with food which can be readily absorbed, is of high importance. But in order that its work may be well done, attractiveness is not to be neglected. Indeed the preparation of this food demands *especial* care; for the admissible means of attraction are more limited; "lumpiness" in a cup of gruel or arrowroot is as disastrous from a physiological as from an aesthetic point of view. We remember that not only is secretion of the digestive fluids under nervous control, but there is a nervous machinery which brings about **vomiting**; and distasteful food, promptly rejected, can have little chance of nourishing.

The words just written refer more especially to changes in texture, flavour, &c., which cooking and dressing produce in the foods themselves. And they may be extended in part to the use of **flavourings** and **condiments.** These are used with care and reserve in nursery and sick room cookery, and in certain special cases their use is to be regretted even where food for the adult is concerned. Thus, to eat vinegar with starchy food, is to strike a blow at such digestive power as the saliva possesses, and the inordinate use of pickles and other irritating condiments inflames the mucous membrane (the internal surface) of the stomach and bowel.

The intelligent eater, however, does not prize such excess,

[1] See above, § 28.

but rather that delicate touch of flavour which is given by the restrained use of condiments and flavourings. The best curries are not exceedingly hot; we should be conscious, but not more than conscious, of the presence of cloves and of lemon, of vanilla and of tarragon in their appropriate places: that flavouring of a sauce is most successful which, "half suspected, animates the whole."

§ 57. We may perhaps illustrate these general statements by brief examination and comparison of a day's diet suitable for convalescence, and a carefully chosen dinner suitable for the healthy. The menu for dinner is one taken from Sir Henry Thompson's work on *Food and Feeding.*

Diet for convalescent who is ordered to take light food.

8 A.M.	Cup of café au lait *or* cup of freshly infused tea.
	Toast, toasted slowly and thoroughly. Buttered when cold.
10.30 A.M.	Beef tea, cooked lightly; fingers of dry toast.
1.30 P.M.	Fillets of plaice *or* sole, steamed. Bread and butter (not new bread).
	Sago pudding *or* baked apple.
5 P.M.	Freshly infused tea.
	Toast *or* biscuits.
8 P.M.	Oatmeal gruel with milk *or* Bread and milk.

What points are characteristic in such a scheme of diet?

We notice in the first place that the quantities are small. The convalescent is doing no active work; his digestive glands are probably acting feebly: we do not, then, tax them severely at any one moment; but, on the other hand, the intervals between meals are shorter than is advisable in health.

In the second place the food is very simply prepared and in such fashion that easy digestion is aimed at; all the foodstuffs are present, but fats are used with care. One meal—luncheon—has a fluid for its main feature, and this if cooked lightly will contain extractives and salts in solution and finely precipitated proteid in suspension. In the sago pudding the yolk and white of egg are separated and the white, beaten in at the last moment before cooking, gives porosity to the whole mass. Moreover the sago is "fine" sago and cooked thoroughly. It is fine oatmeal also that is used for the gruel, and of this only the finest part; all the coarse particles are allowed to "settle" before cooking; and gruel at its best is a bland, almost gelatinous liquid, faintly flavoured with sugar, lemon, or, if it be permitted, butter. In the baked apple the cellulose cell-walls are thoroughly softened and much broken; valuable organic salts are present (for little is lost in baking) and the flavour is delicate and distinctive. The toast is thin and thoroughly cooked, so that no soft spongy indigestible central layers remain; and there is change to dextrin in the external layers.

Thirdly, the tea is freshly infused; it is long stewing of the tea which gives it the constituents most harmful to digestion; tea which has infused only for two minutes is as refreshing and stimulating as the tannin-laden product of a day's "stewing." The nutritive value of café au lait is considerable, thanks to the milk it contains, and probably the coffee diluted by milk is less potent as a nerve stimulant than if taken strong, and black.

Menu of Dinner.

Soup.	Paysanne.
Fish.	Fillets of turbot à la ravigote.
Remove.	Braised veal and macédoine of vegetables.
Entrée.	Scalloped oysters.
Roast.	Wild duck.
Entremets.	Stewed celery in gravy.
	Apricots with rice.
Savoury.	Caviare.

We notice first that a clear soup introduces the dinner. Now a soup, cleared by modern methods, is exceedingly poor in nourishment; but it is pleasant to the eye and palate, and slightly stimulating. Useless as a meal alone, therefore, it is a fitting introduction to an abundant dinner.

In the second place we see that hardly any article of food in this menu is prepared without dressing or accompaniment; only the wild duck stands alone, complete in itself. That oysters should be served in any way but *au naturel* may be regretted by some diners, and there is undoubtedly a loss of digestibility in cooking: but on the other hand cooked oysters are less dangerous as a source of bacterial infection. The dressing of the veal is all a gain; veal is the somewhat indigestible flesh of an immature animal, less full-flavoured than mature meats; and the slow cooking, in fragrant vapours from vegetables, is a happy treatment. The final crisping by "top-heat" probably lessens digestibility, but is certainly welcome to the palate.

Thirdly, we see that the amount of food offered is large; such a meal, taken in its entirety, should follow a long period (say five hours) of abstinence from food, a period which also includes some form of activity. The menu is, however, a thoroughly good one of its kind; there is hardly a dish in it (with the exception of the veal and the almost negligible caviare) which might not be offered singly to a convalescent somewhat more advanced than the invalid we have imagined above. There is change of "colour" in the dishes, there is variation of flavour; the excellence of the simple *roast* is allowed its full effect; the *entremets* are simple.

CHAPTER IX.

Clothing.

§ 58. To deal with *clothing as an adornment*, demands an excursion into the domain of aesthetics which would be out of place here. We will therefore consider clothing only from *the point of view of utility.*

In this consideration we will divide the subject into two main sections, but it must be remembered that the division is purely arbitrary and made only for convenience of discussion.

The first section (A) deals with the *mechanical effects of clothing;* the second section (B) with its *physiological effects.* In one sense, indeed, the mechanical effects are physiological also, for they are only important to us in as far as they help or hinder physiological processes; but in the sense in which we shall take the words, the distinction is just, for the physiological effects, grouped together in *section B*, are direct; whereas the effects described in *section A* are mechanical directly, and indirectly, physiological.

A. The mechanical effects of clothing.

§ 59. We distinguish here the effects of **weight** and of **pressure**, and we may note, in passing, that these effects are largely independent of the nature of the materials of which clothes are made. A very tight garter may be made of silk, of wool, of cotton, or of leather: as far as the pressure it exerts is concerned, the effects are the same in each case. A gown may carry many pounds' weight of jet, or it may be weighted round its edge with lead: a slight difference in mechanical effect is produced, because, in the former case, the weight is more evenly distributed; but this difference is unimportant compared with the total effect in each case.

Effects of pressure.

§ 60. **Pressure** is exerted by all clothing that binds or confines. We ought strictly then, to speak of all "fitting" clothes. But for practical purposes we need only speak of clothes which sometimes exert excessive pressure,—of garters, collars, belts, boots, stays,—and with the last-named we may count such a garment as a tight and heavily whaleboned bodice. How do these garments act? In the first place, when organs can be displaced, the pressure displaces them. There is probably hardly an adult foot in England among the "well-shod" which shows the great toe and the second toe in the relative positions in which they stand on the foot of a healthy baby; in a baby the great toe is almost "opposable," that is, it can almost be used as a thumb is used, but after long practice of the habits of civilized life this power is lost, and the use of boots, which are so unlike the foot in shape, often crushes together the first and second toes. The organs in the abdomen, and to a less degree those in the chest, can also be displaced; so it comes about that, when tight waist-belts or stays are constantly worn, the diaphragm has not its right play, the lungs are pressed upwards, expand feebly themselves, and probably impede the heart; the liver, stomach, and bowel do not have their natural relations[1].

[1] In a somewhat different way, unnatural pressure is set up by the use of *high heels to boots*. This pressure alters the range of action of the striated muscles of the foot and leg, and upsets the healthy balance or

In the second place, *pressure has very important action upon the blood-vessels of the body.* We remember that the **heart** does hard work; that it drives the blood through the **arteries**, through the minute **capillaries** (which offer great resistance to the flow), through the widening **veins**, back to itself,—for the circulation is a closed circuit.

We remember too that the arteries, even down to their small branches, the **arterioles**, are highly muscular, that they grow narrow and widen through the contraction and relaxation of the unstriped muscles in their walls. Now the proper circulation of the blood depends on the one hand upon efficient action of the heart, and on the other hand upon the healthy condition and efficient action of the walls of the blood-vessels. In the healthy condition, and with a good heart-beat, the **capillaries** allow interchange between the blood within their delicate walls and the tissues outside, and one important outcome of this interchange is the formation of lymph. Lymph is the fluid which moistens all the cells of the body, and is at once the medium by which they are supplied with food, and drained of waste matters. The healthy **arteries** are delicately responsive to the needs of that part of the body in which they run; and under the stimulus of nerves, they narrow or widen according as a scanty or abundant blood-supply is desirable for the moment. Moreover, by means of the nerves which run to and fro between themselves and the central nervous system, there is ready interaction among all the arteries of the body: so that (for example) events taking place in the brain may affect the condition of the small arteries in the intestine. The healthy **veins** play a more passive part; they can shrink and expand slightly, and so accommodate themselves to varying quantities of blood, but they are to be looked upon primarily

relation between various muscles of the abdomen and the back, and secondarily, by the consequent unnatural attitude of the back, may affect the nervous system generally, and even the sight.

as channels by which the blood can return freely to the heart; it is of the **first importance** that they should be patent or open tubes, i.e. that this return of the blood should be easy and complete.

Now of these blood-vessels, the arteries are probably the least affected by external pressure; they do not generally run near the surface of the body, and their walls are made stout by the presence of muscular and elastic fibres. The capillaries are pressed upon when the organs in which they run are compressed, but it is the **veins**—thin-walled, and lying comparatively near the surface—which are the first to feel pressure from the outside.

When *tight boots* or *tight gloves* are worn, capillaries of the hand or foot are narrowed, for the tissues in which they run are compressed. Cold hands and cold feet are the result of this, for it is abundant and vigorous blood-supply which gives us the feeling of warmth.

When the pressure is on a narrower zone, i.e. when we have a *high, tight collar*, or a *tight garter*, it is more especially the veins that are touched; swollen feet (following on excessive lymph-formation, due to obstructed venous outflow), varicose veins, and again, coldness of the extremities; these are some of the penalties paid.

Pressure round the *waist* or upon the *abdomen* needs especial note; excessive pressure is, of course, bad; the blood-supply of the important abdominal organs is diminished, their nutrition is affected; digestion, kidney activity, and other physiological activities slacken. But slight pressure does aid in the emptying of the great abdominal veins; it aids the venous blood-flow to the heart, it is said even to increase the heart's output. Must we then accept or even urge the use of waist-belts and stays? For the healthy human being—**No.** If we apply such pressure, we apply a pressure which, at the best, does not vary delicately. The muscular walls of the abdomen have always, in health, that partial contraction which is known as **muscular tone**; and this can be increased or lessened with every change of posture, with all variations of exertion, or rest. To place these muscles within some rigid support is to weaken them; but, on the other hand, to make demands on them, from childhood upwards, for unsupported activity, is to harden and strengthen them, together with all the muscles of the body. By means of nerves they are in intimate relation with the central nervous system, and so, potentially, with all parts of the body; they are able to respond through nerves to varied nervous impulses[1]. But no waist-belts or stays can be thus responsive reflexly; they can only be roughly adjusted from time to time. There is no doubt, however, that if tight lacing has been a cause of death to some, others—far more numerous—literally *strait-laced*, have lived to be old. There is no doubt too that thousands to whom this term cannot be applied, wear moderately tight stays and belts with no clear injury to health. But then there are thousands of human beings who hardly know what full physiological life is, whose muscles, nerves, glands, and lungs are habitually sluggish in action, and it may be that moderate constriction of the waist, while not clearly injurious to health, has a tendency to slacken the vigour of the abdominal muscles. There is abundant evidence that artificial support of the abdomen and compression of the waist are of great use when special weakness exists; we would urge that this support should be kept in reserve for special need, and not be looked upon as part of the regular outfit of young and healthy women.

Effects of weight.

§ 61. **Weight,** in itself, is to be looked on merely as a special encumbrance. Let us suppose that a man of 14 stone weight, walks 20 miles. He does a great deal of muscular work in that walk, and the most important item is that, step

[1] See above, Introduction.

by step, he lifts 14 stone. Now, if he wears clothing which weighs 20 lbs. the amount he lifts is 15 st. 6 lbs. at each step. If the extra weight is well distributed it is not so much noticed as if it were represented by a lump of iron carried in the hand, for in this case certain muscles are specially and greatly fatigued. Still the encumbrance is there, and we all know the rapid fatigue which follows physical exertion taken in heavy clothes. And two drawbacks, even more serious, attend upon weight in dress. The first is the pressure set up by *unevenly distributed weight.* This belongs most perhaps to heavy skirts, which often drag upon the waist and hips. The second is *volume.* Voluminous sleeves, and voluminous skirts are both sources of inconvenience, but, when the volume of a skirt takes the form of excessive length, then (for walking) it is an unmitigated evil. We may say that **real cleanliness is incompatible with the use of long walking skirts.** Even when such skirts are lifted with care, there are, almost certainly, moments in which they fall to the ground, and the practice of allowing them to trail along a street or road is **absolutely indefensible.** We have urged elsewhere (§ 11) that the surface of the earth is covered with dust, dust of mingled and often harmful nature. Among this dust in every large town are **bacteria** of most varied powers—often disease-producing—and light fragments of **dried excreta** of man and of other animals—healthy and unhealthy. The trailing skirt whirls this filthy dust into the air, to be breathed not only by the wearer, but by defenceless passers-by. It is also carried home clinging to the skirt, scattered into the air there by "brushing the dress," and probably brought into contact with other clothes. We can hardly picture the end of the disasters that may follow. *Garments which trail in the streets should certainly be counted among the carriers of disease.*

§ 62. In the foregoing paragraphs we have spoken chiefly of women's dress because the mechanical effects of clothing (we might almost say the mechanical defects) are more noticeable in the case of women. The scheme of a man's dress is, roughly, arrangement in layers, with suspension from the shoulders, and the addition of some extra layers on the body. And this type of dress commends itself, although the conception is often better than the execution, and although the whole costume is often marred by such a detail as a high, stiff collar. It is not suitable, however, for great physical exertion, and, as we know, the coat and waistcoat are often discarded in such conditions. Another preparation for exertion is the replacing of the braces by a belt, and that this should be a change for the better is strange, from a woman's point of view. We are accustomed to think that suspension of clothing from the shoulders is the mechanical ideal; it may be that the difference in judgment is the expression of some discomfort proper to braces, and not to garments hung from the shoulder, or, on the other hand, that it is the result of real unlikeness in the conformation of the waist and hips of men and women.

B. The physiological effects of clothing.

§ 63. In considering these effects we have to deal equally with the dress of women and men. Moreover the material of which the clothing is made is of greater importance than its arrangement. For the great physiological effect of clothing is the checking of loss from the surface of the body, and different materials act very differently in this direction[1].

Now the loss from the surface of the body is in the first place a loss of **heat**, and in the second place a loss of **substance**. And the substance lost is varied in nature;

[1] See above, § 12.

it is, firstly, that complex fluid to which the name of *sweat* or perspiration has been given—water holding in solution inorganic and organic salts—; secondly, *fatty matter* from the sebaceous glands; thirdly, *epidermal scales*, that is, fragments of skin, rubbed off from the surface.

Let us examine these processes a little more nearly.

Loss of heat. We know that the temperature of a healthy warm-blooded animal is approximately constant. Heat is generated by all metabolism, that is to say by all the chemical changes in the living body. Heat is lost by warming food and the egesta, by warming the air expired from the lungs, but *mainly from the skin.* The loss from the skin is a loss by evaporation, by radiation, and by conduction. Thus there are in the body two great antagonistic areas, a *warming internal area* and a *cooling skin area*, and the blood gains heat in the one, loses it in the other, and, by means of nerves, is directed now to the one area, now to the other, as the needs of the body demand. We at once recall illustrations of this. If the surrounding air is very cold the blood is withdrawn from the skin area (in obedience to nervous impulse) and circulates chiefly through the warming internal area (muscles, glands, &c.); on the other hand, if great muscular exercise be taken and the production of heat by metabolism be increased, the vessels of the skin dilate, blood passes freely through the cooling area which they form and so there is compensating loss of heat. Now, a relatively bloodless skin gives us the sensation of cold; when the skin is flushed we "feel hot"; it must be remembered then the sensation of cold arises when loss of heat is really being lessened, while the sensation of warmth arises when the loss of heat from the skin is great.

Loss of substance. The substance which is lost from the skin is waste matter. The epithelium scales are the remnants of what were once living cells of the skin; the fatty matter of the sebum has been used as lubricant for the hairs and the surface of the body generally; the sweat carries off waste matter which springs from chemical changes in the tissues. The amount of sweat excreted varies greatly, but it has been estimated as 2 to 20 litres per day.

We have said that **clothing checks loss from the skin**; is this action advantageous or disadvantageous?

In certain conditions the checking of *loss of heat* is a great gain. The chilling effect of very cold air upon the skin would be dangerous to the naked human being[1]. However great the withdrawal of blood to the great internal heating area, it would not be sufficiently warmed *in ordinary metabolism* to prevent serious disturbance of health. In the case of many warm-blooded animals, fur or feathers protect from such disaster; man protects himself in cold climates by garments which prevent loss of heat

(*a*) by their own thickness,

(*b*) by their non-conducting properties,

(*c*) by the fact that they enclose strata of fairly warm air, which air is more or less stationary.

When metabolism is greatly increased, the need for clothing is less: thus the crew of a racing boat are quite warm when they have "rowed a course" in winter, although their clothing is scanty. Conversely, when metabolism is more than usually quiet, and the temperature surrounding the body is low (as in sleigh-driving), abundant, fur-lined garments are not too warm. It is almost always disadvantageous to check the *loss of substance* from the skin. The epithelium scales are dead; others are ready to replace them; the sebum and sweat are, as we have said, waste matters. The complete removal of all these effete matters is the ideal here; thus, to wear clothes is to depart from the ideal.

[1] Certain races, however, go unclothed even in a severe climate. We hear of the Patagonians sleeping naked upon the snow.

The physiological effects of clothing, then, are mixed: there are, doubtless, climates in which, if these effects only were considered, all clothing would be rejected; in the climate of England and with modern habits of life this is impossible, but the choice of clothing may be such that the physiological gain may be as high as possible, the physiological loss as low as possible. Let us recapitulate the conditions which we should endeavour to satisfy:

As to the form of clothing:

(*a*) Pressure should be avoided.

(*b*) Weight should be avoided.

(*c*) Contact with the earth should be avoided.

As to the substance of clothing:

(*a*) The body should be shielded from direct contact with great changes of external temperature; to this end material which conducts heat badly should be chosen.

(*b*) Clothing should, as far as possible, permit the free passage of water and excreted matter from the skin, so that evaporation is checked as little as may be.

§ 64. What materials, shaped in what form, will meet these needs? Any garment that is loose (but not shapeless), light, and hung from the shoulders, is good in **form**, provided that (if for out-door use) it does not touch the ground, or hinder locomotion. And this is widely recognized: the suspension from the shoulders may be direct, as in the case of the *combination*, or the *Princess dress*, or indirect, as when a skirt is hung on to its bodice, or trousers upon braces. An unconscious acknowledgment of the value of looseness in dress is found in the lasting popularity of *blouses*, and in the shape and fit of all *flannels* and "blazers"; and the walking-skirt is probably gaining the recognition that has already been given to skirts for bicycling, shooting, and hockey.

We may consider the **materials** of clothing first as regards their *warmth-preserving properties*, and we may first recall the fact that these materials are both animal and vegetable in origin; wool, silk, leather, kid, feathers, fur, are derived from animals and are nitrogenous; cotton and linen are made from non-nitrogenous vegetable fibre, really from cell-walls. The constituent threads of wool are really hairs and have rough irregular surfaces; the threads of silk, of cotton, and of linen are variously shaped but of smooth outline; they always lie distinctly, in the fabric which they compose, whereas threads of wool may be milled to form a hardly distinguishable mass. Of these materials, fur and feathers take the first place as warmth-preservers; next come the various woollens, the softer "wools" probably coming before the harder worsteds; then the silks, then cottons (with muslin), and linens (with cambrics). Cottons and linens are poor warmth-preservers, but their powers may be heightened by suitable treatment. Both cotton thread and linen thread are manufactured into those fabrics which are now widely known as *cellular*. The manufacturers of these fabrics claim that by the tiny depressions or pits in which the cloth is woven, a mechanical arrangement is made which imprisons a layer of almost stationary warm air next the body; and there can be no doubt that, from the point of view of sensation, the cellular cloth is much less chilling than plain linen or cotton cloth.

When we turn to consider the *permeability* of materials we must place the woollen fabrics first. Doubtless they differ among themselves, but they are all more permeable than silk, cotton, or linen. Among the cottons and linens, the cellular cloths must be counted as exceptionally permeable, as we have just seen they are (for cotton and linen respectively) exceptionally warm. Fur and feathers (which head the list when warmth is the property considered) are not permeable forms of clothing; for they are mounted on dead skin, and that has been subjected to a form of tanning. Now tanning makes the skin durable, and pliable, but relatively impervious, so that all skins—whether still bearing hair, or made into leather or kid—do not allow free escape of water and dissolved substances from the body of the wearer. Probably only one article of clothing is less permeable than they—namely mackintosh (and with this oilskin may be included)—and this allows so little escape of skin-excreta that it is highly insanitary for anything beyond a narrowly limited use, and its properties as a warmth-preserver are rightly disregarded.

§ 65. It would seem then, that, when the utility of clothing is considered, the woollen materials stand easily first in advantage. They may be light in weight, they are poor conductors of heat, they are readily permeable; thus, while retaining heat, they do not check excretion. There is however one great drawback attending upon the use of wool. It forms fabrics which shrink readily; they must always be washed with great care, and they **cannot be boiled** without lasting damage. Therefore woollen garments may be a serious source of infection. If they come in contact with disease-producing bacteria it is very difficult to free them from these. Special methods of disinfection there are, but the safe and ready method of sterilizing by boiling cannot be used; and the practice of wearing cotton dresses for nursing is hygienically sound.

Even for the healthy we are not prepared to urge the constant use of loose, light, short, woollen garments, varying in number with the time of year. Man is a creature of a hundred occupations; and clothing, which might be suicidal in one occupation, is fitting or even ornamental in another. In fact, in suiting the dress to the occupation, lies the secret of really rational clothing. The secret is learnt in part, but as yet only in part. There is hardly an Englishman who would climb, or row, or play cricket, except in "flannels," or woollen clothes of some sort; but all Englishmen dance in the regulation shirt, and suffer thereby at least discomfort.

It is probable that the majority of men dress more hygienically than the majority of women. Faults of dress they certainly do show; they cling to hard, impermeable and unpicturesque hats, they line woollen garments with cotton, they run to excess in collars. But their garments are cleanly and not voluminous, and they cover the limbs almost equally with the body. The correct "town" dress can be worn without hindering quick walking, and, as we have said, when real exertion is taken, the town dress is laid aside.

There is little doubt that the dress of women will be less faulty as time goes on. As increased physical activity becomes part of the life of girls, the effort to be active in unsuitable dress will end in the evolution of suitable garments. Indeed the change is in progress; the very general use of woollen combinations—often even high-necked and long-sleeved—the adoption of stocking suspenders instead of garters, the substitution of knickerbockers for an underskirt in walking and bicycling—these are all specimens of the reforms of the last twenty years. And it is this sort of reform which we would urge. There can be little harm in allowing a dinner dress to trail over well-kept carpets, and it is all a gain that its lines should be guided by long petticoats, frilled or shaped; there can be little harm that a man should dine in a somewhat chilly and impervious shirt front. Excessive changes of outside temperature are suspended at these times; the metabolism of the skin, too, is not active. But to undertake physical exertion in these clothes would be a physiological as well as an aesthetic sin.

PART II.

THE PRACTICE AND TEACHING OF DOMESTIC ECONOMY.

BY FLORENCE BADDELEY.

CHAPTER X.

Housewifery: Hygiene in the House, Practical Housekeeping and Laundry Work.

§ 66. THE term Housewifery is defined as "skill in the art of managing a home," and covers all the duties and knowledge expected from one to whom the care of a household is delegated. The word embraces a vast field of knowledge, an infinity of duties, from the choice and furnishing of the dwelling, to the nursing and feeding of infants and sick people. Of late years Housewifery has formed a subject of instruction in the elementary schools and is now being taught in all classes and sections of the community. It threatened to become a lost art, and the idea that "housewifely" instincts are inherent and blossom naturally in every woman has vanished before the stern realities of the daily routine.

The House, its aspect and Construction.

§ 67. The House comes first under this section. It is not possible in many instances to choose a dwelling-place, but certain precautions should be observed in every case, as the health of the inhabitants largely depends upon the healthiness of the house. It is essential that the site should be well chosen, that there should be a good supply of pure air, fresh water and plenty of light, and that the drainage should be efficient and in good working order. Where the choice of a house is possible, the question of rent and distance from the daily work has to be considered. A house facing north should be avoided, a south or south-westerly aspect is best, as all the living rooms should receive plenty of sunshine, the larder is the *only* place that benefits by facing north. For bedrooms an easterly aspect is not to be recommended, especially for invalids, who often depend greatly on their early morning sleep after a bad night.

Aspect.

Soil.

The best soils to live on are gravel, sandstone and loose sands; clay and made soils should be avoided. The latter are often excavations, which have been filled in with town refuse and sweepings; if such a site *is* chosen a foundation of concrete should be laid, projecting beyond the outer edge of the walls. Ground-water should not be nearer the surface than 10 feet and not be subject to sudden fluctuations.

Construction.

The next point to consider is the construction of the house. Bricks are generally used and if well made are good material for the purpose; they are porous and the walls should be at least one and a half bricks thick. The foundations of the house must be solid and deep enough to give firmness to the building. The walls of no room or cellar should be in direct contact with the soil; this can be secured by laying a damp-proof course along the full thickness of the wall, which is made of glazed tile, slate, asphalte etc. Stone, sandstone and limestone are also used in constructing houses, they are porous but in a less degree. Wood is not much used for external building parts, but enters largely into the construction of the fittings. Timber for this purpose should be close, straight-grained and well-seasoned. For the roof tiles or slates are best, nailed on a good framework, strong enough to bear the tiles and a certain quantity of snow. The gutters should be made of lead, and where they join well fixed into the brickwork. The eaves should always project beyond the walls and be provided with a good gutter discharging into rain pipes. These again should discharge into properly ventilated rain-water tanks or over a drain covered by a grating. They should never be *directly* connected with the drains or sewer, neither should the heads of the same come beneath a bedroom window. If there are trees near the house, it is necessary in autumn to see that the gutters do not get choked up, and after a heavy fall of snow the roof should be cleared, this is the duty of the tenant.

Floors.

Floors are best made of some impervious material such as wood, stone or tiles, which can be washed. The two latter are suitable for halls, passages or sculleries, but are too cold for living rooms, besides which they do not "give" in the least and are tiring to stand on.

Windows and Doors.

Windows and doors should fit well, and the former should open freely top and bottom and every room should be provided with a fireplace and a chimney, as they form the best means of escape of foul air.

Wall coverings.

Walls may be panelled, painted, distempered, papered or limewashed, but in all cases the surface should be smooth, non-porous, and the material used must not give off any poison such as arsenic. Washing papers or any that have been varnished are suitable for bathrooms and lavatories. In putting on new papers, the old one should be scraped off first. If these are left on they are liable to rot and ferment.

Ventilation.

§ **68.** Ventilation, as will be seen in §§ 12—16, is something more than providing for change of air in a house. The windows of a crowded, overheated room may be thrown open on a cold windy night and change of air will thus be procured, but discomfort to the occupants will result.

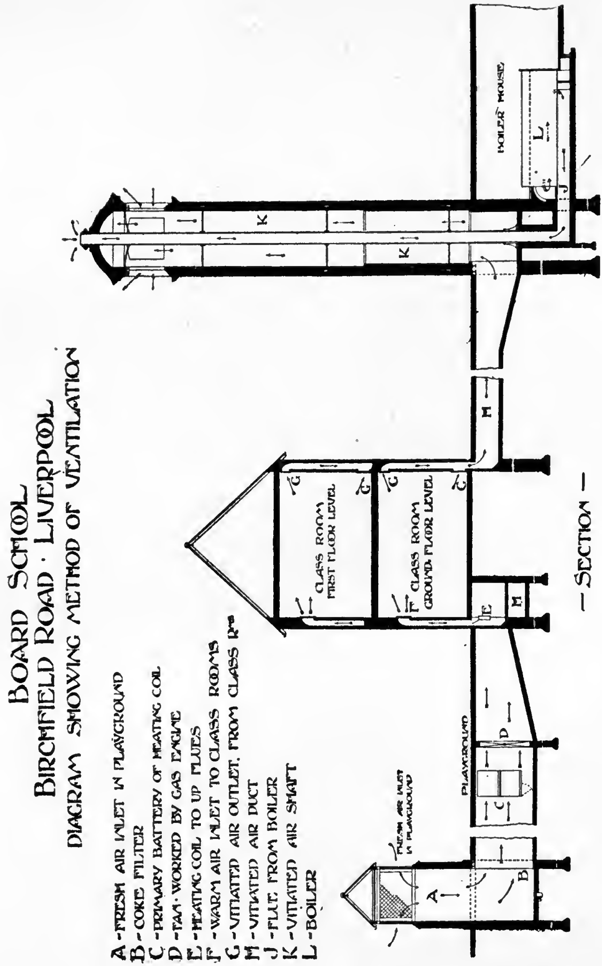
To sustain healthy life, air must be pure and uncontaminated; life can only be sustained when atmospheric air can be freely breathed. Evidence is constantly forthcoming to prove that if air be greatly contaminated death results from breathing it, and impurity, not sufficient to cause death, will impair the respiratory organs or lower the general health of the body.

Movement, sunlight, water, heat and cold are all most necessary for keeping air pure and healthy. The purification of air in buildings is best secured by efficient ventilation. To secure this two things are primarily essential, (1) an air inlet, (2) an air outlet. Constant care must be exercised in order that air may not be contaminated either just before or while entering the building, or after having entered. Openings too must be provided for its exit and entrance with means for regulating one or both.

The three methods in general use are:

1. The Plenum System.
2. The Exhaust System.
3. The Natural System.

Mechanical means such as the first two are not much used for ordinary dwellings, but should be employed for buildings in which many people congregate, as only by mechanical means can constant satisfactory ventilation be obtained. In buildings such as schools where the Plenum System is adopted (see illustration), fans are considered the most economical and satisfactory. A careful consideration of the diagram will show the method recently adopted for ventilating a large school. The fresh air is admitted at *A*, passed over coke filters *B* before being heated and propelled through the building by means of the rotary air propeller, a fan at *D*. Only two rooms are shown, but the same principle is applied to all. In ordinary dwelling-houses it is essential that the ventilating appliances should be simple in construction and easily regu-


BOARD SCHOOL
BIRCHFIELD ROAD · LIVERPOOL
DIAGRAM SHOWING METHOD OF VENTILATION
A - FRESH AIR INLET IN PLAYGROUND
B - COKE FILTER
C - PRIMARY BATTERY OF HEATING COIL
D - FAN · WORKED BY GAS ENGINE
E - HEATING COIL TO UP FLUES
F - WARM AIR INLET TO CLASS ROOMS
G - VITIATED AIR OUTLET, FROM CLASS RMS
H - VITIATED AIR DUCT
J - FLUE FROM BOILER
K - VITIATED AIR SHAFT
L - BOILER
FRESH AIR INLET IN PLAYGROUND
PLAYGROUND
CLASS ROOM FIRST FLOOR LEVEL
CLASS ROOM GROUND FLOOR LEVEL
BOILER HOUSE
— SECTION —
SCALE OF FEET

lated, and that all the flues and ducts should be periodically cleaned. The natural means of ventilation are based on the forces which nature supplies (see Chapter IV.). When the temperature is raised air expands, the result being that colder air falls by the power of gravitation and in so doing causes the lighter air to ascend. It is upon the variable movements of the outer atmosphere that the ventilation within the house is based. The forces they exercise may be employed either for propulsion, or for extraction, or both. In addition, when houses are warmed, forces are developed within which may or may not assist the change of air. In England the open fireplace is the great feature in ventilating the house. The amount of ventilation is secured not only by the presence of the fire, but because of the necessity of an opening to the outer air. On no account therefore should the register be closed when there is no fire in the grate, nor should anything be stuffed up the flue, as the latter should be regarded as a most important outlet for air. The regulation of the amount of the change of air in an apartment is better effected at the inlet than the outlet, consequently all inlets should be capable of easy regulation; in the case of a fireplace this is effected by means of the register. Ordinary dwellings in England are frequently warmer than the outer atmosphere, consequently, unless each room receives a separate and adequate supply of air from the exterior there is risk of down-draught in some flues, particularly if others are more lofty. In order to obviate "smoky chimneys" it is necessary to have air inlets. As change of air is essential to ventilation, there must be movement of air, but when the movement is too rapid, draughts ensue.

The size, nature, and position of inlets and outlets must be carefully considered. The principal outlet is generally, as has been pointed out, the fireplace flue, and if the inlet is placed on the same side of the room as the outlet the risk of setting up draughts is reduced to a minimum, unless the incoming air is at a very low temperature. Special inlets other than doors and windows should be situate at about two-thirds the height of the room and be so shaped as to give the incoming air an upward tendency. In order to decide upon the position of a special air inlet it is important to ascertain the direction of the air-current in the room. This may be done by employing volatile essences such as oil of peppermint or by using smoke, but the most simple method is to hold a lighted taper which will be useful as a test by observing the deflection of the flame. *Tobin* tubes have been largely used for air inlets, but they are usually fixed so as to cause much discomfort and are consequently closed up. Another inlet is known as the *Louvre* regulator, and when placed on the same side of the room as the fireplace is by far the best air inlet. As a rule inlets are too small, and when the extract power in the outlet-flue is considerable, air enters with too great velocity and causes draughts. The *Sheringham* air inlet necessitates a hole through an outer wall with a grating on the outside, and an inner frame provided with a hinged flap weighted so that when a weight attached to a cord is raised the flap may be opened at will. The most simple arrangement and one which may be used by all is the fixing of a board or deep bottom rail to an ordinary double-hung sash which permits of the window being opened to allow air to enter at the meeting rails. The object of all these contrivances is to admit air so as to cause diffusion throughout the apartment and to avoid a direct current or draught.

Heating and Lighting.

§ 69. The chief requirements of a good system of warming are the following:

1. The apparatus should produce and keep up an equable warmth all over the building or at least over every part of a given apartment.

2. It should not vitiate the air in any way.

3. It should not lessen the humidity of the air.

4. It should not require skilled attention or be likely to explode or cause damage to property.

5. The apparatus should be of such a nature as to promote ventilation.

Heating.

Modern houses of any size are heated either by hot water or by hot air, and in taking a house it is well to ascertain that the heating apparatus is in good working order. In heating by hot water, the pipes should be protected from frost and the flues and boiler kept clean: hard water furs the inside and causes the pipes to choke. The chief objection to the use of air as a means of warming a room or house is the fact that heated air is often unpleasantly dry. Open fireplaces heat a room very unequally, but are cheerful and ensure ventilation. They should be constructed with as much firebrick as possible to retain the heat, and the space beneath the fire should be closed in front by a close-fitting iron shield or "economizer," this secures as complete combustion as possible of the fuel at the bottom of the fire by the exclusion of cold air.

Lighting.

Artificial lighting may be supplied by gas, lamps or candles, all of which require a considerable amount of oxygen and vitiate the air. Coal gas when burned produces carbonic acid gas, and each cubic foot in burning consumes 8 cubic feet of air in one hour. It is liable to explode on the approach of a light. When there is an escape of gas, which may be readily detected by the smell, all the doors and windows should be opened before taking a light to find out the cause. In the absence of a plumber the leak may be stopped temporarily with soap, but the pipe should be repaired as soon as possible. Incandescent gaslight is economical in its consumption of gas and sound from a hygienic standpoint; it gives a very white light and is dazzling in its illuminating power. Electric light is perfect hygienically, but is not yet within the reach of many private individuals. Where electric light is being introduced into a town it is possible to have it laid on at a comparatively low cost. Lamps are in general use when gas is not obtainable. Formerly colza oil was largely used but it is expensive and requires a special lamp, and has been almost entirely replaced by the use of the mineral oils, paraffin and petroleum. These mineral oils should be of the best quality; cheap oils have a low flash point and are very dangerous. In America the flash point is 100° Fahrenheit while in England 75° Fahrenheit is the recognized standpoint, hence the many accidents that occur. The London County Council have recognized this danger and have issued printed directions for the construction and management of lamps, a copy of which should be in every household.

Suggestions for the safe construction and proper management of Lamps.

Construction.

1. The oil reservoir should be of strong metal properly folded and soldered at the joint, and should not be of china, glass or other fragile material.

2. There should be no opening between the reservoir and the burner, other than through the tube which holds the wick; and this tube should be extended to within ¼ inch of the bottom of the reservoir and should have no opening into the reservoir except at its base.

3. The burner should be securely attached to the reservoir, preferably by means of a strong and well-made screw attachment.

4. There should be no openings through which the oil could flow from the reservoir should the lamp be upset.

5. Every table lamp should have a broad and heavy base, to which the reservoir should be strongly attached.

The Use of Lamps.

Suggestions for securing Safety in the use of Lamps.

Petroleum oil (or paraffin) such as is commonly used in lamps becomes dangerous from fire and explosion when it is heated above its flashing point.

The flashing point of ordinary petroleum oil is a little above 73° Fahr.; and while being burnt in lamps such oil is frequently heated above this temperature, and many fatal and other accidents are caused.

Oil in the reservoirs of lamps is rarely heated above 100° Fahr., and the most important safeguard against accident is therefore *never to burn oil which has a flashing point of less than* 100° *Fahr.*

The flashing point is the temperature at which oil flashes when tested in the Abel testing apparatus.

Oil of over 100° Fahr. flashing point should be sold by every oilman or dealer in lamps as cheaply as low-flash oil.

Lamps should be strongly made, and should be kept *thoroughly clean.*

In choosing a lamp, see—

That the *reservoir is thick and strong*, and is not made of thin glass or china.
That the burner is strong, and is securely connected to the reservoir by screwing into the collar.
That the lamp has a broad and heavy base.

The wick should be soft, and not tightly plaited, and should quite fill the wick tube without having to be squeezed into it. Wicks should be frequently renewed, and immediately before being put into lamps should be dried at a fire.

In managing a lamp, take care—

That the reservoir is *filled* with oil before the lamp is lit.
That the burner is kept thoroughly clean, that all oil is wiped oft, and all charred wick and dirt carefully removed before lighting.
That when first lit the wick is partially turned down, and then gradually raised.
That the wick while alight is not left turned down, as there is then greater liability to explosion when low-flash oil is used.

That lamps which have no extinguishing apparatus are put out as follows—The wick should be turned down until there is only a small flickering flame, and a flat piece of metal should then be placed on the top of the chimney, so as to entirely close it.

That cans or bottles used for oil are free from water and dirt and are kept closed.

On no account should a lamp be re-filled while it is alight.

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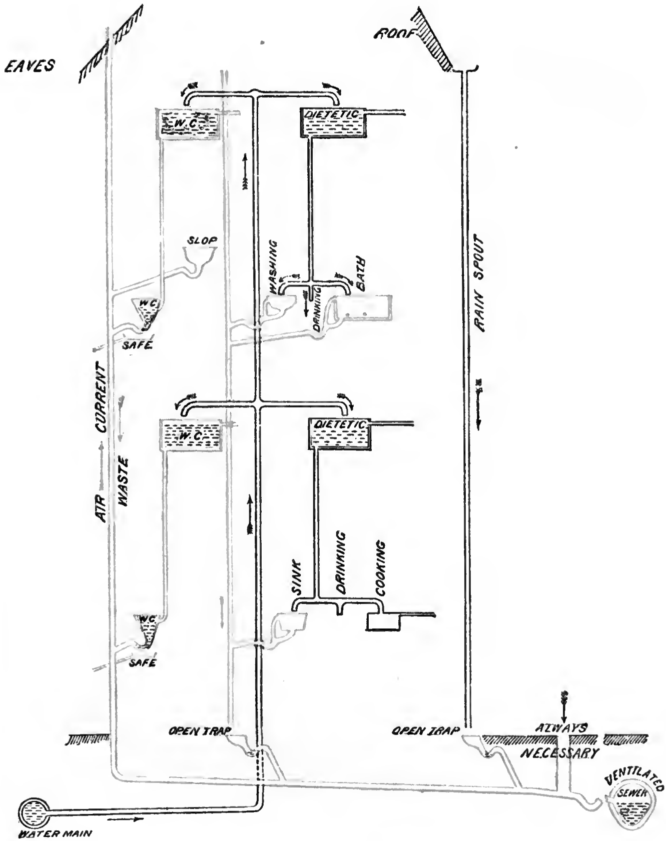
Drainage and Water Supply.

Drains.

§ 70. All refuse matter should be removed as speedily as possible from the neighbourhood of dwellings, and the problem of how to dispose of sewage is one of the most pressing of the day. Sewers are conduits to carry away waste water and waste products to be disposed of in the manner most suitable and possible for the district. House-pipes are the channels or conduits inside the house, and are either *soil-pipes* connected with the water-closets or *sink-pipes* for carrying away waste water. House-pipes lead into *drain-pipes.* Pipes leading from any water-closet in the upper part of the house should be outside the wall of the house; while the pipe from the water-closet should be obliquely connected with the soil-pipe and have air-tight joints. To secure ventilation the soil-pipe should be carried well above the roof, not ending near any window. Where the house-pipe joins the drain, it should be disconnected by a good water-trap and ventilation secured by connection with the open air. Waste-pipes discharging water from sinks, lavatories, baths etc. should not connect directly with any drain, but must discharge into the open air over a grating covering a good water-trap. The best and safest trap is the syphon, consisting of a curved tube, the curves being full of clean cold water which should stand three-quarters of an inch above the top of the curve.



SANITARY WATER SUPPLY.

To face page 172.

This trap is also known as the U-bend from its shape; a screw-cap is placed in the bend to allow of the pipe being readily cleaned with a penny cane or a chain.

Water-closets. The best modern kinds of water-closet are the wash-out and the wash-down closets. Both are made out of glazed earthenware and present a minimum amount of surface between the basin and the trap. The quantity of flushing water available should be at least three gallons. This water should be supplied from its own cistern and not from a cistern or pipe which supplies water for other household purposes. The door of the lavatory should always be shut and the window kept open.

Bathroom. The best place for the bathroom is at the side of the house, so that the waste water can be carried away outside. The pipes should be trapped inside and cut off outside and have no direct communication with the drains.

To test the drains. In taking a house it is best to have the drains thoroughly examined by a competent person. The test generally used is that known as the "smoke test." A simple method, which can be carried out by everyone, is to make a mixture of one ounce of oil of peppermint and a few gallons of hot water and put it down the pipe at the highest part. As the oil is very volatile, there is no difficulty in tracing the smell and thus detecting a leak in the pipe; the tracing of the smell should not be entrusted to the person who pours the peppermint and water down the drain as the odour is pungent and lingering and may be misleading.

House Refuse. House refuse is usually stored up on the premises until removed at certain intervals by the scavenger's cart. When this is done it is necessary to see that the receptacle is made of some non-porous material, such as galvanized iron with a closely fitting lid. It is far better and safer to store nothing but dust and ashes and to burn all vegetable and animal refuse. This may be done by rolling up such things as food scraps, tea-leaves, etc. in paper, drying them on the stove or under the grate and then putting them on the fire when it is bright and fierce; there will be no smell, and if the dampers are pulled out the whole mass will soon disappear. Another method is to bury such refuse, but this is impossible except in the country.

Water Supply.

A good supply of water is a necessity and health depends upon the quantity and quality of the supply. Water is wanted for drinking and cooking purposes, for personal ablutions, for washing, for flushing drains and sewers; these amounts are generally included under domestic supplies, at least 20 gallons per day per head is required. In addition streets have to be watered, horses and cattle supplied, etc. In large towns the arrangements for the water supply are generally in the hands of a water company and it is often brought from long distances, as for instance Manchester, which gets its water from Lake Thirlmere, a distance of 95 miles. The quality of the water is very important. It should be clear, transparent and colourless, it should have no taste or smell and give no deposit on standing. Very clear *sparkling* water may be dangerous, because it contains organic impurities which will produce cholera and typhoid fever. Water is roughly divided into hard and soft water. The hardness is due to the presence in the water of the salts of lime and magnesia; rain water is the only natural soft water and is best for washing purposes. What is known as temporary hardness can be removed by boiling or by the addition of an alkali, but permanently hard water is only affected by distillation. Drinking water if pure is best untouched, but unless absolutely satisfied on this point it is better to boil it; from 10 to 20 minutes will be an absolute protection even if the water be not pure to start with. As boiled water has a flat insipid taste, it can be aërated by pouring it from one jug to another, in fresh air if possible.

Filtration is often resorted to, but it does not take the place of boiling. Filters must be kept scrupulously clean and the water should not be allowed to remain stagnant in them.

A cistern for storing water temporarily is needed where the water supply is intermittent, that is, only turned on at certain hours; the constant supply is far more healthy and convenient. Cisterns should be cleaned out every few months and be supplied with a tightly-fitting lid, and those used for drinking water should have no communication with a sanitary convenience. Wherever possible, rain water should be collected and stored for use. As it has a solvent action on lead, neither the cistern nor the pipes should be made of that substance.

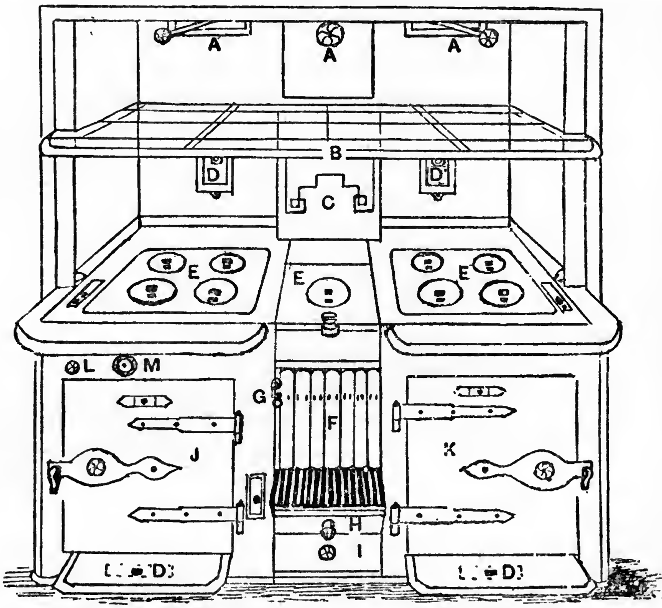
Kitchen, Larder, and Store Room.

Kitchen.

§ 71. When all these points have been carefully looked into, the next important part of the house to be considered is the kitchen, for on it and the construction of the range depend much of the comfort of the house. Most kitchens are fitted with a fixed range, that is, a range built into the wall with a self-filling boiler at the back which supplies the house with hot water. The latter should be easy of access, protected from frost and have a constant supply of water. For a large household or where the kitchen range is not in continual use, the independent boiler is most useful for providing a good supply of hot water. The one known as the Simplex Vertical answers extremely well, and is worth the outlay. It can be fixed in a scullery or in some back premises and the pipes carried upstairs; the cylinder is sometimes placed in a cupboard fitted with shelves, and this may be used for airing linen, drying towels, etc.

The boiler when once started, burns refuse and the cost of fuel is very little. Slacked down at night, it will only need attention in the morning early and a plentiful supply of hot water is constantly secured. The pipes or water ways are unobstructed and provided with ample cleaning doors and thus where the water is hard much trouble is avoided.

The range should be provided with two ovens, one well ventilated for roasting purposes; the grate should be fitted with a patent lifter by means of which the fireplace is made larger or smaller according to the purpose for which the fire is required. The backs of the modern ranges are usually made



A	Dampers	F	Fire Box	K	Meat Oven
B	Plate rack	G	Movable Bottom	L	Regulator
C	Hood	H	Cinder Sifter	M	Regulator for Top and Bottom Heat
D	Soot Doors	I	Ash Box		
E	Hot Plate	J	Pastry Oven		

of tiles, which are easily cleaned and give a fresh, clean appearance to the stove. Much depends on the setting of a range, and on taking a house it is well to give the one provided a trial before settling down. It is no longer necessary to have a range "built in," they can be obtained with hot water boilers and can be placed in an ordinary fireplace or against a wall. The cost of these ranges varies from £20 upwards.

An American or portable range is cheap and useful, and may be placed in a back kitchen for use during the summer months or in any house where a large supply of hot water is not required. Many are provided with a side boiler, but this limits the oven room, which should not be less than 16 × 14 inches. The cost is from £2. 10*s.* upwards.

Gas-stoves are now used by rich and poor, the introduction of the penny in the slot system enabling the latter to use these stoves economically and with great advantage. They should not be placed unprotected on a wooden floor, but should stand on a sheet of iron or on a slab of slate. They should also be well ventilated to carry off the noxious fumes of gas, a point very often overlooked.

The advantages of gas-stoves in cooking are very obvious; there is no dirt or dust and an even, easily regulated temperature can be maintained.

Oil-stoves are much used in all parts of the country, especially during the summer months. The cost of buying and heating is very little, a small stove costing about 22*s.*; they are suitable for baking, boiling and stewing. The lamps must be kept thoroughly clean and well trimmed and the flues on each side of the ovens kept free from soot; the oil used should be of the best (see lamps) and each lamp fitted with a patent extinguisher.

In cleaning ranges of all kinds, the fireirons, fender, etc. must first be removed and then the contents of the grate thoroughly sifted, the cinders, which are porous, should be laid aside for lighting the fire, while the ashes are carried out to the dustbin. The flues should then be thoroughly brushed out by means of a long-handled flexible brush, known as the flue brush; access to them is gained through the openings in various parts of the range, known as soot doors. This cleaning of the flues is a very important point and a regular day once a week should be set aside for the duty. Complaints of ovens not heating, of the want of hot water, may all be traced to the neglect of cleanliness. If grease be spilt in the ovens or on the range, the shelves, etc. should be washed with hot water and soda before the blackleading is proceeded with. Mix the black lead or enamelline with a little water or turpentine and apply lightly with a brush, rub off with another and polish with a third. Nickel fittings should be rubbed bright with a leather, steel and brass fittings cleaned with powdered bathbrick. In cleaning a gas-stove, the openings through which the gas jets come must be carefully cleared, a long fine pin is useful, as the openings often get choked with grease or blacklead and refuse to burn properly. In laying the fire it should be borne in mind that there can be no fire without plenty of air. Put first a few pieces of cinder, then some lightly crumpled paper, sticks laid crosswise, and finally some pieces of coal.

The next point of importance after the kitchen range is the position of the sink; ill-health may often be traced to want of attention to this part of the establishment. It should be placed against an outside wall and be constructed of hard glazed earthenware, slightly tilted towards the opening of the pipe to allow the water to run off freely. The opening should be protected by a piece of perforated zinc or copper to prevent bits from going through and choking the pipes; a sink-basket is an additional protection and collects the pieces which may afterwards be dried and burnt. The pipe should have a bend in it, U-shaped, with a screw-cap at the bottom of the bend which may be easily removed for cleaning purposes: a penny cane or a chain may be used to remove any obstruction. The pipe itself should penetrate the *outer* wall and discharge into the open air over a grating covering a good water trap; it should not be made to open under the grating as sewer gas may be sucked up through the pipe by the higher temperature of the air inside the house. Sinks should be well scrubbed from time to time with plenty of hot water and soda, this will help to remove the grease which congeals and clings to the inside surface of the pipe. At least once a week a pailful of disinfectant should be poured down to keep everything sweet and clean; Condy's fluid or permanganate of potash may be used mixed with water, as it is non-poisonous and removes offensive smells; it should be understood that Condy's fluid is a deodorizer, but does not destroy micro-organisms. Quantities of cold water should be poured down the sink drain the last thing; this purifies and freshens the pipes and stands in the U-bend of the *Open Trap* so that any sewer gas arising from the drain would be less likely to pass through into the scullery or kitchen. The use of sand in cleaning sinks or kitchen utensils is not to be advocated as it is apt to choke the pipe; cabbage-water should be emptied away out of doors, as it causes a foul penetrating smell in the house. The coloured diagram on page 173 should be carefully studied in illustration of the above instructions.

Larder and Store-Room.

Next to the consideration of the kitchen-range, the drains, and the position of the sink, comes the question of the larder. As already stated, it should face north, but, besides being cool, it is also necessary that it should be dry and well-ventilated. A current of air should move through it by means of two windows or by a window and ventilating bricks. The larder should be light, the walls and ceiling whitewashed at frequent intervals and everything kept sweet and clean; the shelves therefore are best made of slate or earthenware instead of wood. No closet, ashpit or drain ventilator should be anywhere near, as all food, especially milk, is easily contaminated.

The larder should be used for the purpose of storing food only, and all food should be kept covered with muslin to keep off dust, flies, and possible mice. The ceiling should be furnished with hooks for hanging meat and game; bacon also should be hung in a dry place well away from the walls, and hams tied in bags for protection from flies. Lard done up in skins may be suspended from nails. Apples and pears may be stored on the floor, placed so that they do not touch each other and carefully looked over from time to time; bunches of grapes may be strung on a string, the stalks may be put in bottles of water which may be hung with string tied round the necks. Root vegetables, such as potatoes, artichokes, carrots, should be stored in a dark, dry place, onions should be plaited in strings and suspended from a hook, lemons may be hung in nets from a nail in the ceiling so that they may be surrounded by air on all sides. Herbs should be dried, rubbed fine, and kept in tightly corked bottles. In some houses the larder and store-room serve one and the same purpose, but a larder should be used for the food in use only, while dry goods, such as rice, sugar, biscuits, soap, matches, etc., which are cheaper bought in large quantities, are kept in the store-room. Here also should be found jams, jellies, pickles, and tinned foods; in the country a store-room is a necessity, as supplies of all kinds are not always obtainable at a moment's notice and the housekeeper will find it useful to keep a stock of provisions in case of unexpected guests and any other emergency. Where stores are bought in large quantities a special day should be set apart for giving them out and each servant be instructed to bring a list of things required in her special department during the week. Every article should be kept in tins or jars, each distinctly labelled and replenished as the contents get low.

The cost of furnishing the kitchen is very considerable, and must depend a great deal on the income of those about to live in the house and the amount of cooking required.

A good furnishing ironmonger and draper will supply priced lists of kitchen requisites suitable for an average household; it is false economy to buy cheap utensils, as they quickly wear out; this is especially the case with saucepans, good ones can be re-tinned at a small cost and will last a long time. If a kitchen is to be used as a servant's hall as well, it is advisable to have a gas or oil stove in the back kitchen for use during the summer months. It should also be furnished comfortably with 2 or 3 tables, chairs, plate-rack and dresser, fender, fireirons and blinds, and the floor should be covered with linoleum and a cover chosen for the table.

The Sick-Room and its appliances: medical and surgical[1].

§ 72. The following section deals with some of the emergencies that may present themselves in the home; they do not aim in any way at being a complete manual on sick nursing, but are merely suggestions what to do in the absence of the medical man.

The Sick Room.

Among the many duties that fall to the lot of the housewife comes the very important one of nursing and tending the sick and the preparation of their food and that of infants. A little knowledge on the part of the head of the house will often detect the first symptoms and ward off a serious illness by sending for the doctor in time and being able to apply the remedies prescribed at an early stage of the disease. This is especially important with childish ailments, which develop with alarming rapidity. In the case of illness in a house, the choice and preparation of the room must be considered. In cases of accident, an apartment on the ground-floor should be chosen, light, airy, and, as in all cases of illness, free from superfluous furniture. Except perhaps in the height of summer a fire should be lighted, as the patient frequently suffers from collapse and will require warmth to restore him. When an infectious disease declares itself a top room should be chosen, as much isolated as possible. A sheet dipped in carbolic acid and water (1 in 40) may be hung in front of the door and the room

[1] Teachers are advised to make themselves acquainted with the more detailed applications to School life of the rules laid down in this section which will be found in Hope and Browne: *The Teachers' Manual of School Hygiene*, Cambridge, 1901.

cleaned by wiping over with a cloth wrung out in hot water to which some Condy's Fluid (permanganate of potash) has been added or some carbolic acid. The latter is a poison and should be kept carefully apart from medicines. Permanganate of potash is a deodorizer and not a disinfectant, but it is harmless. Next to the preparation of the room comes the bed. Never attempt, unless it is absolutely unavoidable, to nurse any one in illness on a double or on a feather bed. An iron bedstead 6 ft. by $3\frac{1}{2}$ with spring and hair mattresses is the most comfortable for both patient and nurse; the bedding should be light and warm; in cases of rheumatism sheets are not used. In most illnesses a draw sheet is put on to keep the under sheet clean. It is folded lengthwise to reach from the shoulder to the knees and is partly rolled up. Both ends are tucked tightly under the mattress, sometimes secured by safety pins, as any wrinkles in the sheet or blanket will cause bed sores; when soiled or a fresh cool surface is required, part may be unrolled and drawn through without disturbing the patient. In some cases a sheet of mackintosh may be placed under the draw-sheet. Sheets are changed in two ways. Should the patient be quite helpless, as in surgical cases, the under sheet is removed by rolling from the head to the feet; one person on each side of the bed. The soiled sheet is loosened and rolled, the clean one arranged at the top of the bed, the rest of it being rolled and placed parallel with the soiled sheet. The two sheets are then worked downwards, the soiled one rolled up and removed, the clean one unrolled and tucked in at the end of the bed. In medical cases and when the patient may be moved, the sheets are changed from the side. The sick person is turned on to one side, the dirty sheet loosened and rolled up close to the patient's back, while the clean sheet is loosely rolled parallel with the roll of the soiled one. After tucking in the clean sheet gently turn the patient over so that he crosses the rolls; the soiled sheet may then be removed and the clean one arranged and tucked in. During the changing of the sheets the patient must be kept covered up. Changing the top sheet is a comparatively easy matter. The clean upper sheet with a blanket is laid on the soiled sheet and blanket, which have been previously loosened. One person holds the clean clothes in place, the patient can do this if well enough, while the other removes the soiled ones from beneath, the rest of the coverings are then replaced. All sheets and linen should be well-aired and warmed. The nurse should wash the patient's hands and face twice a day with warm water and a complete washing should take place *at least once* a week. It is necessary to uncover only one part at a time, to have everything in readiness before beginning and to arrange a blanket or flannel so that the bedclothes and nightdress may be kept dry; in fever cases patients require frequent sponging. In changing body linen, the fresh garments should first be aired and warmed. In cases of injured limbs the nightdress should be removed from the *sound* side *first*; when dressing the reverse occurs, put the injured arm into the sleeve first. Bed sores are caused by wrinkles in the bedclothes, uncleanliness, moisture, crumbs, or from long lying on one part of the body. Every precaution should be taken to prevent their appearance by rubbing the parts likely to be affected with spirit of some kind, Eau de Cologne, methylated spirits, whisky, etc. Impromptu cradles for keeping the bedclothes off an injured limb may be made with a band-box or a three-legged stool; bed-rests by turning a chair upside down so that the back forms a slant, this can be made comfortable with pillows; a pulley made of knitted cotton or a roller towel can be fastened to the foot of the bed by which the patient can raise himself. The temperature of a sick room must be studied and a thermometer should be hung in a convenient part of the room, *not* too near the fire or in a draught. The ordinary temperature is 60° Fahrenheit, and it should be remembered that the vitality of a patient is at its lowest from 2 a.m. until sunrise, so that care must be taken not to let the fire out during the night. As soon as a case of illness occurs in a house the doctor should be sent for, but in the meantime the one in charge of the sick person should carefully jot down on paper any symptoms that may help the doctor to diagnose the case on arrival; a time-table should be kept of the hours at which food or medicine have been administered and of the length and depth of sleep.

§ 73. A few simple remedies may be stored for use in an emergency, especially in a house where there are children: linseed meal for poultices, castor oil, Kutnow's powder, boracic ointment, ipecacuanha, oil-silk, cotton-wool, sal volatile, a feeding cup, clinical and bath thermometers, a bronchitis kettle, a medicine glass and a few bandages. In sending for the doctor it is advisable to state whether it is an accident or not, that he may come with the necessary appliances and much valuable time be saved.

Burns and Scalds.

In the case of slight accidents, first aid may be rendered at home. Should the clothes catch fire the person should be wrapped up in a thick woollen garment or even a door mat, and be rolled on the floor until the flames are extinguished. In dressing a burn or scald great care must be taken in removing the clothes for fear the skin should be torn or broken. Scissors should be used, and if any part adheres, it may be sponged away with warm water. In dressing these injuries it is necessary to exclude the air; this may be done by covering the wounds with flour, and with bandages or strips of old linen. The burn or scald may be further enveloped in cotton-wool. Equal parts of lime water and oil (linseed or olive oil) shaken up together form an excellent mixture for application. Strips of linen should be dipped in the mixture and then laid on one by one, in order that as little of the surface as possible may be exposed at once. Pain may be relieved by the application of a paste made of bicarbonate of soda and water spread over the burn and covered with cotton-wool.

A foreign body in the *ear* demands specially careful treatment. If turning the head on one side and tapping the other ear is not successful, it is best to let the patient see a doctor at once. If an insect has got in, a little warm oil may be poured in and the head turned on one side. If, on the contrary, the foreign body should be a pea or bean no liquid should be put in, or the pea or bean will swell. In trying to remove anything from the *eye* hold down the lower lid with the fore-finger of the left hand and remove the foreign substance with a tightly folded piece of paper or a soft camel's hair brush. Should lime have got in, bathe the eye with vinegar and water and afterwards with warm water.

Substance in the ear.

Substance in the eye.

Bruises may be rubbed over with fresh butter or olive oil, cuts should be washed in warm water to remove any dirt or glass and bound up. If the bleeding continue cold water will help to reduce it.

Bruises and cuts.

Unconsciousness may be due to various causes, it is not always easy even for a medical man to diagnose the case at once. In the meantime the patient should be kept quiet in a recumbent position, all tight clothing removed, a hot bottle may be put to the feet and cold applications to the head. It is better to give no stimulant unless ordered by the doctor. In cases of poison it is often necessary to act at once, and for this reason it is well to know something of the various kinds of poisons and how to treat them. They may be divided into two classes, cases in which an emetic must *not* be given, and those in which one should be given *at once:*

Unconsciousness.

Poisons.

1. An emetic should *not* be given in cases of poisoning by corrosives, substances which destroy life by corroding the tissues. They include (*a*) acids, such as carbolic acid, oxalic acid, etc., (*b*) alkalies, such as soda, lime, caustic potash. The antidote depends on the nature of the poison. If an acid has been taken give an alkali, such as a tablespoonful of

magnesia, chalk, plaster from the walls, etc., in a tumbler of water; if the poison is from an alkali the antidote will be a weak acid, such as a tablespoonful of vinegar or lemon juice in half a glass of water. After that give barley-water, olive oil or white of egg.

Poisons which *require an emetic* are various and only a few can be mentioned.

(*a*) *Narcotics*, such as laudanum, chlorodyne, morphia, &c. The patient under these circumstances must be kept awake, he should be given strong coffee and be made to walk about. Douches of cold water will help to overcome the deadly drowsiness. A quickly made emetic is a tumbler of warm water in which a tablespoon of mustard or salt has been mixed.

(*b*) *Excitants*. These poisons are caused by deadly nightshade, prussic acid, some kinds of fungi, etc. After giving the emetic a douche of cold water should be administered. The symptoms are excitement and delirium.

(*c*) *Irritants*. These cause pain at the pit of the stomach, vomiting and great prostration, and result from taking arsenic, lead, mercury, phosphorus, laburnum seeds, foxglove, aconite, putrid meat, etc. If the patient has vomited freely there is no need to give an emetic, but barley-water, white of egg in water or gruel should be administered and stimulants may be ordered. Oil may be given in most cases of poisoning except when the trouble is caused by taking phosphorus. The doctor should always be sent for at once, and, if possible, the nature of the poison taken described. A clue may be obtained by taking a rapid survey of the patient's surroundings and circumstances and noting any bottles or papers which may help in the identification of the poison.

Infection.

Fever cases may be divided into various stages. 1. Incubation, the period that elapses between taking the infection and developing the disease. 2. Invasion, the time of the actual attack when the temperature of the patient rises; common symptoms are shivering fits known as rigors or severe headache. 3. Eruption, the rash then appears; its absence is often a dangerous symptom. 4. Defervescence, when a return to the normal temperature sets in, if the patient is to recover. 5. Convalescence is the period that lasts until the usual state of health is re-established. All cases of infectious disease must be strictly isolated; different fevers are infectious in various ways, so that precautions must be taken from the very outset. Scarlet fever is catching from the breath and through scales from the skin, typhoid through the excreta, measles through exhalations, diphtheria through a deposit on the throat and through the breath.

Disinfectants destroy micro-organisms, while a deodorizer merely prevents an unpleasant smell, but does not take away the risk of infection.

The best disinfectant to use is carbolic acid, but it is a dangerous poison and should be kept locked up and never placed within the reach of children or near medicine or food. Chloride of lime may also be used. After an infectious illness the patient should be bathed, dressed in clean clothes and removed from the room, which should then be well disinfected. The wall paper should be stripped off and burnt, the crevices of door and windows and the opening into the chimney stopped up, while sulphur candles, protected by a tin tray or bucket, are burnt and the room left shut up for 24 hours. All the bedclothes, etc., should be sent to a disinfecting chamber, where they will be properly treated. When the room has been reopened and ventilated, floor and furniture may be washed with a weak solution of carbolic acid and water and soft-soap, the walls repapered, doors repainted.

Convulsions.

In cases of convulsions where the child should be placed in a hot bath up to the neck and when it may be frightened by the steam, a blanket should be laid over the bath and the child gradually lowered into the water.

It is dangerous to put children into too hot water, therefore a bath thermometer should be kept. Failing that, the elbow may be used as a test, the hand being used in so many different ways is less sensitive as a guide.

Temperature of baths.

Tepid	bath	85°	to 95°	Fahrenheit.
Warm	„	96°	to 104°	„
Hot	„	102°	to 110°	„

Surgical.

Cases of hæmorrhage or bleeding require prompt attention, and valuable lives may be lost while waiting for the doctor. It is necessary to distinguish if possible the different kinds of bleeding. This is set forth in any good manual of Physiology and it is sufficient here to point out that it is of three kinds, from the arteries, the veins, and the capillaries. The arteries bring pure blood from the heart and should one of them be severed serious consequences may ensue unless the bleeding is stopped at once.

Arterial bleeding.

Arterial blood is known by its bright red colour and by the way it rushes forth in jerks or spurts. In order to stop this kind of bleeding pressure must be applied. This may be done, (1) by pressing the two thumbs over the point in the wound from which the blood is seen to be issuing. (2) by applying pressure to the main artery higher up the limb on the side *nearest* the heart. (3) a tourniquet may be put on. The latter may be rapidly improvised by means of a large handkerchief folded into a bandage a few inches wide; in the middle of the folds insert a piece of wood, a penny or some hard substance, draw the ends of the bandage round the limb and tie it, a stick or key may then be inserted and twisted until the bleeding stops. If however the wound should be in the neck the tourniquet cannot be used and pressure is the only thing to be done until the surgeon comes; the helpers may have to relieve each other, one slipping his thumbs under the other when changing. If a hand or foot is wounded the elbow or knee may be flexed, the pressure at the bend of the joint helping to diminish the bleeding.

The veins bring blood to the heart, and their contents are of a darker colour and flow more slowly. Pressure must be applied over the wound, pads steeped in cold water bound on, and where possible the limb must be elevated to diminish the flow of blood. One ot the most dangerous kinds of venous bleeding is that from varicose veins in the legs; the same rules apply, elevation of the limb, bandages and perfect rest.

Venous bleeding.

Varicose veins.

Bleeding from the nose is sometimes difficult to stop. Cold substances or wet cloths should be applied at the back of the neck on the top of the spine; the nostrils may be syringed out with a solution of alum and very cold water or vinegar, or lemon-juice and water, even with very strong cold tea; the head should not be allowed to hang over the basin.

Bleeding from the nose.

Sometimes after extraction of a tooth, hæmorrhage continues for some time. A small piece of cotton-wool dipped into steel drops or into glycerine or lemon-juice and pressed firmly into the cavity will help to stop the bleeding.

Bleeding from a tooth.

Internal hæmorrhage from the lungs or the stomach is very dangerous and can only be treated by a medical man. In the meantime absolute quiet is necessary and ice may be given to the patient to suck.

Internal bleeding.

The capillaries are the hair-like blood-vessels which connect the arteries with the veins; when cut or injured the blood oozes slowly from them and is easily stopped by placing a pad of lint over the bleeding part.

Capillary hæmorrhage.

Cuts.

It is very important that cuts should be kept clean or blood-poisoning may result. The old-fashioned plan of using a cobweb for the purpose of stopping the bleeding should never be resorted to. Glass, gravel, etc. may be washed out of a wound by pouring cold water over before bandaging, and then the edges of the cut may be carefully drawn together and strips of sticking plaister laid across, not to cover the wound but to keep the edges together. The part may then be bandaged up.

Fractures and dislocations.

Fractures and dislocations can only be treated by a doctor, but it is very necessary to understand as far as possible the nature of the injury to prevent further mischief. Fractures may easily be recognized by the following simple rules:

1. There will be shortening and alteration in the shape of the limb.

2. Inability to use the injured leg or arm.

3. Pain and swelling at the seat of fracture.

Simple fractures are often converted into compound and complicated fractures by the want of knowledge of those whose duty it is to render first aid.

A person suffering from a fracture should never be placed in a cab or cart, but be taken home or to the hospital on a stretcher. A gate or a shutter may be used for this purpose, and coats and cloaks laid down to make it more comfortable. Splints may be improvised from an umbrella, long flat pieces of wood, or even a broom-handle. Should the leg or thigh be fractured, the two feet may be bound together, the sound limb acting as a splint to the injured one. Every precaution must be taken to prevent jarring or further mischief.

Dislocations may easily be distinguished from fractures as they always occur at a joint. Swelling of the part follows soon after dislocation and should be reduced as quickly as possible, this can only be done by a duly qualified person.

Bites should be treated by pressure of some kind applied *above* the wound so as to prevent the poison from getting into the circulation. The wound may be sucked and warm water poured over it to induce bleeding, which helps to carry off the poison. If the animal that caused the bite is known to be rabid, cauterisation should be applied. Prompt action is the great thing in order to stop the circulation above the wound. Should the bite be inflicted by a dog it is a great mistake to have the animal destroyed at once unless known to be mad. It should be tied up and watched as the bite may only have been inflicted because the animal was teased or some other harmless cause.

Bites.

A raw onion slowly chewed and swallowed is considered an excellent remedy for a sting obtained while eating fruit. For external stings press out by means of a small key, and apply soda and water, ammonia and water, or the homely blue-bag moistened.

Stings.

§ 74. Food plays an important part in the sick-room, especially during convalescence.

In the first place it is absolutely necessary to observe the doctor's orders, as disobedience has caused many deaths, especially in typhoid fever. In the second place, the food should be well-cooked, punctually and daintily served and at regular intervals, the patient should not be asked beforehand what he will take. No cooking should be carried on in the sick-room, nor food left about. If necessary, milk may be kept on the outside window-sill covered over by a clean, ordinary red flower-pot. Ice keeps for several days if in a block and wrapped up in a blanket on the cellar floor; it may be easily broken into small pieces by means of a hat pin. Sick people, and convalescents especially, like a change of diet, and it is not necessary to keep to the same thing, such as beef-tea, chicken and jelly day after day. Any good cooking book will furnish the names and recipes of innumerable nourishing and appetizing dishes suitable

Sick-room Cookery.

for the sick-room. It is sometimes necessary to give pre-digested or peptonized foods, and the amateur nurse may have some difficulty in knowing how to prepare this. Peptonisation renders *protein* foods soluble and capable of entering the blood. It is accomplished by means of liquor pancreaticus or by peptonising powders with the addition of a little bicarbonate of soda; they may be bought at any reliable chemist's. In peptonising milk for infants take ¼ pint of new milk (it can be boiled first and allowed to grow cold), ¼ pint cold water, and one quarter of a peptonising powder, put them in a jug, which is placed in a basin of water as hot as the hand can bear, let it stand, shaking occasionally; in 20 minutes it may be taken out of the water, sweetened and a teaspoonful or two of cream added. If the milk is not to be used at once it may either be boiled or set on ice; boiling destroys the process, putting on ice merely suspends it. Gruel, beef-tea, soups, may all be peptonised. *Starchy* foods should be malted: this is done by mixing 3 ozs. of crushed malt (see beer-making) in a jug with ½ pint of cold water. Let it stand 12 hours, decant the liquid, straining through folds of muslin until it is clear and bright. One tablespoonful of this liquid thoroughly mixed with ½ pint of gruel will in a few minutes so digest it that it will become liquid.

Peptonizing.

2. Practical Housekeeping.

Economy and Thrift.

§ 75. It is essential that the housekeeper should fully understand the income with which she has to deal or at any rate the allowance she will have at her disposal for the purposes of keeping house. Most people buy this knowledge by bitter experience, whereas all difficulties may be avoided if a few simple rules are observed.

It should be ascertained at the outset of housekeeping how much money may be spent, and this should not be planned out without leaving some margin for unforeseen events, as expenses are apt to increase, and it is far easier to spend more than to retrench. Rent depends on many contingencies, such as locality, health, work, etc.; as a general rule one-eighth or one-tenth of the income may be devoted to this item, and one-third of the rent may be reckoned for taxes. The expenditure on Food depends on the style of living; 8*s.* per head a week is the least sum to allow, unless the household be a large one: 10*s.* is the usual amount for not less than five in family, or it may be reckoned as follows: £1 for the master of the house, 15*s.* for the mistress, and 10*s.* for each servant. Where possible the books should be paid weekly, especially when the income is small. This plan checks extravagance and waste. Here comes in the difficulty of the occasional fifth week in the month, the bugbear of so many housekeepers. In calculating expenses, allow thirteen months to the year or reckon the year by weeks. If five weeks be allowed for each month in the year a small margin is left to meet extras such as occasional visitors, parties, etc.

Rent and Taxes.

Food.

An income of £600 a year may be planned out somewhat on the following lines, but no hard and fast rule can be laid down as expenses must vary with the family and locality:

Income £600 a year, household consisting of husband, wife, 2 children, nurse and 2 maids.

	£	*s.*	*d.*
Rent	60	0	0
Rates and Taxes	20	0	0
Fuel	24	0	0
Laundry	27	4	0
Food	163	16	0
Wages	58	0	0
Gas and lighting	10	0	0
Clothing	104	0	0
Education and books	50	0	0
Holiday	35	0	0
Life and fire insurance	15	0	0
Repairs to house	10	0	0
Doctor	5	0	0
Sundries	18	0	0
	£600	0	0

It is impossible to give a number of detailed tables of expenditure, but one more showing the very least on which people can set up housekeeping and keep a servant may be useful.

Income £200 a year, household consisting of husband, wife, 2 children, 1 maid.

	£	*s.*	*d.*
Rent, Rates and Taxes	30	0	0
Food (5*s.* per head)	65	0	0
Servant's wages	12	0	0
Clothing	40	0	0
Fuel and lighting	12	0	0
Laundry	6	0	0
Life and fire insurance	10	0	0
Repairs, etc.	2	0	0
Education	14	0	0
Sundries	9	0	0
	£200	0	0

In an income of £600 a year allow £2 a month winter and summer for coals. Washing will come to about £20 a year; it is sometimes possible to get the servants' washing done for 10*s.* 6*d.* a quarter each—£2. 2*s.* 0*d.* a year. A certain sum should be put aside for holiday expenses, for unforeseen contingencies such as a doctor's bill etc., and for sundries which include cabs, stationery, newspapers, amusements etc., and a tenth of the income should be devoted to charity.

Servants' wages.

Servants' wages vary with the style of living and the work required:

A Cook	gets from		£18 and upwards
A Housemaid	"	"	£15 to £25
A Parlourmaid	"	"	£18 to £30
A General Servant	"	"	£8 to £25
A Laundry-maid	"	"	£12 to £30
A Butler	"	"	£40 to £100 with board
A Footman	"	"	£20 to £60 and some livery.

In very few houses are regular allowances given out for each servant, except in the matter of tea and sugar. The following list may help mistresses to calculate quantities in ordering.

Quantities.

For meat the consumption depends on the number in family, a small family requiring a larger proportion than a large one. For the former 1 lb. a head daily should be reckoned, whereas $\frac{1}{2}$ to $\frac{3}{4}$ lb. with bone is sufficient for the larger family. The butcher's book should not exceed 7 lbs. a head weekly. Butter $\frac{1}{2}$ lb. a head weekly with, in a small family, an extra $\frac{1}{2}$ lb. for cooking; more if many cakes are made at home. Of tea, coffee or cocoa 4 ozs. a head weekly are sufficient. Sugar 1 lb. per head, bacon 1 lb. a week, cheese $\frac{1}{2}$ lb., milk 1 quart a week for each person. In ordering bread allow 1 lb. per head a day. These quantities are merely meant as a guide for a young housekeeper; experience will soon show where more or less is required and the quantities must be brought within the limits of the income.

Thrift and Insurance and Benefit Societies.

§ 76. Besides the items included in the foregoing tables the question of life insurance should always be considered. Where future prospects are good, it may be possible to dispense with this otherwise indispensable provision for the future. A man may insure his life between the ages of 28 or 30 for £500 for about £15 per annum. Life insurance may be effected either through a well-known Society or through the Government by means of the Post Office by an immediate payment or by an annual payment extending over a number of years. At the age of 25 a man can insure his life for £100 by the payment of an annual premium of £2. 0*s.* 6*d.* through life or of £2. 12*s.* 0*d.*, payment to cease at the age of 60. Besides life insurance, there are many ways of encouraging thrift by means of the Post Office Savings-Bank or the many well-known trustworthy Societies such as the Odd Fellows, the Foresters or the Benefit Societies on the Holloway system attached to the various political parties. The Post Office Savings-Bank gives interest at the rate of 2½ per cent. upon every pound, as much as £50 may be deposited in one year, and £200 is the highest total amount received from one person. The advantages of the Post Office system are, its perfect safety, its convenience for deposit and withdrawal, its strict secrecy. All correspondence is carried on free of charge, bank books and forms of withdrawal are provided by the Government. For children and others desirous of saving their pennies, slips of paper marked with twelve divisions for postage stamps may be obtained from the post office, and when twelve stamps have been obtained, it can be handed in as a shilling deposit. The system of Annuities undertaken by the Government through the Post Office is of two kinds, the *Immediate*, obtained by payment of a sum down, the *Deferred*, obtained by paying a certain sum down or yearly for a certain number of years, at the end of which period these payments cease, and the annuity commences. All particulars as to Annuities or the purchase of Government Stocks may be obtained free of cost on application to the nearest post office. The collecting Savings-Bank system established in connection with the Charity Organization Society meets the various needs of the wage-earning class. This method increases the spirit of wholesome independence of character, and helps those needing help, to help themselves.

The Benefit Societies provide for sickness or death[1]. For joining the Odd Fellows a medical certificate is required and members are admitted between the ages of 18 and 44. An entrance fee of 2*s.* 6*d.* to 5*s.* is demanded and a weekly subscription of 6*d.* to 1*s.* 6*d.* After 6 months a member may receive 8*s.* to 20*s.* per week during sickness for 12 months and during the following 12 months half the amount, afterwards one-fourth as long as illness lasts. £8 to £20 at death, £4 to £10 at the wife's death. For joining the Foresters, a man

[1] The rules of these clubs vary somewhat with the district in which they are established.

must be between 18 and 40, of good health and character. Birth and medical certificates are required, the entrance fee, according to age from 2*s*. 6*d*. to 5*s*. After 12 months the member receives 10*s*. to 20*s*. per week during sickness, £12 to £24 at death, £6 to £12 at the wife's death.

The Benefit Societies connected with the political parties have the following objects: (1) to pay a weekly allowance to members in times of ordinary sickness; (2) to ensure the payment of a sum of money on the death of a member to his or her nominee or representatives; (3) to make provision for the maintenance of members in old age. These objects are obtained by the voluntary subscriptions of members in accordance with a table drawn up and submitted to those wishing to join. On attaining the age of 65, members retire from the Society and receive the whole of their savings without deduction.

The Co-operative Societies, organizations managed chiefly by the working-people themselves, present other methods of thrift, self-control and self-help. This system was started in 1844 by workmen in the north of England, who devised the plan of dividing the profits of a business among the customers by a system of tickets given with each purchase and exchangeable for money or shares. This system flourishes best in the north, and has not taken deep root in the south, even in London. The system of insurance can successfully meet the difficulty of maintenance during sickness, but it is less easy to apply to the need of medical treatment. The system of Provident Dispensaries is an application of the principle of insurance to this need. Where these dispensaries are so placed that they are not obliged to compete with free hospitals, they prove a valuable means of securing for their members medical attendance at very small cost.

Income Tax.

Besides the questions of insurance and saving, a young housekeeper on a small income will do well to understand something about the Income Tax. For this purpose it is necessary to know and to put down all the sources from whence the income is derived. At the time of writing the tax amounts to 1*s.* 2*d.* in the £, but abatement up to £700 a year may be claimed according to the following table:—

Total exemption may be claimed when the income from all sources does not exceed £160 a year.

When the income exceeds £160 but does not exceed £400, an abatement of £160 may be claimed.

When the income exceeds £400 but does not exceed £500, an abatement of £150 may be claimed.

When the income exceeds £500 but does not exceed £600, an abatement of £120 may be obtained.

When the income exceeds £600 but does not exceed £700, an abatement of £70 may be claimed.

Any individual who claims and proves that his total income from all sources, although exceeding £160, does not exceed £500, and that he has a child or children living, and under the age of sixteen years on the 6th April 1910, shall be entitled in respect of every such child, to relief from income tax equal to the amount of income tax upon £10.

The form to be filled up may be obtained from the Inland Revenue, Somerset House, London, W.C., or through the local office of the Inland Revenue.

When the income from all sources does not exceed £3000, and any part of that income is Earned Income, a claim may be made for the reduction of the Income Tax on the Earned Income to the lower rate applicable thereto. In order to obtain this relief, a claim must be preferred at the time the return is made, and must in any case be preferred before 30th September in the year for which the tax is charged.

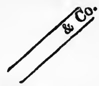
Duties.

Certain duties or taxes are payable annually and should be considered when portioning out the income, *i.e.* dog licence 7*s.* 6*d.*; armorial bearings £1. 1*s.* 0*d.*, if used on carriages £2. 2*s.* 0*d.* Carriages are taxed according to the number of wheels, and every man servant 15*s.* Receipts upon payment of money amounting to £2 or upwards should be signed over 1*d.* stamp.

Discount.

§ 77. Discount is an allowance made where goods are sold or purchased, generally for prompt or advanced payment. Five per cent. equals 1*s.* in the pound, 10 per cent. equals 2*s.*, 2½ per cent. equals 6*d.*, 1¼ equals 3*d.* The general rule for finding commercial discount is to multiply the amount by the rate per cent. and divide by 100.

Cheques.

A young housekeeper sometimes finds a difficulty in dealing with cheques, therefore a short explanation as to their nature may not be out of place. A cheque is an authority for a Banker to pay money and is of three kinds: cheques payable to "Bearer," to "Order," and "Crossed cheques." A cheque "to Bearer" is payable to any person who may present it. A cheque "to Order" must first be endorsed by the person to whom the cheque is made payable, that is, he must write his name on the back. A "crossed cheque" is one on which two parallel lines are drawn and the words "& Co." written between, thus 

, or the words "not negotiable" may be inserted. When forwarding money by post, crossed cheques should always be used, as they can only be cashed through a bank.

In order that money spent on housekeeping may be accounted for, and to be able to ascertain quickly whether the amount laid aside for this purpose is being overdrawn or not, it is necessary to keep accounts, but these may be of the simplest kind. A cash book contains an account of all cash receipts and cash payments, with the discount allowed. It should be a book ruled for money and arranged as follows:—

Dr.			*Cr.*
Date.	Enter here all monies received.	Date.	Enter here all payments, with discounts deducted.

To balance: cast up the Dr. side and the Cr. side separately, find the difference which exists between the two sides and place that difference on the lighter. The meaning of an account is not altered by this process, the difference which existed between the original entries is still the same, but the amount is now *visible.* This difference, added to the *Cr. side*, should agree with the *cash actually in hand.* If the difference has to be placed upon the *Dr. side* it implies either that some monies received have not been duly entered or that money has been borrowed from some source to pay bills. The term

Debtor (Dr.) usually means the one who owes, Creditor (Cr.) one to whom money is due. They are also used as adjectives—Dr. side, Cr. side; then they simply distinguish one side of the account from the other. "To debit" means to place an amount on the left-hand or Dr. side of an account; "to credit" means to place an amount on the right-hand or Cr. side of an account. It is advisable to have a fixed time for balancing accounts, and where economy is an object this should be done weekly.

Domestic Servants and their duties.

Servants.

§ 78. The engaging and management of servants is confessedly one of the chief difficulties of the present day and one which threatens to revolutionize the system of Housekeeping which up to the present has formed one of the chief features of an English home. It is impossible to discuss this burning question, but as probably ignorance on the part of both mistress and maid has a great deal to do with the matter, especially in ordinary households, a few practical suggestions may be of use to the young housekeeper. A reference to the scale of servants' wages was made on p. 194 in connection with the division of income, so that we pass at once to the engaging of servants and the various duties expected from them.

Registry Offices.

The two methods generally employed to obtain a servant are by advertisement or through a registry office. In both these ways great care must be exercised; in the first place that the advertisement is bona-fide, in the second that the office bears a good character. The good old-fashioned way of obtaining a servant through the Vicar's wife in a Country Parish has nearly passed away.

Engaging Servants.

When engaging a servant spare no trouble in finding out as much as possible about the person you propose to make a member of your household, and this is especially necessary with regard to nurses, to whom the great responsibility of the early training and care of a child are to be confided.

The first essential is not to take a servant unless a personal interview is possible, or failing that, the last mistress has been corresponded with personally, not through a third person. A servant who has been long out of place should be carefully enquired about and no story believed unless it can be authenticated. It is never advisable to engage a servant whose master or mistress has gone abroad, unless a friend of the family can be interviewed, and a domestic, who speaks badly of her last place and accuses her employers of drunkenness should be avoided. At the same time perfection is not to be had even should it be expected; as in all intercourse with our fellow creatures it is a case of "bear and forbear." In arranging for an interview with a former mistress, a stamped envelope for reply should be enclosed, and when the appointment is settled it should be punctually kept. There is no law compelling a mistress to give a personal interview or even a character, but where possible it should always be done. Anyone with moderate shrewdness can soon find out whether the mistress is just or not, by observing whether the house looks tidy and well-managed etc. *Absolute* truthfulness should be observed in giving a character, suspicions should never be mentioned, and in giving a written character nothing should be said that cannot be proved.

It is customary to give a month's notice on either side or a month's wages unless a special arrangement has been made. If a servant be dismissed without notice, he or she cannot claim a month's board wages unless it was included in the original agreement. A servant may be dismissed without notice for the following causes, which must be provable: dishonesty, drunkenness, immorality in the house, hopeless incompetence. Masters and mistresses are not bound to provide a doctor or medicine for their servants, but if they send for the doctor they are bound to pay the fee and cannot deduct it from the wages. Neither can a master or mistress legally claim compensation or deduct from wages for broken articles however careless the servant may have been, unless an agreement to that effect has been made beforehand. A mistress who has given a servant a character upon the strength of which she has obtained a situation should not, if the servant leaves at the end of a few weeks, consent to be referred to again, unless the reason for leaving be clearly not the servant's fault: the character should be given by the last mistress. It is now usual, since the passing of the Workmen's Compensation Act, to insure servants against accident. This may be done through any good Insurance Agency at about 3*s.* a head, 5*s.* a head includes certain illnesses as well as accidents, full particulars may be obtained when applying for a policy. In engaging a servant set forth the duties as plainly as possible. There is no better plan in household management than for the mistress to think out a table of work for each servant, whether she has one or several. The plan must vary with each household, be written or type-written very plainly and pasted on card-board and hung up in each department; this saves much friction and avoids that formula so well-known to housekeepers: "It is not my place." It is often somewhat difficult to know exactly what should be expected from each servant, and in making out a time-table it is necessary to know something of the duties which should fall to each and also in planning out the work to remember that servants require leisure and fresh air, and no household can be expected to progress or run smoothly where the comforts and welfare of the servants are totally disregarded. Where young under-servants are kept, such as kitchen or scullery maids or that mysterious being known as a "tweeny" (between kitchen and house) the mistress should have a kindly eye to their well-being and see that they are not over-worked and get sufficient food, sleep and exercise.

Servants' Duties.

A butler in ordinary households is the chief servant and has the charge of the wine and plate. His duties further include waiting at meals, carving, the serving of wine, tea and coffee. He answers the front door and drawing-room bells, announces visitors and attends to messages, letters and cards. In most houses he has charge of the billiard room and study, and is responsible for his own pantry and the safe shutting-up of the house at night.

The footman is sometimes the complement to the butler, sometimes he combines the duties of a valet and a parlourmaid. Where only one is kept he cleans the boots, knives, windows, calls the gentlemen of the household, lays breakfast, clears away, washes up glass, silver and china. He also fills the coal-scuttles, trims lamps and attends to the fires and the bells. His duties also include the cleaning of silver, waiting, carrying up hot water to the gentlemen's rooms and care of their clothes. A parlourmaid is a female butler and her duties are the same as his.

A housemaid's work depends to a certain extent on the number of servants kept, but her special duties are dusting and putting rooms in order every day with special cleaning of the same once a week. She also has care of the housemaid's closet and cloths and has to attend to the cleaning of brushes, combs and sponges. A single-handed kitchenmaid will have the kitchen range to clean and light in the morning, the kitchen itself to clean and any passages that may be allotted to her. She will have all the dishes, pots and pans to keep and the vegetables to clean and cook. She has also to prepare the servants' food and to assist the cook and wash up. Where a scullery-maid is kept, most of the cleaning devolves on her and the preparation of the vegetables, the kitchen-maid doing all the plain cooking and helping the cook. In a small establishment where only a cook and house-parlourmaid are kept, the duties should be very carefully thought out and the mistress will have to undertake some of the lighter work herself, such as washing and dusting china and "knick-knacks," sorting and counting the linen for the laundry, mending and putting away house linen, arranging the flowers. The following table for a house where only two maids are kept may be useful. Wherever possible a boy should be employed if only for a couple of hours daily, to clean knives and boots, fill coal-scuttles and go on errands.

List of Cook's Duties.

The *Cook* should light kitchen fire at 6.30 a.m.

Sweep basement, passage, hall, and dining room. Clean boots and knives* (this can be

* It is usual for the housemaid to clean the dining-room knives and the ladies' boots, while the cook does the kitchen knives and gentlemen's boots.

done over-night if wished), dust the dining-room and prepare breakfast for both kitchen and dining-room.

Time:—Kitchen breakfast 7.30 a.m. Dining-room 8.30 a.m. After breakfast clear away and wash up, having everything tidy in time for the mistress' visit to the kitchen to order meals. Answer door-bell in the morning. Cook the meals and wash up plates and dishes afterwards, leave the kitchen tidy for the night.

Special Work.

Monday.	Polish brasses and tins.
Tuesday.	Turn out larder and pantry.
Wednesday.	Clean the dining-room and hall.
Thursday.	„ „ servants' room.
Friday.	„ „ kitchen range and flues.
Saturday.	„ „ kitchen and prepare for Sunday.

Duties of House-parlourmaid Daily.

The *House-Parlourmaid* should be down by 6.30 a.m., take up early tea (if required) and hot water at 8 a.m. Sweep and dust the stairs. Lay the kitchen and dining-room breakfasts. After breakfast, do the bedrooms and drawing-room. Lay the table for the middle-day meal, clear away, wash up glass and silver and be ready to answer the door by 3 p.m. (It is better to allow ½ hour before lunch for the housemaid to change her dress and get ready for the afternoon.) Bring up afternoon tea at 5 p.m. Lay the dinner, take up hot water. Wait at table. Wash up silver and glass. Lay kitchen supper. Arrange bedrooms for the night. Take up hot water.

Special duties.

Monday.	Prepare clothes for the laundress and turn out the best bedroom.
Tuesday.	Turn out one or more bedrooms.
Wednesday.	Turn out the drawing-room.
Thursday.	Turn out the study and bathroom. Clean the stair rods.

Friday. Clean the silver and tidy the housemaid's pantry and the china closet.

Saturday. Count the clothes from the laundress, air, and put them away.

At the end of each list of duties it is well to add the arrangements made for going out on Sundays and week-days, and when possible specify the time allotted to each maid.

Whenever a new servant is engaged, she should be given a list of the various things under her care, the mistress keeping the duplicate. Even where no change takes place in the domestic arrangements, these lists should be gone through carefully at least once a year and worn out or broken articles replaced or mended.

'No beer' is the best rule, and certainly no 'beer money'; the latter often induces drinking. Board wages vary from 7*s.* to 15*s.* a week each; money for laundry should never be included in the wages. The allowance varies from 9*d.* to 1*s.* 6*d.* a week except in the case of nurses wearing white dresses, when a larger sum is needed.

To furnish a housemaid's closet the following are required:

A box known as a housemaid's box containing a pair of gloves, a coarse piece of crash or sacking for the front of the fire-place, brushes, black lead, bath brick, etc. Three to six dusters, dust sheets, two good chamois leathers, a set of brooms and brushes—the latter for cleaning plate as well as rooms, a decanter drainer, a wooden bowl for washing-up in and another for rinsing purposes, half-a-dozen tea and glass cloths. As a rule the housemaid should wash out her own cloths and dusters.

The question of food is sometimes a difficulty. In small families it will be found by far the best way to allow the servants to make their supper off what is left from the dining-room late dinner, always with a proviso that any special dish is to be reserved. Under these circumstances a simple lunch may be provided for the kitchen. Sometimes, and especially where there are children, it is advisable to have the joint at lunch time when the servants get it for their own dinner. With reference to meat other than that allowed at dinner, a "relish" as it is termed should be given three times a week, and if only a plain supper is given, a relish may be allowed for tea on those when a plain breakfast has been the order of the day. If the mistress knows how long things should last, she can soon check any waste. The actual food allowance per head in the kitchen is: half a pound of butter, one pound of sugar and a quarter of a pound of tea per week; one third of a pint of milk daily.

Linen cupboard.

After the planning and arranging the servants' work, the linen cupboard comes next in importance. In olden days the plenishing of this especial cupboard was the pride of the housewife; now that spinning is no longer fashionable and that everything can be bought, this part of household furnishing is often neglected. First as to quantities. It is a mistake to have too little, each article is then constantly in use and there is not enough to use on an emergency. This linen cupboard should be the pride of the mistress and tended accordingly. The usual allowance is three pairs of sheets to each bed, or in some cases five pair between two, with three slips to each pillow, three hand towels per head and three bath towels to each couple. In a small family the average should be half-a-dozen towels to each person. Bath sheets are a matter of taste but at least one should be allowed to each bedroom. Table cloths generally have twelve napkins to match them. In some houses, it is customary to have different cloths for lunch and breakfast, to what are used for dinner, in which case three dinner cloths with napkins to match, and three breakfast cloths, with a best cloth and napkins for special occasions, will be sufficient to start with. For quilts and toilet covers, two quilts for each bed should be purchased, the same rule applying to toilet covers. Three roller towels should be reckoned for each roller and at least half-a-dozen cloths and dusters to each maid. The servants' bed-clothes and table linen should be on precisely the same scale but different in quality. Besides these, there are fancy cloths of all kinds, such as tea, sideboard and tray cloths, d'oyleys etc., but they vary in quantity and quality with each household. House-linen varies considerably in price, and a list may be obtained from any reliable firm.

Spring Cleaning.

§ 79. Associated with lighter, warmer days, and the promise of summer, comes the well-known, much-dreaded household upheaval known as spring cleaning. After months of gloom and wet, of fires and artificial light, the reappearance of the sun draws attention to many a corner that has escaped even a practised mistress' eye and shows how soiled all curtains and hangings have become. With the lengthening days a good housewife sets about looking through stores, seeing what white-washing and papering is required and planning alterations. Where work-people have to be employed, it is best to take advantage of the absence of several members of the family, leaving a responsible person in charge; but where ordinary spring cleaning has to be gone through a little planning and arranging will enable it to be carried out to the minimum discomfort of the inhabitants. One room or floor may be done at a time, the whole house need not be turned upside down at once. If possible choose a fine, dry day.

To turn out a bedroom.

The bed-clothes should all be removed and the bedstead thoroughly cleaned and dusted, the mattresses well beaten and looked carefully over to see that the tick is not worn or any of the buttons loose. The blankets should be well shaken out of doors and those no longer in use put carefully away packed up with napthalene or camphor to keep off moths. Turpentine applied freely to the places they are believed to infest is the best cure. Brown paper may be soaked in turpentine and fastened underneath all the furniture. Things packed away may be sprinkled with dried alum powdered with bitter apple or pepper. It is well to change the remedies occasionally as after a time moths appear to get over their objections to any particular one. Blankets should not be washed too often and only by a competent person who understands the cleaning of woollen goods (see page 224). Curtains and valances should be well brushed and shaken and then pinned up. The bed is then made if the room is in use, covered closely with dusting sheets. These are best made of holland, crash or twilled unbleached calico. They should always be used one way, the hem showing the right side so that the clean side may always be against the furniture. As many articles as possible should be removed from the room and each brushed, dusted, and polished, and covered closely with a dusting sheet. Rugs or movable squares may be rolled and taken out of doors for shaking or beating. A carpet should be laid over a clothes line and beaten with canes until the dust ceases. It should then be laid flat and brushed on both sides with a carpet brush, folded by the seams and put away until wanted. To clean carpets, rub them over with a damp sponge and dry with a coarse cloth. Salt and vinegar should be put into the water in the proportion of one table-spoonful of each to a quart of water.

Carpets and Rugs.

These floor-cloths should not be washed too often but may be kept fresh and bright by rubbing over with a dry cloth. Once a week they may be washed with warm water and soap and when thoroughly dry rubbed over with a flannel dipped in milk. Beeswax and turpentine will give a high polish, but render the linoleum so slippery as to be dangerous.

Linoleum.

When the pictures have been taken down, the chimney should be swept and the grate and fire-irons cleaned and polished. It is advisable to sweep the room before polishing the grate. The black-lead should be mixed with a little turpentine and applied lightly and then brushed off with a hard grate brush and finally

Grates and fire-irons.

polished with a soft brush. Steel fireirons may be cleaned with fine emery paper and polished with a leather. For keeping them all bright use powdered bath-brick and equal quantities of water and methylated spirit made into a paste. Brass fenders etc may be treated with ordinary polishing paste or sapolio; or, if much tarnished, a cut lemon or a little paraffin oil rubbed on will clean them beautifully. This same treatment applies to stair-rods, copper kettles, etc. Most modern copper and brass goods are laquered (this is done to prevent tarnish) and should never be cleaned with any kind of polishing paste or powder. They only need wiping with a damp cloth and polishing with a leather or soft duster.

Hearths.

Most hearths are now tiled and only need wiping with a damp cloth, but should they be made of stone, clean in the following way: Take up all the dust from the hearth with dustpan and brush and wash all over with flannel and warm water. Then rub on hearth-stone or pipe-clay, the latter mixed with water or milk to the thickness of cream. Wring the flannel dry and wipe all over to get a smooth surface, this should be done across from side to side, *not* round and round. Instead of pipe-clay, Venetian red, a powder sold at the chemist's, is sometimes used. This should be mixed with water, put on with a brush as smoothly as possible and left to dry.

Cupboards and drawers should be turned out, scrubbed, and when thoroughly dry, re-papered.

Walls and Pictures.

Pictures, when carefully dusted, should have the glass washed with ammonia and water and when dry polished with a dry cloth; gilt frames may be gently wiped with a damp cloth. Small soft brushes with long light bamboo handles can now be obtained for brushing down walls, or in their absence a broom may be used covered with a soft duster or cloth, care must be taken to change the cloth as soon as it gets soiled.

Windows.

Windows in many places can be cleaned by men whose special business it is, and in the case of high windows this is generally the best method and prevents accidents which often occur when servants sit on a window sill and can only reach the panes by leaning out in a most dangerous manner. The dust should be rubbed off the windows first both inside and out and the sills washed; the glass may then be cleaned with a chamois leather or a sponge wrung out of tepid water, and polished with another leather; ammonia added to the water gives the glass greater brilliance. Hot or even warm water should never be used to clean paint, as it destroys the varnish and the paint soon wears off. In cleaning wood-work wash, beginning at the bottom and working upward, with a flannel and soap-suds, this prevents dirty marks from running down and making streaks; rinse with a sponge and tepid water and dry with a soft cloth.

Painted Wood-work.

Sweeping.

In sweeping a room, begin at one end and sweep towards the fire-place or towards one spot from which the dust may be gathered up. Tea-leaves are used to prevent the dust from rising and should first be put into a colander, washed in cold water and squeezed dry. If put straight on to a floor or carpet they are apt to stain. Boards should be swept with a hair brush and carpets with a twig. A so-called carpet-sweeper requires careful use and is apt to take the nap off the carpet as well as the dust. When the carpets have been taken up and the room swept, the floor should be scrubbed, and care must be taken not to do this late in the afternoon if the room is in use. There are a few important points to remember in scouring rooms. 1. Scrub the way of the grain of the wood. 2. Change the water directly it is dirty. 3. Always leave the doors and windows open after scrubbing so that the air may dry the room. 4. Choose a fine day for the operation.

Scrubbing.

Grease marks may be removed by making a paste of fuller's earth and hot water and laying it when cold in a thick layer over the marks. It should remain on for at least 24 hours and then be scoured off. In many houses now the boards are stained and rugs laid down here and there. A good floor stain may be made as follows:—

Stained Floors and Furniture Polish.

1 lb. of burnt umber ground in oil, 1 gallon linseed oil. Boil the oil and mix with it enough umber to make the colour desired. It may be tried on a piece of wood. Rub the mixture into the floor, the way of the grain of the wood, with a piece of flannel tied on to a piece of stick. When dry, rub off the superfluous stain and the floor is then ready for bees-waxing. Permanganate of potash dissolved in water also makes a good floor stain.

Floorine and other preparations may be bought at any ironmonger's, but the first staining is the most important and should be done by a competent person. If not well done the stain wears off in patches and there is no remedy except having the floor planed, always a matter of expense. Polished floors should be beeswaxed and polished once a week. The beeswax, about 1*s.* 6*d.* a lb., should be finely shredded into a jar, covered with turpentine and placed near gentle heat until dissolved and of the consistency of thick cream. This polish may also be used for furniture, but it will spoil good dusters, and old soft rags should be kept for the purpose; they can be burnt when dirty. Another recipe for furniture polish is ½ pint turpentine, ½ pint linseed oil, ¼ pint methylated spirit and ¼ pint vinegar mixed well together and put into a wide-necked bottle. Boiled linseed oil may be used for rubbing up old oak furniture, oil and vinegar mixed together in equal proportions are excellent for furniture cleaning.

Marble.

Marble is found either as forming a top to the washstand or as part of the fire-place, and as a rule soap and water will be sufficient to keep it clean. If very dirty and stained, monkey brand soap or hot vinegar and water may be used; if not successful the following recipe may be tried: Boil ¾ lb. soap with 1½ pints of water; stir in 3 lbs. of whitening. The mixture should be applied with a flannel, left on for some hours, then washed off with water. Sapolio also may be used; it is very injurious to marble washstands to let them lie wet constantly; they should be dried after use.

To clean Toilet Ware.

Wash toilet ware with soda and hot water, using a house flannel or a little mop made of tow or rag on a stick. Water bottles should be allowed to stand with tea leaves and vinegar or salt and vinegar in them and then be well shaken until clean and rinsed until clear. Glasses may be washed in cold water and polished with a soft linen cloth. If greasy, wash first in warm soda and water.

When the bedroom is thoroughly dry, the various articles of furniture may be replaced in order, any fireirons or other steel goods not in use may be thoroughly greased or rubbed over with paraffin and wrapped up in brown paper. For turning out a sitting room proceed in the same manner as for a bedroom, taking care to brush all sofas and chairs well, standing them on a sheet meanwhile, if the carpet cannot be taken up.

To clean Plate.

§ 80. In making out a time-table of a servant's duties, time must always be allowed for cleaning the silver. A careful house-parlourmaid will wash the forks and spoons thoroughly every day and a little ammonia in the water will help to keep them bright and untarnished. A basket lined with green baize should be provided and a good chamois leather so that each article may be polished before being placed on the table. Salt-cellars should be emptied every day and the inside as well as the outside be carefully wiped over. The plate-basket should be locked up in a safe place at night and the articles counted over at least once a month. For the special cleaning, which should take place once a week, two brushes, some soft rag or pieces of flannel, a chamois leather and some plate powder are required. Plate powder should be bought with caution as some kinds contain quicksilver, which in time has an injurious effect. The best are made of precipitated whiting and jeweller's rouge, and this may be made at home. To precipitate whiting scrape a quantity into a piece of fine muslin, place it over a jug of water, letting the part of the muslin containing the whiting be in the water. After standing like this for some time it will be found that the whiting has passed through the muslin to the bottom of the jug, while the grit remains behind. The water is then poured off and the whiting is ready for use. Plate powder may be moistened with a little spirit and rubbed on thinly; when dry it is brushed off and the silver polished with a leather.

Knives.

Knives when dirty should be placed in a jug of warm water so as not to allow the handles to get wet. After wiping them, stains may be removed by rubbing the blade with potato parings or with monkey brand soap. They should be wiped and rubbed on a board with brick-dust. The brick-dust should be scraped on to the board and the knife rubbed horizontally with the shoulder of the knife against the edge of the board. For the point rub up and down. The knives are then dusted with a cloth and put all one way in a knife-box. Instead of a board a cork may be used, wetting one end and dipping it in bath-brick and rubbing the knife up and down. A piece of board may be covered with a bit of soft carpet and used for rubbing the knives, this will give them a high polish. Knife machines are sold for about 30*s.*, the price varies with the number of knives they can take; they save time and labour, but wear out the knives very quickly. Knife handles may be cleaned with lemon and salt or with monkey brand soap.

Zinc utensils.

Zinc or galvanised iron baths and pails should be washed with hot water, soap and soda. If furred inside scrape with a knife and rub hard with a piece of cloth dipped in paraffin. Let the paraffin dry on, then polish with dry powdered bath-brick.

It is not always easy to get boots well cleaned, and should a boy be employed for this purpose, he will probably need teaching before satisfactory results can be obtained. In the first place he must be taught to discriminate between patent leather and ordinary boots, and to keep a bottle of prepared polish for brown boots with separate rags for applying the same. The dirt should be brushed off first and the heel may be scraped with a piece of wood or an old knife. The blacking should be mixed to a creamy consistency with vinegar and applied lightly with a sponge. Some people think the vinegar hurts the leather, but it is difficult to get a good polish without. Blacking can be bought ready mixed for use. When the mixture has been rubbed over the boot thinly, the shining brush must be applied immediately, this brush should always be kept quite dry Patent leather should be treated with cream or vaseline; a mutton bone rubbed on ordinary leather will soften it. Glacé kid should be sponged, allowed to dry and then thoroughly polished with a soft rag or handkerchief, which is slightly oiled occasionally. Boots and shoes will wear twice as long if they are placed on trees directly they are removed.

Cleaning of Boots and Shoes.

So many and varied are the requirements of a house, that it is somewhat difficult to make anything like a complete collection of what is wanted by each individual housekeeper. Many will have inherited special recipes for polishes and plate powders etc., but it is hoped that the foregoing suggestions will enable a young housekeeper to understand some of the many duties that fall to her lot.

3. LAUNDRY WORK.

§ **81.** Before entering upon the details of Laundry Work it is necessary here to consider it from two different standpoints; first that of the mistress of a house, secondly that of a teacher or manageress of a laundry. For anyone desiring to take the latter post, a thorough course of laundry work in some good technical school, with the addition later of a short time spent in a steam laundry to learn packing and sorting on a large scale, is strongly to be recommended. The mistress of a house will probably find this question of cleanliness one of the most difficult she has to solve, after the much debated one of domestic service. Cleanliness in respect to apparel and bed-clothes is very important and is too often neglected; this is probably due to want of thought and method, but now that personal hygiene is being taught in nearly all schools from the Fifth Standard upwards, any disregard of these matters should be looked upon as false economy. The health of the home depends in great measure on the attention paid to cleanliness and on the manner in which this is carried out. Formerly washing was chiefly done at home, and "washing-day" was frequently a source of domestic disorganization. In the present day, although still carried on in many homes on the ground of economy, the establishment of public laundries with their labour-saving appliances has proved a boon to many, the vans fetching the soiled linen at the beginning of the week and returning it clean at the end of the week. Many who have travelled abroad, especially in parts of Austria, will regret "washing at home" when they see the way it is carried out there, but unfortunately in most places in England there is no space for the erection of the outside laundries which belong to each house or group of houses, nor is there the supply of water which is such a feature in foreign towns and villages. The question of public washhouses has been keenly debated and should be a help to many living in cottages with little or no accommodation for either washing or drying, but the reason they have been less successful than might be expected, is probably due to the fact that most people like to wash their soiled linen in private. The first requisites of a good laundry are a plentiful supply of water, a healthy open situation and careful supervision against infection. The question of machinery should also be carefully considered, many people preferring the old-fashioned hand laundries on the plea that machinery weakens the material and tears the articles. Such great improvements have been made in this respect during the last few years that under a good manageress this danger may be disregarded.

All clothes, whether washed at home or sent to the public laundry, should be plainly marked. When sent away from the house, the articles should be carefully marked, counted, and a list made for the laundress on Monday morning; when the clothes are returned at the end of the week they should be recounted and aired before being put away. It is also advisable at the same time to look through articles that may require mending and a certain order should be observed in the putting away, that the same things may not be constantly in use.

As we are not concerned here with the establishment of laundries on a large scale, it will be sufficient to point out what materials and utensils are required and how they should be applied and kept in good repair both at home and when furnishing a Laundry Centre for the use of Elementary Schools.

Water.

The first requisite mentioned above, namely water, has been exhaustively treated in Chapter IV.; it is essential for laundry purposes that this should be plentiful and as soft as possible. Clothes are frequently ruined by the use of soda and other matters employed to soften the water.

Soap.

The next requisite for washing is soap, a substance produced by the action of an alkali on an oil. Vegetable as well as animal fats are employed in the manufacture. The alkali displaces glycerine from the oil and forms an alkaline stearate which is soap. The alkalies used are caustic alkalies, that is, alkalies in their pure state

Soft soap is made of potash and coarser kinds of fats and oils, while the best hard soaps are made from animal fat and caustic soda; the former is not used for washing the skin as it is too irritating, but it is best for coarse greasy clothes. The melted fat, soda and resin (the latter added to give bulk) are boiled together for some hours, then, on the addition of salt, the soap will rise to the surface, leaving glycerine behind. This process is repeated several times and towards the end water and special ingredients are added. A good soap should not contain too much alkali or it will injure the fabric of the clothes and also cause irritation to the skin. Too much fat will cause the soap to become rancid and too much water will cause great waste. Marine soap is made with cocoa-nut oil, because, unlike other kinds of fats, it is not rendered insoluble by brine and will form a lather with sea water. The use of hard water wastes large quantities of soap, as a lather is not produced until the lime salts have been neutralized by the quantity of soap used.

Alkalies.

There are three alkalies used in washing. Soda, potash and ammonia, sometimes known respectively as the mineral, vegetable and volatile alkalies. Their chief properties are to act as detergents or cleansers and to neutralize fatty acids. Used alone they destroy fabrics and turn white clothes yellow.

Soda.

Soda is manufactured now from common salt (chloride of sodium); it was formerly obtained from the ashes of seaweed. It should always be dissolved in hot water before being brought in contact with the clothes or iron-mould stains may be caused.

Potash.

Potash is obtained from the ashes of plants and vegetables and is known to the housekeeper under the name of pearlash.

Ammonia.

Ammonia is chiefly obtained during the distillation of coal in the manufacture of coal gas; it is colourless, very volatile and has a pungent odour. It is used for washing Jaegar and natural wool garments, the proportions will be given in the part treating of washing of woollen garments.

Borax. Borax, a saline substance found in its crude state in many of the salt lakes of North and South America and Asia, has a powerful effect in softening water, but is too expensive to be used in large quantities. It loosens dirt and dissolves fats and starches very readily without injuring the fabric as soda does, and it is used in removing simple stains and in the preparation of both cold and hot starch. Borax is also produced by artificial means.

Blue. Blues are divided into three kinds, Indigo, Prussian blue and Ultramarine; they are sold in two forms, liquid and solid, the latter is the one in general use. The cake or ball of blue should be tied in a flannel and then dissolved in the water by crushing it with the fingers, when sufficiently coloured the water should be sky-blue when held in the palm of the hand. It is used to give the clothes a good colour, and to prevent a streaky appearance; the garment should have been thoroughly rinsed and be free from any remains of soap.

Starch. Starch is used (1) for stiffening clothes, (2) to give them a good appearance, (3) to keep them clean longer. In its raw state it is a white glistening powder found in all cereals, but the best for laundry purposes is obtained from rice, the grains are finer and penetrate the linen more easily. Starch for stiffening clothes is made in two ways, hot starch for prints and muslins, cold starch for collars, cuffs and shirt fronts.

Hot starch. *Recipe for hot starch.* 1 table-spoonful white starch, sufficient cold water to mix to a cream, ½ tea-spoonful of borax dissolved in hot water, a piece of wax or candle about the size of a sixpence. Boiling water is then poured on these ingredients until the starch thickens and becomes a semi-transparent jelly. If it is too thick, for example for table linen, it may be diluted with cold water directly it is made. The borax is added to give a gloss and to whiten and stiffen the linen; the wax or candle will keep the iron from sticking. All articles stiffened in hot starch should be dried before they are sprinkled and ironed.

Cold starch.

Recipe for cold starch. 1 table-spoonful white starch, 1 breakfast-cupful of cold water, ½ tea-spoonful of borax dissolved in hot water, ¼ tea-spoonful of turpentine. The latter takes the place of wax or candle used in making hot starch, and for the same reason. These ingredients when thoroughly mixed should be strained through a piece of muslin. Cold starch is used for articles requiring to be made very stiff. They should be thoroughly dry before being starched or they will not be of the required stiffness. Collars and cuffs should be placed in the starch and then rubbed together with the hands; this ensures the starch getting into the linen. Each article should be squeezed dry and placed separately on a clean cloth; the cloth should then be rolled up very tightly and left to stand for about an hour.

Washing powders.

Washing powders are best avoided in a laundry as they may contain chemicals which injure the clothes. As a rule they are composed of soda, borax, with the addition of lime, and if used at all, should be dissolved before they are brought in contact with the clothes.

Soap Jelly.

This dissolved soap is prepared by shredding up soap into small pieces and dissolving it either by pouring boiling water over it (¼ lb. soap to 1 gallon of water) or by placing the soap in a saucepan of cold water and allowing it to melt on the fire. This jelly is added to the water in which flannels or woollens of any kind and prints are washed. Enough should be used to raise a lather by moving the hand about in the water.

Paraffin washing, as it is called, saves time and labour, but cannot be carried out in ordinary households. Half a pound of soap should be dissolved in a boiler three parts full of water, and when it is boiling 2 table-spoonfuls of paraffin oil are added. The clothes are then put in dry and allowed to boil quickly for half-an-hour, any scum being carefully removed. The clothes should then be thoroughly rinsed in several warm soapy waters and finished with the ordinary rinsing and blueing, and dried in *the open air*. The disadvantages of this method are the frequent rinsings, the danger of the oil catching fire and the difficulty of getting rid of the smell in large thick articles.

Paraffin.

Salts of lemon and oxalic acid are sometimes used to remove stains, but should always be labelled *Poison* and kept in a safe place. They are likely to injure the fabric, and after their application the material should always be well washed to prevent it from rotting. Stains if dealt with before they are dry can be removed without the aid of chemicals; they will be dealt with in detail in the part relating to practical washing.

Acids.

This is not the place to touch on machinery worked by steam, etc., but many excellent washing machines may be obtained that can be used by hand and which will greatly save time and labour.

Machinery.

A good hand-washing machine costs about £10, and will wash any kind of clothes. In using the one shown in the diagram, the clothes should be sorted and the white garments put in first and warm water poured in by means of the tap. When this has been let out, hot water is added and dissolved soap; enough of the latter is put in to make a good lather. The machine is then turned continually for about 20 minutes, and if the clothes are very dirty, fresh water and soap are added, if not they are rinsed until the water comes out quite clean. Where steam is used, this is turned on to boil them. The clothes are then blued; liquid blue should be used, not too strong, they are turned about in this for about 10 minutes. If the clothes are to be starched, it is put in by the bucketful (4 lbs. starch and 2 candles will make 4 bucketsful). The clothes are then taken out and put through a wringer.

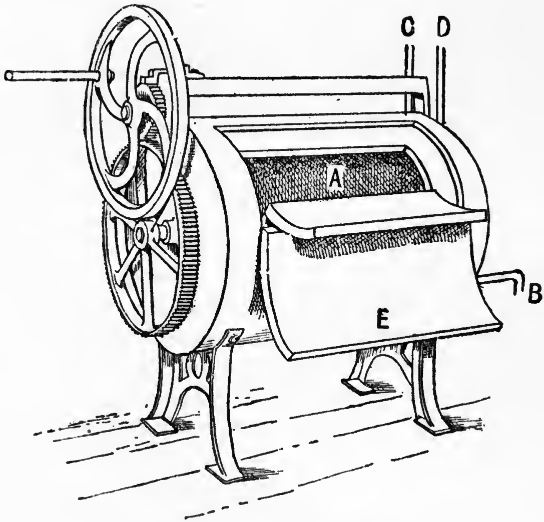


DIAGRAM OF WASHING MACHINE.

A. Clothes put in here. B. Waste pipe.
C. D. Hot and cold taps. E. Closing lid.

In a small laundry, dolly tubs are used, price about £1. 1*s.* 0*d.*: they are not suitable for very fine clothes; washing boards cost about 12*s.* Then there are starching machines in shape like a box or tub. The collars and cuffs are put in and the machine turned round for 15 minutes, this beats the starch well into them. Ironing machines turned by hand for body or table linen can also be obtained and goffering machines heated by gas.

Care and choice of utensils.

Besides the machines mentioned above there are various utensils required in the laundry. If not fitted with troughs, it should be furnished with wooden tubs for washing; when these are not in use they should be kept in a cool dry place filled with clean water to prevent the wood from shrinking and the tub from leaking. The rollers of the mangle or wringer should always be wiped dry after use, the bearings loosened and oiled from time to time, the whole kept covered up and free from dust when not in use.

The irons in general use are known as flat irons, they require cleaning on finely powdered bath-brick when they are taken off the stove or fire. They are sold in all sizes, but the best medium size is no. 5. Box irons have the advantage of being always clean, but they are heavy and cumbersome, at least two heaters should be allowed to each iron. Gas irons have much to recommend them, but they must be connected to the pipe by a piece of tubing and can only travel a certain distance, also special arrangements have to be made for ventilation. Charcoal is used for heating irons, chiefly in France, it saves much time and labour, but the fumes are unhealthy. Goffering irons somewhat resemble a pair of scissors and vary in size according to the "flute" required. When not in use, irons must be well greased, mutton fat is the best, and wrapped up in brown paper. The ironing stove in the shape of a pagoda is the most useful kind, and it is made to hold any number of flat irons and has a special arrangement on the top to hold goffering and polishing irons. These stoves are lighted in the usual way and the fire is kept up by adding coke. Iron stands are best made in tin or earthenware, and an iron holder should be oval in shape and of several thicknesses, an old stocking folded several times, covered by an old glove and sewn into a print cover, makes the most economical and substantial holder. Felting or baize should be bought for covering the ironing table and should be exactly the right size with no join; old blankets and shawls may also be used. The sheets can be made of calico and should be furnished with tapes to tie them securely over the felt to the legs of the ironing table. Steam may be prevented from filling the laundry by fixing a copper hood to the boiler, the steam is carried off by these means into the flue, and when the lid is on none can escape into the room. If the floor is tiled and likely to get wet, boards raised about 2 to 4 inches from the ground should be provided to stand upon.

Order of washing.

Having briefly touched on some of the principal materials and utensils required in Laundry Work, it is necessary to say something of the order in which the work should be taken. Upon the day before the actual day set apart for washing, the clothes should be sorted ready for steeping in cold water.

1. Fine things such as muslins, laces, collars and cuffs.
2. Table linen.
3. Bed and body linen.
4. Handkerchiefs.
5. Coarse things.
6. Prints and flannels. These are never soaked.

Each of these sets is put in a separate tub and a little dissolved soda or borax may be added to the cold water; very dirty parts may be soaped. Handkerchiefs may have "Sanitas" or some other simple disinfectant added to the water in which they are soaked. On the actual washing day the flannels and woollen garments should be taken first, and as they are often spoilt in the process of cleaning, it is well to go into detail.

For ordinary woollens two tubs should be filled with lukewarm water (2 parts cold to 1 part boiling). Soap jelly should be added until a good lather is formed.

The flannels should be well shaken, then *kneaded* and *squeezed* in the lukewarm soapy lather first on the right side and then on the wrong. When clean, white flannels may be rinsed in clean warm water to which a little ammonia has been added. For coloured flannels, salt may be added to the water to prevent the colour from running. They may then be squeezed or put carefully through the wringer and well shaken to raise the "nap" and dried fairly quickly before the fire or in the open air; on no account must the fire be too fierce or the sun too hot. Knitted or crochet garments should be pinned out while still wet. Flannels may be ironed with a cool iron. To prevent shrinking, before garments are made up, it is a good thing to soak new flannel in cold water for 12 hours and then wash as above. Flannel with little holes at intervals along the selvedge has been well stretched in the manufacture and will shrink a great deal the first time it is washed. Blankets should be washed on a day when they can dry out of doors. They should be washed in two lathers of warm soapy water to which a table-spoonful of dissolved borax has been added, then rinsed in a large tub of warm water slightly blued. The blankets should be wrung as dry as possible, then well shaken to raise the nap. The surface will be much improved by being shaken twice or more during the process of drying.

White clothes.

The things which have been put to soak should be rubbed and wrung out of the steeping water and then taken in order, that is to say, the cleanest and finest articles should be taken first, and the water should be as hot as the hand will bear. Muslins and laces require special treatment, and coloured prints should be washed in the same way as flannels and stiffened with hot starch. After washing, white clothes should be boiled from 15 to 20 minutes to keep them a good colour, the water should be soft and soapy and it is generally necessary to put the articles in a bag to prevent the scum from settling on them. After thorough rinsing, all clothes not required very stiff may be starched in hot water starch, thick or thin as required, and put to dry in the open air if possible; this not only improves the colour of the clothing, but also makes them fresh and clean. Failing an out-of-doors drying ground, a clothes-horse near the fire may be used, or a bar of wood fastened by means of ropes and pulleys to the ceiling. The latter is an excellent method either for drying or airing, and can be easily fixed if the room be lofty enough. Clothes require to be carefully folded before being damped and mangled; it is owing to want of attention to this part of the cleaning process that so many garments are pulled out of shape and buttons broken off. The clothes should be folded in long strips with the buttons and tapes laid flat within the folds of the garments, and the folds should be of equal thickness so that the pressure of the mangle may be equal in every part.

Polishing Linen.

When collars and cuffs or shirt fronts have been ironed, a hot polishing iron may be used to gloss them. The collar or front should be placed on a hard board and the starched surface rubbed with a lightly damped piece of clean flannel or linen. The hot polishing iron is then rubbed quickly backwards and forwards until a gloss is produced.

Silk.

Silk should be washed in warm soap lather as quickly as possible, and if white, rinsed in clean cold water, or in vinegar and water if the silk be coloured. It should be ironed while still wet by placing a piece of cambric over it and using a moderately hot iron. Silks are sometimes dipped in gum water before ironing, this gives a slight stiffness and gloss. The proportions are 1 oz. of gum arabic to 1 pint of boiling water, strained through muslin and used as follows: 1 dessert spoonful to a cup of water.

Lace.

Lace may be treated in various ways. If very fine a glass bottle should be covered with folds of flannel and the lace sewn on round. The bottle is dipped into a warm soapy lather and pressed until clean; it should be rinsed in clean water. Fine laces should not be ironed, but pinned out on a board covered with flannel or pulled into shape, placed between folds of blotting-paper and pressed. Another way is to fill a bottle with warm soap lather and shake the lace up and down in it until clean. It may be stiffened by dissolving 2 oz. of lump sugar in 1 pint of boiling water or by using gum water in the same way as for silk. Coarse laces may be starched in ordinary hot water starch and ironed.

Bran washing.

Art work and cretonnes should be washed in bran water, this not only cleanses them but gives them a slight stiffness.

To make bran water, boil 2 handfuls or 1 quart of bran in 4 quarts of water for an hour. The mixture is then strained through a piece of muslin and enough cold water added to make the whole mixture lukewarm. Soap jelly may then be added and the material kneaded and squeezed in the water, each piece being washed separately and finished off as soon as possible; the colours will run if they are allowed to soak. To set the colours the work may be rinsed in a strong solution of salt and water. Cretonne curtains and covers may require to be starched in thin boiling water starch and they should be ironed when partly dry with a cool iron on the wrong side. If they are ironed on the right side a piece of cambric or muslin should be placed between them and the iron.

Stains.

Stains in most cases are easily removed if attended to while still fresh, if allowed to dry, chemicals must be used and the fabric is likely to be injured. It is necessary before removing stains to consider first their nature, and secondly the material from which the stain has to be removed.

Table linen is the most subject to stain, either fruit, wine, or tea and coffee stains.

To remove the former, stretch the stained portion of the material over a basin, rub with common salt and pour on boiling water, and repeat the process until the stain disappears. If the stain is dry, salts of lemon must be used in the same way, but unless the material is washed and rinsed immediately afterwards, it will rot. Tea and coffee stains should be removed at once by soaking in cold water, borax and boiling water may then be used and the cloth dried in the open air; no soap should be used, as this fixes the stain.

Ink stains if wet may be removed by being rubbed with powdered starch and afterwards moistened in milk or by being soaked in boiled milk. *Dry* ink stains can only be removed by having recourse to salts of lemon or oxalic acid. Lemon juice may be used, and turpentine often proves useful in removing ink stains from white muslin.

Grease stains on cloth material should be removed with powdered French chalk. The chalk is rubbed on the stain, which is held over a hot iron; as the heat meets the grease, it is absorbed by the chalk which can be rubbed off with a dry rag. Benzine is also very useful but should not be used near a fire as it is very inflammable.

Paint stains may be removed by the application of spirits of turpentine or spirits of wine. Mildew is very difficult to get rid of, but repeated applications of chalk and salt, and moistening with water followed by drying in the sun will sometimes remove it.

Disinfecting.

The clothing of a person suffering from any infectious disease should be completely separated and never washed with the ordinary clothes of the household. Heat is one of the most reliable processes of disinfection and may be applied either in a dry form such as baking, or by wet heat as in steaming or boiling.

For baking clothes a special apparatus is required and the local sanitary authorities will carry out the necessary process. Clothes may be disinfected by boiling them for half-an-hour. It is difficult to use any strong disinfectant such as chloride of lime or carbolic acid without staining the clothes, and it is always necessary to distinguish between disinfectants proper, which should destroy micro-organisms, and deodorizers, which simply get rid of bad smells. In cases of small-pox, scarlet-fever, diphtheria, etc. the proper authorities should at once be communicated with, as clothing, unless properly treated, forms one of the chief means of spreading infection. It is now compulsory for the head of the household to notify the medical officer of health as soon as a case of infectious disease has occurred under his roof; neglect of this renders him liable to a penalty of £10.

CHAPTER XI.

Foods.

I. Animal Food:—meat.

§ **82.** THE term *Food* may be strictly defined, as the material taken to repair the substance of the body.

The Proximate Principles of which Food is composed may be classified as

Nitrogenous Foods, example, Proteins;

Non-Nitrogenous Foods, such as Fats, Starches, Sugar;

Mineral Salts and water.

All Proteins contain Nitrogen as well as Carbon, Oxygen and Hydrogen, and this Class of Food may be found in the Vegetable as well as in the Animal Kingdom.

The most important Animal Foods are Meat, Fish, Game, Poultry, and the proteins derived from them are said to be more readily digested than those obtained from Vegetables.

Meat may be divided into

(*a*) *Red Meat*, such as Beef and Mutton.

(*b*) *White Meat*, as Veal and Pork.

The latter are the least digestible, taking four and five hours respectively, while beef and mutton each take three to digest; much however depends on the manner in which they are prepared by cooking.

Animal Flesh consists of 72 % of Water, about 20 % of Proteins, and a varying amount of Fat[1].

Good Meat should be bright red in colour, leave no mark when pressed, be free from smell, and marbled in appearance from the fat between the muscle fibres.

To be tender, meat should hang for two or three days; the time varies according to the climate or time of year. Immediately after death, a stiffening of the muscles takes place, *rigor mortis*. This lasts about two days, after which the meat becomes tender and is better flavoured. This condition lasts a very short time, putrefaction setting in.

Beef is best obtained from an ox about four years old: the flesh should be bright red, firm, free from smell, and the fat white and firm.

Cow-beef is more closely grained and the lean of a deeper red.

Bull-beef is dark in colour and has a strong smell.

Average beef contains about

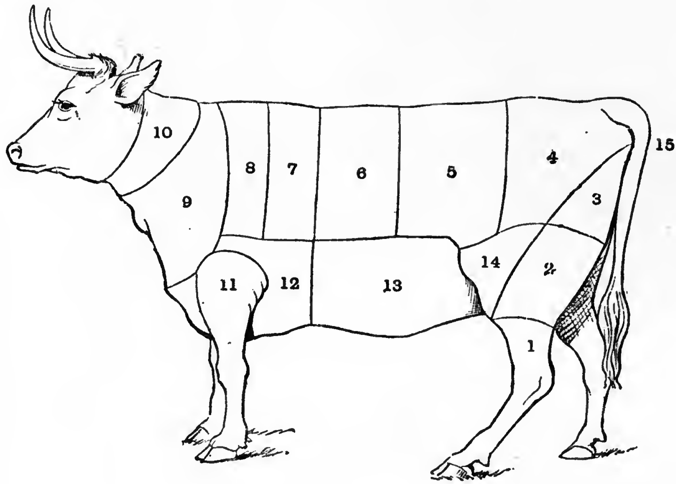
Water	Proteins	Fat
54·76	16·93	27·33.

The manner of cutting up an ox varies in different parts of the country; but the following are the different joints and the average price:

Rump, from 10*d*. to 1/- a lb.
Buttock or round, from 8*d*. a lb.
Aitchbone, from 7*d*. a lb.
Sirloin, from 10*d*. a lb.
Ribs, from 10*d*. a lb.
- *a*. Fore Ribs.
- *b*. Middle Ribs.
- *c*. Chuck Ribs.

Neck and Clod.
Heart, from 8*d*.
Palate.
Skin, from 4*d*. a lb.
Shoulder, or Leg of Mutton piece.
Brisket, from 7*d*. a lb.
Flank.
Cheeks, about 2/-.
Tail, from 1/6.
Tongue, from 2/6.
Liver, 8*d*. a lb.

[1] The Food-values are taken from Prof. Knight's book, *Food and its Functions*.



DIVISION OF THE OX.

1. Leg of Beef--used for beef-tea and soups. 2. Buttock or Round—may be divided into Top Side and Silver Side. 3. Aitch-bone. 4. Rump. 5. Sirloin—cut into 3 parts, a chump end, a middle and a wing end. 6. Fore Ribs. 7. Middle Ribs. 8. Chuck of Beef. 9. Clod—used for stewing. 10. Neck or Sticking piece. 11. Shin. 12. Brisket. 13. Thin Flank. 14. Thick Flank. 15. Tail.

N.B. Beef Kidney is used for puddings and pies—Suet for pastry and force-meat—Tongue for pickling and boiling.

Tripe is the inner lining of the stomach of the cow or ox: there are five kinds but the two generally eaten are known as the Double and Honeycomb.

Tripe is very nourishing and easy of digestion.

When bought at Tripe Shops it is usually dressed and only requires re-cooking.

When bought raw it must be soaked in salt and water, scraped, blanched and boiled; it costs from 6*d.* to 9*d.* a lb.

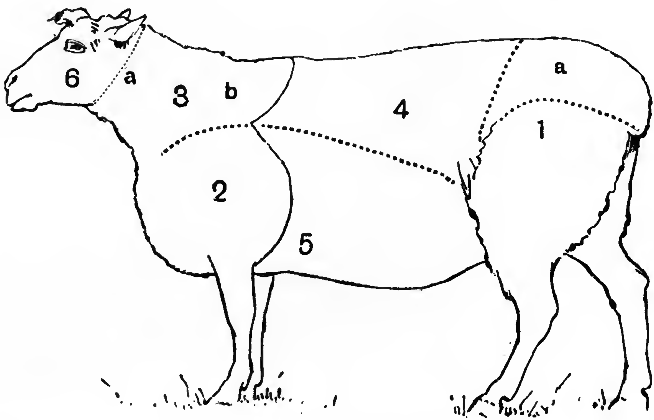
Mutton. Home-grown mutton is best from a sheep about three to four years old.

In appearance the meat should be fine grained, the lean bright-coloured and firm, and the fat very white and hard.

Welsh and Scotch mutton is smaller than ordinary mutton, but has a fine flavour: the legs only weigh 6 lbs. or even less shoulders from 3 to 5 lbs.

It contains:

Water	Proteins	Fat
75·99	18·11	5·77.



DIVISION OF THE SHEEP.

1. Leg. 2. Shoulder. 3. Neck: a. Scrag end; b. Best end. 4. Loin: a. Chump end. 5. Breast. 6. Head.

The following table gives the chief joints, with the average prices:

Leg (2), 9*d.* to 11*d.* a lb.
Shoulder (2), 8*d.* to 9*d.* a lb.
Loin, from 10*d.* a lb.
Saddle, from 9*d.* to 1/- a lb.
Breast, from 6*d.* a lb.
Neck:
  1. Best end, from 9*d.* a lb.
  2. Scrag end, from 7*d.* a lb.

Head, from 6*d.*
Tongue.
Suet, 6*d.* a lb.
Kidneys, 3*d.* each.
Heart, from 6*d.*

Welsh and Scotch mutton vary in price, some of the best parts fetching 1*s.* 2*d.* a lb.

Mutton-suet is cheaper than Beef-suet and less digestible on account of the Stearin it contains—it is much whiter and harder in appearance.

Pork. Fresh pork is obtained from a pig under one year old, and to be delicate it must be small and not too fat.

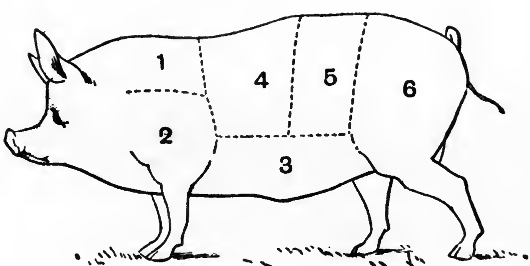
Composition:

Water	Proteins	Fat
47·40	14·54	37·34.

The fat should be very white, the lean pink and free from spots, and the skin thin.

The pig is very liable to disease, being an omnivorous feeder, and the flesh should be carefully chosen and *thoroughly* cooked.

Dairy-fed pork is the most wholesome, and it is always best to buy from a farm or from a reliable dealer.



PIG—Pork.

1. The Spare Rib and Neck. 2. Hand. 3. Belly or Spring. 4. Fore Loin. 5. Hind Loin. 6. Leg (Ham).

A *Porker*, i.e. a pig to be used as fresh meat, is divided as follows:

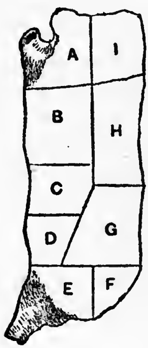
Leg (2), 6*d.* to 8*d.* a lb.
Loin (including fore loin and hind loin), 8*d.* a lb.
Spare rib, 6*d.* to 8*d.* a lb.
Belly or Spring, about 6*d.* a lb.
Head or Cheek, about 6*d.* a lb.
Hand, about 6*d.* a lb.

Fry—internal parts—including:
Heart, Liver, Sweetbread, Chitterlings } 6*d.* a lb.
Feet or Pettitoes, 1*d.* to 2*d.* each.

The internal fat is melted down and known as Lard, price 8*d.* a lb.

A *bacon pig* is older than a Porker and is divided differently:

Guide to ordering Bacon.



A. Fore hock (fore end).
B. Thick streaky (prime piece).
C. Thin streaky.
D. Flank.
E. Cushion (gammon).
F. Corner of gammon.
G. Loin.
H. Back and ribs (prime cut).
I. Collar (prime part and end).

There are two kinds of bacon, smoked and unsmoked; the latter is often known as "*green bacon*" and costs from 6*d.* to 7*d.* a lb.

The best home-cured Wiltshire comes to 11*d.* or 1*s.* a lb.

Bacon and hams may be prepared in two different ways; by dry or wet pickling.

When meat is salted dry it has a better flavour, but it loses in weight.

In the wet process meat gains in weight, and is said to keep longer.

Meat for salting must be fresh.

Sugar, used in pickle, is a powerful antiseptic and gives mellowness to the meat.

Saltpetre gives it a red colour, but should not be used in large quantities as it tends to harden.

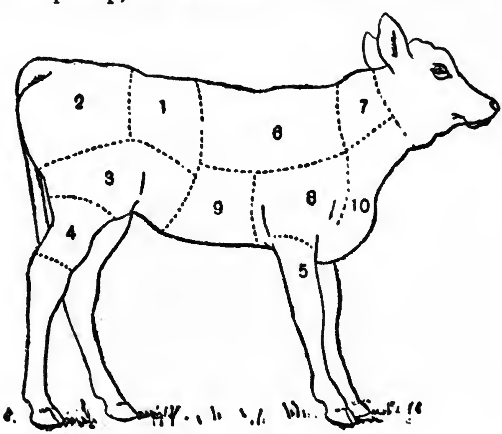
Pickle should always be deep enough to cover the meat, and be placed in an earthenware pan with a tightly-fitting lid.

Veal and *Lamb.*

Veal obtained from the calf, and *Lamb* taken from the young sheep, are both taken from immature animals and their flesh contains a large proportion of water.

They are less wholesome and digestible than beef and mutton, and should be thoroughly well-cooked.

In choosing Veal the flesh should be of a fresh pink, fine grained and plump, the fat white.



CALF—Veal.

1. Loin, Best end. 2. Loin, Chump end. 3. Fillet.
4. Hind Knuckle. 5. Fore Knuckle. 6. Neck, Best end.
7. Neck, Scrag end. 8. Blade Bone. 9. Breast, Best end.
10. Breast, Brisket end.

Veal will not bear hanging, and should not be kept more than a day or two, especially in hot weather.

There are two so-called Sweetbreads: one from the throat, the other called the heart sweetbread; the latter is larger and the one most generally used.

Veal contains:

Water	Proteins	Fat
78·82	19·76	0·82.

It is divided into the following joints:

Head, from 3/-.
Loin, from 10*d.* a lb.
Chump.
Fillet, 9*d.* to 1/- a lb.
Hind Knuckle, 7*d.* a lb.
Fore Knuckle, 7*d.* a lb.
Neck, 7*d.* to 9*d.* a lb.
Breast, 8*d.* a lb.
Feet, 4*d.* to 5*d.* each.
Pluck, including:
  Heart, 10*d.*
  Liver, } 9*d.* a lb.
  Lights, }
Sweetbread, from 2/6 each to 5/-.

Lamb. Lamb is to be had from Christmas, when it is called *House Lamb*, and is considered a great delicacy.

Grass Lamb comes into season in March.

Like all other meat obtained from young animals it should be thoroughly cooked.

The flesh should be clear and firm, the fat delicately white and hard.

When quite young, lamb is divided into quarters; and the fore-quarter, consisting of shoulder, breast and neck, is considered the best.

Later on the quarters are divided into joints:

Breast, 8*d.* to 9*d.* a lb.
Fore-quarter, 9*d.* to 1/2 a lb.
Hind-quarter, from 11*d.* a lb.
Leg, 11*d.* to 1/- a lb.
Shoulder, 9*d.* a lb.

Lamb's Fry includes:
  Heart,
  Sweetbreads,
  Liver,
  Kidneys,
  Milt.

Foreign Meat. A large quantity of foreign meat is imported to England and sold at a lower price than home-grown and home-killed meat.

There is

1. *Frozen Meat.*

This is meat killed in the United States, Australia and New Zealand, and frozen before *rigor mortis* has set in.

This kind of meat requires very thorough thawing before it is cooked, and this should not be done before a fire, but by leaving it to hang in a kitchen or larder of ordinary temperature. When quite thawed it is ready for use, and, as a rule, will not bear keeping much longer.

2. Animals exported alive and slaughtered after arrival in England.

The flesh is exposed to a low temperature without being actually frozen, and is then sent in specially constructed vans to various parts of the country.

Tinned Meat. Tinned meats are now consumed everywhere in large quantities and, if carefully used and chosen, are wholesome and cheap.

Directly a tin is opened the contents should at once be emptied into a basin.

Tins that have been standing in shop windows and exposed to sun-light should not be bought, nor those that bulge outwards; the latter shows that the air has not been fully expelled.

Tins should bear the name of a well-known firm and, if stored at home, should be kept in a dark, cool, dry place.

II. Poultry.

§ 83. *Poultry* includes all domestic birds such as Turkeys, Fowls, Geese and Ducks.

In choosing Poultry it is necessary to take age, freshness, condition and colour into consideration.

In young birds the end of the breast-bone will be gristle and bend easily, the legs and feet are smooth, and in male birds the spurs are only represented by scaly knobs.

When fresh and in good condition the skin looks clear and unwrinkled, and the flesh is plump and firm.

White-legged fowls are best for boiling, while dark-legged fowls may be used for roasting; but this is entirely a matter of taste.

Being deficient in fat chickens are served with bread-sauce and bacon.

They are dear in the spring and cheaper towards the end of the year, average price from 2*s.* 6*d.* to 3*s.* 6*d.*

Ducks should be chosen by the softness and elasticity of the feet and the rounded contour of the breast.

They may hang for a few days before cooking, weather permitting. They are less digestible than fowls on account of the fat they contain and the strong flavour of the flesh. Apple or gooseberry sauce, and sage and onion stuffing are served with duck to correct the richness of the dish.

Ducklings are in season in May and June.

Geese should have yellow pliable feet, and white skin; like ducks they are better hung for a few days. They are in season in September, cost 5/- to 10/-.

Turkeys are at their best in December and January. They should hang for a week before being dressed. Hen turkeys, which are considered the best, cost from 1/- a lb.

Guinea-Fowls are often used when game is out of season. They are very dry birds and should be larded with fat bacon before cooking and carefully basted, cost from 3*s.* 6*d.*

Rabbits are in season from August to April. Wild ones are best for the table and should be cooked while fresh. In young rabbits the claws are sharp and the ear tears easily; in old ones the teeth are very long and yellow, cost 8*d.* to 1*s.* 9*d.* each.

Pigeons, 9*d.* to 1/- each. Young ones should be chosen and the age can be tested by the wings which will not be fully fledged inside, the feet should be smooth and the beak soft. They should be drawn as soon as they are killed.

Game includes all wild animals hunted by sportsmen and protected by law.

To attain perfection game must hang for some days; the length of time depending on the weather, the kind of larder, the way the bird has been killed.

A *pheasant* will sometimes hang as long as 20 days, but should be carefully watched.

To judge the condition of game, notice whether the eye is much sunk. If almost invisible the bird has probably been killed several days. This year's birds may be known by the smoothness of the legs and the softness of the beak.

	In season.	*Price.*
Grouse,	12th August to December 10th.	5/- to 6/- a brace.
Hares,	October to March.	3/6 to 6/- each.
Partridges,	1st September to March 12th.	3/- a brace.
Pheasants,	October to March 12th.	6/- a brace.
Plovers,	August to March 15th.	1/6 each.
Ptarmigan,	November to March.	from 1/6 each.
Quails,	March to July.	1/- each.
Snipe,	October to March 15th.	2/6 a brace.
Teal,	September to February.	1/6 each.
Wild Duck,	October to December.	2/- each.
Woodcock,	December to March.	5/- a brace.

Venison, the flesh of the deer, is a savoury food, short in fibre, containing little fat, but when young very tender and rich in albumen.

Buck-venison, which is considered the best, is in season from June to September; Doe-venison from October to December.

The haunch is the prime joint, cost variable.

III. Fish.

§ 84. *Fish* forms a valuable article of diet when carefully chosen and well-cooked.

It contains a large proportion of water, a varying amount of fat and proteins; it is also rich in gelatine.

As in the case of all animals, fish, when eaten, should be fresh.

A fresh fish should have bright eyes, red gills, plump, firm flesh, straight, stiff tail and be free from all smell.

Mackerel and herrings keep a very short time; cod, turbot, haddock and whiting keep best when stored in a cool place.

During spawning fish is said to be "out of season" and is then unfit for food.

It is divided by the cook into three classes:

1. *Oily Fish*, i.e. fish containing oil distributed throughout the body; examples: salmon, herring, mackerel, etc.

2. *White Fish*, fish containing oil in the liver only; such as whiting, sole, cod, etc.

White fish are the most digestible because they contain less fat.

3. *Shell-Fish*:

(*a*) Crustacea: Crabs, Lobsters, etc.

(*b*) Mollusca: Oysters, Mussels, etc.

Shell-fish are often foul feeders and are considered, with the exception of the oyster, very indigestible. They are best eaten unaccompanied by any liquid.

Fish may also be divided into Salt and Fresh water Fish; the close time for the latter is from March 15th to June 15th.

One of the most usual methods of cooking fish is by boiling; the general rule is to allow six minutes to the lb. and six minutes over, the water should just cover the fish and be only allowed to simmer.

In frying fish care should be taken to make it as dry as possible, first by wiping and then by dusting over with flour.

The roe in large fish is removed and cooked separately; that of the Sturgeon is known as Caviare.

	In season.
White Fish:	
Cod,	Jan., Feb., Oct., Nov., Dec.
Haddock,	Jan., Aug., Sep., Oct., Nov., Dec.
Plaice,	Jan., Feb., March, April, Oct., Nov., Dec.
Smelts,	Jan., Feb., March, April, Oct., Nov., Dec.
Sole,	Jan., Feb., June to Dec.
Turbot,	Jan., Feb., March, April, Oct., Nov., Dec.
Whitebait,	June.
Whiting,	Jan. to April, Aug. to Dec.
Oily Fish:	
Eels,	Jan., Feb., June to Dec.
Herring,	May to Dec.
Mackerel,	Jan. to June, Oct. to Dec.
Salmon,	Feb. to Sep.
Shell-Fish:	
Lobster,	Feb. to Oct.
Oyster,	Jan., Feb., March, April, Sep. to Dec.
Prawns,	Feb. to Nov.
Mussels,	Jan. to April, Sep. to Dec.

IV. Milk.

§ 85. *Milk* is generally called a complete or perfect food, because it contains all that is necessary for the support of the *young* mammal.

It is however too deficient in Carbo-hydrates to be a proper food for adults in health.

The constituents of milk are in 100 parts:

Water	Proteins	Lactose	Fats	Salts
86	4	5	4	1.

Milk contains these chemical substances as follows:

Nitrogenous, in the Caseinogen and albumen;
Carbo-Hydrates, in the Lactose or milk-sugar;
Fats, in the cream;
Mineral Matters, in the whey, salts and water.

After standing a short time milk turns sour, the milk-sugar having been changed into lactic acid owing to the presence of a micro-organism called *Bacterium lactis*, which abounds in dairies and other places where milk is kept. It also readily absorbs disease-producing micro-organisms, and great care should be taken to keep everything about milk scrupulously clean.

All pans and vessels should be scalded before use and care taken that the water used is fresh and pure, and in no way contaminated.

Tuberculosis or "wasting decline" in cows affects the milk, and the disease may be conveyed to human beings.

Scarlet fever, enteric fever and diphtheria, may also be propagated by this means. It is thus much safer and better to use *boiled* water and *boiled* milk, bacteria being effectually destroyed by exposure to a high temperature.

Boiling milk gives it a somewhat disagreeable taste but, if it is placed in an airy place after boiling and the skin removed, it soon loses this flavour.

Even when boiled, milk should be kept away from strongly smelling substances and protected from dust by being covered with a piece of clean muslin.

The *Cream* which rises to the top of the milk after standing is composed of globules of fat; being lighter it rises to the surface.

Through the process known as churning, cream is converted into a solid substance called butter, the most wholesome and nourishing form of Fatty Food.

Devonshire or *Clotted Cream* is made from milk allowed to stand and then placed over gentle heat. When the milk has reached a certain temperature the cream clots and can then be taken off.

Cream is often removed by means of a separator and the milk left behind is called skim-milk. It is very wholesome and nutritious, and can be obtained more cheaply than whole-milk.

Butter-milk is what is left when butter has been made and contains all the constituents of milk, even a small proportion of fat; it is useful in cases of catarrh of the stomach.

Caseinogen, which is one of the proteins contained in milk, is an important constituent of Cheese.

In making *Cheese* the new milk is placed in a vessel and warmed, and then a curdling ferment is introduced. Rennet is the one in general use and is obtained from the stomach of the calf.

The curd thus produced is separated from the whey and pressed into moulds.

It is known as

Whole-milk Cheese,
Skim-milk Cheese,
Cream-Cheese.

Also as "hard" or "soft" cheese.

It is composed of almost equal parts of water, fat and casein, with salts, and is most nutritious.

One lb. of cheese contains as much nourishment as two lbs. of meat, but unless eaten by persons engaged in hard, out of door work, it is indigestible.

Milk may be preserved in various ways, but should never be used when fresh milk can be obtained.

1. *Condensed Milk.* Condensed milk is prepared by the evaporation of the water and is kept in hermetically sealed tins.

There are two kinds, sweetened and unsweetened: the latter should be used directly the tin is opened; the former is very fattening on account of the quantity of sugar it contains.

2. Chemicals may be added, boracic acid is one in general use. The use of boracic acid is now considered unsafe but has not yet been absolutely condemned. Cream to which chemicals have been added cannot be whipped.

3. Milk may be desiccated after evaporation.

4. It may be preserved by the application of

(*a*) heat, as in boiling, or

(*b*) cold, as in freezing.

Cold does not destroy the disease-producing bacteria, *heat* does.

The composition of milk varies in different animals.

Mare's and ass's milk resemble human milk very closely, cow's milk is richer, except in sugar.

The latter forms large clots of curd in the stomach and should be diluted by adding boiling water or barley water before being given to an infant.

In using boiling water, dilute at first to three times its bulk and add a little sugar.

Barley water contains so much mucilage that it prevents the casein from forming large hard clots and is also nourishing.

It should be given to an infant in the proportion of one tablespoonful of milk to two of barley water.

At six months old, the quantities should be half-and-half.

EGGS.

§ **86.** Next to milk, eggs form an important, perfect food, the young chicken being entirely developed out of the nutriment contained in the egg and shell.

They are deficient in Carbo-hydrates and Salts, which are supplied when eggs are eaten with bread and butter, and salt.

An egg consists of:

1. The **Yolk,** which is rich in fat and phosphates.

2. The **White,** which consists chiefly of albumen and water enclosed in a delicate membrane.

It is semi-transparent, liquid and glairy in a raw condition, but on being exposed to heat coagulates at a temperature of 160° Fahrenheit. The white then becomes opaque, solid and smooth, and is much less digestible than in a raw condition.

For boiling it is best to put eggs into cold water and bring them to the boil.

The addition of alcohol has also the effect of coagulating albumen and making it into a hard, cheesy, indigestible mass.

The practice of putting eggs into puddings to make them light is somewhat misleading, as the lightness is not due to the eggs, which harden in cooking, but to the whipping of the yolk and whites. In this process air is introduced and the albumen divided into fine particles, instead of being presented in a mass.

As the decomposition of eggs is due to the introduction of germs through the porous shell, they may be preserved:

1. By smearing them over with some fatty substance to exclude the air.

2. By keeping them in sawdust.

3. By steeping them in a mixture of lime and water.

4. By keeping them in brine.

The freshness of an egg may be tested by holding it up to the light, when it should look clear.

Another method is to make a solution of salt and water—1 oz. common salt to ½ pint water.—A good egg will sink in this mixture, while a bad egg will float on the top.

The eggs in general use are hens' eggs, and the average weight is about 2 oz.

Ducks' and turkeys' eggs are also used, and plovers' eggs are considered a great delicacy.

The price of eggs varies with locality and season, the dearest time being during the autumn and winter months.

The so-called "egg and custard powders" have no connection with eggs proper; they only consist of baking powder and some form of starch coloured a pale yellow. This should be borne in mind when preparing food for invalids, as these powders, quite harmless in themselves, in no way replace the nutritive value of a hen's egg.

VEGETABLES.

§ 87. **Vegetable Foods**, which may be divided for convenience into **Cereals, Roots** and **Tubers, Green Vegetables** and **Legumes**, are too often, in England especially, looked upon merely as accessories or **Food Adjuncts.**

They contain the same proximate principles as are found in the animal kingdom, **Proteins** in the form of Legumin and Gluten, **Carbo-hydrates** in the Starch, Sugar and Cellulose, **Mineral** Matters in the Potash, Phosphates and water; they are deficient in fat.

It is gradually being recognized that vegetable foods, taken in proper proportion with cream, butter, cheese, eggs and milk, form a healthy, nourishing diet; and, according to Dr Haig in *Diet and Food*, "The Vegetarians of this country are pretty decidedly superior in endurance to those who feed on animal tissues."

For economy's sake this may be pointed out with advantage to the working class, peas, haricot beans and lentils being highly nitrogenous, and their cost within the reach of all.

Cereals occupy the most important part among the vegetable foods: wheat in Europe; rice and maize in India, Africa, and America form the staple diet.

Under the head of Cereals are included all corn-bearing plants in which the nitrogenous matters are present in the form of gluten found after the removal of the starch.

The tenacity and adhesiveness of the gluten found in wheat and rye enables them to be made into bread.

Wheat is an annual cereal grass, bearing grains in rows on an ear-stalk.

The two kinds generally used are known as bearded or beardless, also red or white.

The grain has two coats. The inner one is composed of bran-cells, underneath which are the gluten-cells. The centre of the grain is composed of starch-grains.

In the process of grinding the bran is separated from the flour; the latter is either white or yellowish-white, the former contains little except starch, and is far less nourishing than the flour known as "seconds."

Whole-meal is a mixture of bran and flour, and is used in making brown bread.

It retains all the nourishment of the grain, but is sometimes difficult to digest; it is excellent in cases of constipation.

Preparations of wheat containing a large proportion of gluten are much used as foods; the best known are **Semolina, Macaroni** and **Vermicelli.**

Their nutritive value is greater than that of bread.

Rye is little used in England, but in Germany and Russia it is made into "black bread," a heavy, sourish, indigestible compound.

A mixture of wheat-flour and rye makes a good bread.

Oats form a very important class of cereals containing an abundance of proteins as well as fats and salts.

The nitrogenous principles of oats have no adhesiveness, therefore cannot be made into bread.

Groats are the grains freed from husks, and in a crushed form are sold as Quaker Oats, etc. for porridge and gruel.

Oatmeal in water forms a refreshing drink in hot weather, and oatmeal jelly is valuable for invalids suffering from stomach troubles.

Barley resembles wheat, but the proteins, like those of oats, do not form gluten with the addition of water.

When husked and ground, barley is known as pearl-barley. (For the conversion of barley into malt, see Beer.)

Barley-water is most useful for invalids and babies, and may be flavoured with lemon or mixed with milk.

In preparing barley-water for infants, the barley should first be blanched—i.e. put on in cold water and brought to the boil—then put on to boil in the proportion of 1 oz. pearl-barley to 1 pint of water. It should boil until reduced to half a pint and then be strained. Thin barley-water makes a refreshing, wholesome drink.

Blanch 1 oz. pearl-barley in one pint of water. Strain and place at the bottom of a jug with sugar and lemon rind, then pour over 1 pint of boiling water, cover and strain when cold.

Maize or **Indian Corn** contains little protein matter, but has the most fat next to Oatmeal. In America it is used when green as a vegetable. The best known preparations of maize are, Hominy, Oswego flour, and Cornflour.

Rice consists chiefly of starch and should always be eaten with other foods rich in proteins.

The two kinds of Rice in general use are **Patna** and

Carolina. The former is a long, white-pointed grain, and is used for curries or when the rice is required to be served dry.

Carolina Rice is larger, absorbs liquid more readily, and is made into puddings, etc.

In cooking, rice should be steamed, not boiled, as a large quantity of the nutriment is carried off in the water.

Roots and Tubers.

This division of the vegetable foods is composed almost entirely of starch and water and salts; the best known are the Potato and the Jerusalem Artichoke.

They are deficient in proteins and fat.

Potatoes consist of 95 °/。 of starch and water, and are too poor in protein matters to support life unless the deficiency is supplied, but with the addition of butter, cheese, butter-milk, etc. may form a wholesome, palatable food, the staple diet in some parts of Ireland.

Old potatoes, on being boiled, should present a floury appearance; this is due to the bursting of the starch-grains. Young potatoes contain immature starch-cells, and when boiled look waxy and are indigestible and unwholesome. The process of steaming retains the salts, which are otherwise lost in the water; another way is to cook potatoes in their "jackets."

Jerusalem Artichokes are tubers of the sunflower family. They contain no starch and do not become floury when boiled. They are in season during the winter months.

Sweet Potato. The difference between it and the true potato is the presence of sugar in the former.

Yams are tropical tubers; they keep well and are floury and palatable.

Roots.

Root vegetables are not so much foods as anti-scorbutics, and valuable on account of the salts they contain.

Turnips contain but little nourishment; they are watery and have no starch, but a jelly-like substance of the nature of pectose. The young leaves, known as turnip-tops, are used as greens.

Carrots contain no starch, but a fair percentage of sugar, and are wholesome when young.

Parsnips are used during the winter months; they consist of a good deal of starch and some sugar.

Beetroot is grown in France for sugar. The plant used as a vegetable should be carefully prepared, as any break or cut will cause the roots to "bleed," the red juice is lost, and the beet looks pale and flabby.

Salsify, another useful root vegetable, is but little known; it is easily grown and can be served in many ways, and is a most valuable addition to the winter list.

Onions. This plant has a bulb, the part usually eaten, and the strong flavour is due to the presence of a pungent oil.

Onions grown in England are used for flavouring, while the milder onions imported from Spain and Portugal are served as vegetables. The strong taste, disliked by many, can to a great extent be overcome by putting the onions on to cook in cold water, bringing them to the boil, and throwing away the first water. All articles used in preparing onions should be washed in cold water. This prevents the oil globules from bursting and soaking into the wooden board or spoon.

To the Onion tribe belong **Leeks, Eschalots "Shallots,"** and **Chives,** the latter being of a delicate flavour and useful in omelet making.

In **Garlic** the bulb is composed of divisions called Cloves; it is largely used in Spain, it has a strong taste, but is very nutritious.

Green Vegetables.

Green vegetables are chiefly valuable for the salts and acids they contain.

The **Cabbage,** of which there are many varieties, is the most familiar example of this class of vegetable. The best known are **Savoy, Kale, Red Cabbage.** Their main constituent is cellulose, which cannot be digested except in a very young state; nevertheless they are very important for the maintenance of health, a certain amount of indigestible material acting as a stimulant to the alimentary canal. They also contain potash and other salts.

Before cooking green vegetables, they should be carefully washed and soaked in salt and water to draw out any insects. Cabbages should be boiled in soft water with no lid on the saucepan to keep them a good colour.

Sauer Kraut is made from sliced cabbage sprinkled with salt, pressed and fermented. Vinegar is generally added.

Water in which cabbages have been boiled should not be allowed to go down the scullery drain, but should be poured away outside, on earth if possible.

Sea Kale belongs to the same family. It is forced, and the blanched stems and leaf-stalks are the parts eaten.

Brussels Sprouts are little clusters of leaves like miniature cabbages formed in the axil of the leaves.

Spinach is a specially wholesome vegetable. The leaves should only be used when quite young; they contain so much water that in cooking they may be tightly packed into the saucepan and no water added.

Celery may be eaten raw or cooked. The leaf-stalks are blanched by being grown underground; it is considered good for rheumatism.

Asparagus was originally a wild seaside English plant, now extensively cultivated and looked upon as a delicacy. The green kind is the best. In cooking, it should be tied up in bundles, the stalks only allowed to stand in the boiling water; the heads cooked in the steam.

Globe or **Green Artichokes** are a species of cultivated Thistles. The heads are boiled and the leaves eaten with sauce or melted butter. Inside the leaves is a white part called artichoke bottom. These can be preserved in brine, and are largely used in high-class cookery.

Sorrel is rich in oxalic acid, and is much used for soups and sauces in conjunction with veal, a tasteless dish in itself.

Lettuces are generally served raw, and form the bulk of the salads eaten in England. They are said to possess narcotic properties.

Other green foods used in salads are **Endive, Water-cress, Mustard** and **Cress.**

They have very little nutritive value, but are rich in salts and serve to introduce large quantities of water into the system and are particularly refreshing in hot weather.

Before passing to the Legumes or Pod vegetables there are a few fruits to be considered which are not valued because of the sugar they contain and which generally accompany foods with which salt is taken.

The **Tomato** is now extensively grown in Great Britain, and its use is yearly increasing. It may be cooked in many different ways and is excellent eaten raw. Preserved it is known as ketchup, a sauce resembling the well-known mush-room ketchup, or may be tinned or bottled.

Vegetable Marrows. These are allied to the common gourd. They are largely grown as vegetables, but they contain little nourishment, 94 °/ₒ being composed of water.

Cucumbers. These also belong to the Gourd Order. They are more juicy and digestible when grown quickly under glass, and contain 90°/₀ of water. Young cucumbers pickled in vinegar are known as gherkins.

The name of pulse is applied to peas, beans, etc., the edible contents of pods or legumes—and denotes a very valuable class of food stuffs, containing a far higher percentage of protein matters than do the cereals. Pulse also contains a good deal of starch and of the salts of lime and potash, but is deficient in fats; hence the familiar combination of "beans and bacon, pease-pudding and pork."

Peas. The cultivated or garden pea is probably derived from a plant native of countries bordering the Black Sea.

It is extensively cultivated in England and is eaten green as a fresh vegetable or dry in the form of split peas, pea-meal, etc. The latter are generally prepared from the field pea. Legumes preserved by drying should always be soaked for at least 12 hours before use.

Beans. There are several kinds of beans, but the Haricot or French bean, and the Scarlet Runner may fairly be taken as examples of the same family. The pods are gathered green in an unripe condition and are eaten as a fresh vegetable.

By Haricot beans in England, the white seeds dried are generally understood.

When soaked in soft water and carefully cooked they form a most valuable article of diet and should be more largely used. The peculiar "beany" flavour, so disagreeable to many, may be removed by throwing away the first water in which they are cooked. They form a cheap, nutritious diet when served with fat or starchy foods.

Flageolets are preserved green Haricots. Sir Henry Thompson says of Haricots in *Food and Feeding:* "There is no product of the vegetable kingdom so nutritious, holding its own in this respect, as it well can, even against the beef and mutton of the animal kingdom."

The **broad** or **Windsor bean** makes an excellent vegetable when eaten young, but the skin or outer covering soon becomes hard and indigestible.

Lentils. This plant is largely grown in South Europe. There are several varieties, but the red kind is perhaps the best. Lentils are the only Legumes that do not contain sulphur. They are richer in protein matters than peas and beans. **Revalenta Arabica** and other preparations advertised for dyspeptic patients are largely composed of Lentil flour.

Fungi. Fungi may be mentioned here among Vegetable Foods, although they are not so largely eaten as such in England as they are on the Continent. They are rich in Proteins and some kinds contain fat or oil.

Edible Fungi are seldom high coloured, scaly or spotted, and should always be eaten fresh. The common mushroom, *Agaricus Campestris*, is the one usually sold, it may be stewed, boiled or pickled; when salted and pressed a sauce called Ketchup is produced, largely used for flavouring.

The Morel, another species, is also used for the same purpose.

The Truffle is a subterranean aromatic fungus found chiefly in France and Italy, where it is rooted out by pigs, or by dogs trained for the purpose.

Iceland Moss is a lichen found as its name implies in Iceland, growing upon otherwise barren rocks. It contains a particular kind of starch, which is recommended to diabetic patients as a substitute for ordinary bread.

Irish Moss is in reality a seaweed. Its chief constituent is a kind of mucilage which yields a jelly on boiling and may be used with milk to form a "shape." It is nutritious and digestible, but should be soaked in cold water for at least an hour before use.

§ 88. **Fruits.** Fruits are that part of the plant which succeeds the flower. They are very valuable in the daily dietary, not only because of their nutritive value, but also on account of the Potash salts and the acids they contain. Fruits vary considerably in Food Value. They contain a substance called Pectose and should always be eaten in a sound, wholesome condition. Pectose is found in many fruits while in an unripe condition. This is converted into Pectin by the ferment action known as ripening or in the process of boiling. The setting or firmness of red currant jelly and other preparations of fruit, is due to substances resembling Pectose.

Fruits for domestic purposes may be divided as follows:

1. **Berries.**

Gooseberries—Red, White and Black Currants—Strawberries, wild and cultivated—Raspberries—Blackberries—Whortleberries and Cranberries. The latter are largely imported from North America and Russia, and make a pleasant change in the winter when mixed with apples.

2. **Fruit with Pips.**

Apples, of which there are many varieties both for cooking and eating. They are used too to make a fermented drink called Cider.

Pears. These are generally gathered when hard and tasteless and are stored for several months before they are fit to eat. Cooking pears are best stewed gently in a jar with the addition of sugar, water, and some flavouring, such as cloves or lemon peel.

The Quince is a strongly-flavoured fruit and is often added to preparations of apple. It makes excellent marmalade and jelly.

Medlars are a brown looking fruit picked in late autumn. They are uneatable until they go through a natural process resembling decay.

Oranges. There are many varieties, the best known are the Tangerine, a small orange with a fragrant, easily detached rind, the Maltese or blood orange, the bitter or Seville orange. The latter is used for the preserve known as orange marmalade.

The Lemon, highly prized for its citric acid and the fragrant, essential oil contained in the rind, pomegranates, pine-apples, are fruits imported into England in large quantities every year.

Grapes, both black and white, when fresh and ripe, contain nearly 20 % of sugar. They are chiefly grown for the purpose of making wine.

3. Stone Fruits.

These all have a hard seed containing an edible kernel, and are the least wholesome fruits.

Cherries are rich in sugar. The Morello which is less sweet than the ordinary kind, is used in preparing the liqueur, Cherry Brandy.

To the Stone Fruits belong Plums, including Damsons, Prunes, Greengages, etc. Also Apricots, Peaches and Nectarines.

Figs, Dates and Bananas are all fruits rich in nutritive value; the two former contain more than half their weight of sugar, while Bananas contain less water and more nitrogenous matter than is generally found in fresh fruits.

Fruits may be preserved by

1. Drying, raisins, currants, figs, etc.
2. Bottling, gooseberries, cherries, etc.
3. Preserving with sugars in Jams and Jellies.

Nuts are food products of great value; with the exception of the Chestnut they contain little or no starch, but much nitrogenous matter and a large percentage of oil or fat.

They form a rich food and are difficult of digestion unless ground into meal.

Spanish Chestnuts are chiefly grown in South Europe, where they are made into flour and mixed with maize to form the well-known Italian Polenta.

FOOD ACCESSORIES.

§ 89. **Food Adjuncts** are not, as the German word "Genüssmittel" implies, necessary for existence, but they are important aids to digestion and are used to improve the flavour of food and to render it more appetizing.

They all, with the exception of salt and vinegar, contain essential oils, which stimulate the secretion of the digestive juices.

They may be divided into Condiments, Spices, Flavourings, Acids, Oils, and Salt.

Under the head of Condiments are found:

1. **Mustard**, made from the seeds of a plant grown chiefly in England. There are two kinds, white and black. The seeds are dried, sorted and ground. Mustard is hot and pungent, and excites the palate.

2. **Pepper**, the fruit of a shrub found in the East Indies. Black pepper is prepared from the berries before they are ripe; white pepper is made by removing the dark covering when the fruit is ripe, it is less pungent.

3. **Cayenne Pepper** is prepared from the red pods of a kind of Capsicum; the pods are called Chillies.

4. **Capers** are the fruit of a wall plant, which grows in the environs of Toulouse and Lyons; they are pickled and exported.

Spices.

1. **Nutmegs** are found in the Banda Islands and New Guinea. Mace is the thin skin found between the shell and the Nutmeg.

2. **Cloves** are the dried calyx and flower buds of an evergreen tree belonging to the Myrtle order, growing in the East Indies.

3. **Cinnamon** is the bark of a tree grown in Ceylon and used either ground or in sticks as a flavouring.

4. **Allspice** or **Pimento** is a small dry berry from an evergreen tree grown chiefly in Jamaica.

5. **Ginger** is the root of a plant which grows in hot countries. It is picked green for preserving in syrup. The root is washed and dried for ordinary purposes and should be bought in this state and grated when wanted; powdered ginger is often adulterated.

6. **Cardamoms** are the aromatic fruits of several plants belonging to the ginger order. They are used to give pungency and are one of the ingredients of curry powder.

7. **Bayleaves** are picked from a species of Laurel and used as a flavouring either in a fresh condition or after having been carefully dried. For keeping they should be gathered on a fine day.

8. **Curry powder** or paste is a mixture of aromatic spices, the former is a dry mixture and should be kept in tightly corked bottles.

The following is a good recipe:

12 ozs. Turmeric	1½ ozs. Cayenne pepper.
8 ozs. Coriander seed	½ oz. Cardamoms.
6 ozs. Ginger	½ oz. Cinnamon.
5 ozs. Mustard	½ oz. Cummin.
5 ozs. Black pepper	¼ oz. Pimento.

Under the head of Flavourings are included:

1. **Vanilla.** Obtained from the fruit of an orchid. The pods, of which each plant bears about 40 annually, are the parts used for flavouring chocolate, cream, ices, etc.

2. **Bitter Almonds.** This oil is obtained from bitter almonds by maceration in water and distillation.

3. **Lemon Peel** is the rind of the lemon and owes its fragrance to an essential oil. The fresh peel is used for flavouring, but it may also be preserved by drying and it is eaten after boiling in syrup as Candied Peel.

Herbs are used for flavouring; they should be picked in the summer, carefully dried in the sun, powdered and kept in tightly-corked bottles. The herbs in general use are Parsley, Thyme, Marjoram, Sweet Basil, Sage; the former is used fresh.

Acids.

1. **Vinegar** is the most useful acid employed in the processes of cookery. The chief varieties are Wine Vinegar, Malt Vinegar, and Wood Vinegar; the two first are produced by the fermentation of alcohol. The use of vinegar in moderation helps to maintain the alkalinity of the blood, but when taken in excess it impairs digestion. Vinegar is largely used in the preparation of pickles, such as onions, gherkins, red cabbage, unripe walnuts, etc.

2. **Lemon juice** is a great anti-scorbutic. It should be clear, with an acid but not bitter taste. Citric acid, a chemical product, is often substituted for it. Vegetable acids are chiefly found in fruits; tartaric acid in grapes, malic acid in apples, oxalic acid in rhubarb, tomatoes and sorrel, citric acid in oranges and lemons.

Oils can hardly be classed under the head of Food Accessories as they really form an important section of Carbonaceous foods. They are found most abundantly in the fruits and seeds of plants. Olive oil occupies the first place among vegetable oils. It is obtained from the fleshy exterior of the fruit of the olive tree largely grown in the south of Europe and in the East. As an adulterant cotton seed oil is often substituted and is difficult to detect. In England olive oil is only used as a salad dressing, but in a pure state it forms the best frying medium. It possesses the advantages of never getting rancid or dry and of not solidifying at ordinary temperatures.

§ 90. Salts are essential as an ingredient in foods. They occur in most drinking waters and are found in all parts of plants and animals used as food. Besides chloride of sodium or common salt which is added to all foods, there are the salts of the vegetable acids, useful in preserving the alkalinity of the blood and preventing scurvy; phosphates and potash salts contained in vegetable and animal foods, phosphate of lime found chiefly in seeds and fruits, and iron which occurs in nearly all articles of food in minute quantities.

Salt, Chloride of Sodium, is a mineral consisting of crystals which are white and sparkling when purified. It absorbs moisture very readily and is soluble in water.

Common salt is obtained either as

(1) Rock salt, when the salt is found in mines and quarried out like coal, or

(2) as Brine. Water strongly impregnated with salt is found in certain districts, for example at Droitwich in Worcestershire, at Nantwich in Cheshire. It is pumped up from the earth, run into tanks, where it is exposed to bottom furnace heat, the water is driven off by evaporation and the salt left behind formed into blocks.

Salt may also be obtained from the sea. By boiling down and crystallizing the solution, salt may be obtained of various degrees of fineness.

Baking Powder. Though not in any way a food it is convenient to add Baking Powder to the list of Food adjuncts, as it plays an important part in the preparation of many dishes. It is composed of an acid and an alkali, with the addition of rice flour, ground rice or arrowroot to give it bulk, to absorb any moisture there may be about and to keep the mixture from getting lumpy. The alkali generally used is bi-carbonate of soda, made by passing carbonic acid gas through a solution of the ordinary carbonate, washing soda, thus:—

Carbonate of soda and Carbonic acid in the presence of water	form *bi*-carbonate of soda because the bicarbonate is $NaHCO_3$.

Carbonate of soda is sometimes used alone in place of other baking powders, it always needs the presence of some acid, sour milk or lemon, to avoid a flat, soapy taste.

Tartaric acid or Cream of tartar, the former in powder, are the acids usually mixed with bi-carbonate of soda.

Tartaric acid crystals are prepared from the fermented mass of grapes crushed in the process of wine making; Cream of tartar crystallizes on the sides of the wine casks.

Cream of tartar is best for making baking powder, as it does not part readily with its gas until it is heated.

Baking powder should be kept in dry tins and stored in a dry place. When the acid and the alkali are moistened effervescence takes place and carbonic acid gas is given off, this in trying to escape raises the cake mixture or pastry to which it has been added.

Recipes for Baking Powder:

I.	Tartaric acid	3 ozs.	II.	Cream of tartar	4 ozs.
	Bi-carbonate soda	4 ozs.		Bi-carbonate soda	2 ozs.
	Ground rice	4 ozs.		Ground rice	6 ozs.

The materials should be very dry and thoroughly mixed; to avoid all lumps they may be pounded in a mortar or put through a sieve. In using baking powder the proportions are:

For plain pastry and rich cakes 1 teaspoonful to 1 lb. flour.
For plain cakes, scones, etc. 2 teaspoonsful to 1 lb. flour.

BEVERAGES.

§ 91. Beverages belong to the group known as Food Adjuncts and they may be roughly divided into alcoholic and non-alcoholic.

Several contain *Nitrogenous substances* called *Alkaloids*, which act powerfully on the nervous system.

The most common non-alcoholic beverages are Tea, Coffee, Cocoa.

Tea. Tea is the dried leaves of a shrub grown in China, India and Ceylon. Its value depends chiefly on the age of the leaves and the soil in which the plant is grown. When the shrub is three years old the young leaves at the top which make the best tea are picked first; there are three other pickings during the season with about a month between each, but the first is the best. Teas may be divided into green and black teas; the former owes its colour to being dried quickly when fresh, while the black tea is prepared from the same leaves allowed to lie in heaps for about twelve hours, after which time they are slowly dried over charcoal fires. The name given to tea prepared from the top leaves of the shrub is Orange Pekoe, the lower leaves are known as Souchong and Congou. The alkaloid to which tea owes its stimulating properties is known as *Theine*; it acts upon the central nervous system and promotes the action of the skin, but like all other stimulants should be indulged in in moderation. Besides *Theine*, tea contains *Tannin*, an astringent. Tannin acts on the digestive juices, retarding their action, thus physiologically a "Meat Tea" is a mistake.

In making tea care should be taken to reduce the quantity of Tannin to a minimum. The quality of the tea, and of the water used for making the infusion are in this respect *most* important. The teapot should be heated before the tea is put in and the water should be *freshly* boiled. If very hard it may be softened by the addition of a pinch of carbonate of soda. Tea should never be allowed to stand more than 3—4 minutes, but the infusion may be poured into another previously heated teapot. The common practice among the working class of allowing the teapot to stew on the hob or in the oven cannot be too strongly deprecated.

Coffee. Coffee is made from the seed of a shrub, native of Abyssinia. Large quantities come from Ceylon, Java, the West Indies, etc.

The fruit of the coffee tree contains two seeds, which when removed are roasted and the moisture driven off. This operation should be postponed until the coffee is actually required, as the oil which is developed by the roasting process and which gives coffee its fragrant aroma, is very volatile and speedily escapes. The alkaloid is known as **Caffeine** and its effects are the same as those of Theine.

Coffee is frequently adulterated with Chicory, especially the kind sold under the name of "French Coffee." It is quite harmless and the flavour mixed with the coffee is preferred by many people. It may be easily detected, as pure coffee grounds float on water, while chicory rapidly sinks to the bottom.

To ensure good coffee, the beans should be freshly roasted and ground before use and sufficient coffee allowed, about one ounce to each large cup. To obtain strong coffee, place the grounds in a saucepan over a fire until thoroughly hot, when boiling water should be poured over them, half-a-pint to the oz. and the mixture allowed to infuse for 5 to 10 minutes before being strained. Coffee is not a food, but when made with boiling milk its food value is considerable.

Cocoa. Cocoa is prepared from a tree found in Brazil, the West Indies and Ceylon. The cocoa beans, which somewhat resemble thick almonds, are carefully roasted in revolving cylinders over coke fires. The crushed beans are known as *nibs;* when rolled they form flake cocoa.

It is not only a beverage, but ranks as an important food stuff, containing fat, starch, nitrogenous matters, besides cellulose, water, and an alkaloid called **Theobromine.** The action of the latter is less stimulating than that of tea or coffee. Preparations of cocoa, especially those that thicken in the cup on the addition of liquid, are mixed with starch and sugar. Cocoa husks boiled long and gently will yield a thin refreshing beverage at a very small cost.

Kola nuts contain Theine and have the power of taking away the feeling of fatigue. Mixed with cocoa they are considered most nutritious.

Chocolate is a preparation of cocoa and sugar flavoured with vanilla; the cocoa is crushed under heated rollers and the paste thus formed is pressed into moulds.

Aerated Waters. This class of non-alcoholic beverages may be divided into natural mineral waters, such as Vichy, Ems, etc., and those manufactured from ordinary drinking water by being charged with carbonic acid and other gases.

The best known among the latter are Soda Water, Potash and Seltzers. The materials used are baking-soda, tartaric acid, carbonate of potash, etc.

Ordinary soda water is generally plain water from which the air has been expelled, charged with carbonic acid gas.

The chief source of danger is from the employment of impure water; unfortunately carbonic acid gas under pressure is not fatal to micro-organisms.

Alcoholic Beverages.

Alcoholic beverages may be divided into two classes:

Fermented Liquors. Ale, beer, porter. Wines.

Distilled Spirits. Gin, brandy, rum, whisky.

These beverages are called fermented liquors because the alcohol in them is due to a process called fermentation, set up in the sugars extracted from fruits, etc., or in the sugars prepared by art from potatoes, cereals, grains, and starches generally.

In the process of fermentation the sugar is split up into alcohol and carbonic acid gas, the former remains in the liquid, the latter escapes as a gas. The change is brought about by the action of yeast, a one-cell plant, a microscopic fungus of the simplest possible structure, which feeds on sugar and breaks it up, converting it into alcohol. The necessary conditions for fermentation are warmth, moisture, and sweetness. Starch, such as we find in barley, when moistened and warmed encourages germination, and this develops the diastase, a ferment dormant in the grain, which acts on the surrounding starch, converting it into a species of sugar known as maltose.

There are two distinct chemical processes in the manufacture of fermented drinks; first the change of starch into sugar, secondly the change of sugar into alcohol and carbonic acid gas.

Alcohol consists of carbon, hydrogen, and oxygen, and burns without residue, forming carbonic acid gas and water. It boils at a temperature of about 180° Fahrenheit, an important item to remember in using wine for cooking purposes, for, if added early in the process, the alcohol will evaporate with the heat.

Proof spirit is roughly, half alcohol and half water, weaker or stronger spirits than this are known as under or over proof. Pure alcohol is lighter than water and has never been frozen. It has a great affinity for water and is used for preserving animal substances. When added to the raw white of egg, it coagulates the albumen, rendering it stringy and solid. It acts as a poison when swallowed, causing violent irritation of the stomach and, in extreme cases, paralysis of the brain. Compared with coffee, the stimulus supplied by alcohol is transitory and supplies no real energy. It lowers the temperature of the body by quickening the heart-beat and filling the surface capillaries with blood, giving a momentary sensation of heat, which is immediately lost by radiation.

Beer is a fermented infusion of malt flavoured with hops, or a saccharine decoction with the addition of some bitter. In making beer, barley is converted into sugar by the process of malting, and this saccharine solution is converted into alcohol by fermentation.

For malting, the barley is soaked in water, in order to make it sprout or germinate; the grains are then spread out on a floor and exposed to gentle heat; the two conditions of growth are here supplied, moisture and warmth. In a short time, about 14 days, the starch contained in the grain is converted by the action of the diastase or ferment into a species of sugar, known as maltose. The process is stopped by exposing the malt to greater heat, and the colouring of the various ales depends greatly on the degree of roasting to which the sprouting barley is subjected. In the next process the malt is sifted or screened to remove the sproutings, dirt, stones, etc., before being crushed between iron rollers. The next stage is called mashing. The malt is put into a tub with a moveable false bottom full of holes, which allows the water to drain through, hot water is poured on and the mixture is occasionally stirred to enable it to extract all the sugar from the barley. This "sweet wort" is then boiled in coppers with hops to give it a bitter taste, yeast is next added and the liquor is left to "work." Carbonic acid gas and alcohol are formed; some of the former escapes, the rest remains in the beer and gives it the sparkling taste. The quantity of yeast added and the temperature at which fermentation takes place vary with different kinds of beer. Pale and mild ales are made from the finest dried malt and best hops: porter and stout are beers in which the colour is produced by the roasting of the malt. German beers are fermented at a lower temperature, they contain less alcohol than English beers, but are richer in carbonic acid gas.

	Malt extract	Alcohol	Carbonic Acid	Water
Porter	6·0	5·4	·16	88·44
Ale	14·5	5·9	—	79·6
Munich Beer	9·2	4·2	·17	86·49.

Wines. The term wine is generally limited to the liquor prepared from the juice of the grape. In England and in some part of the Continent there is apple-wine or cider produced from apples, pear-wine or perry made from pears.

When the sugary juice of the grape is left to itself at a moderate temperature, fermentation takes place, the sugar is converted into alcohol and carbonic acid gas is formed. New wines contain aldehyd (alcohol dehydrogenated, deprived of the hydrogen required to form water), which later on gets oxidized into acetic acid and, if exposed long enough to the air, is converted into ordinary wine vinegar.

The colour, taste, and character of wines depend to a great extent on how far they are made from grape juice only. Different kinds of grapes yield different kinds of wine, and much depends on the soil, the season, and the climate, in which the vine is grown and ripened. By a *dry* wine is meant one of a flavour which is not sweetness; it may be produced by juice from a poor grape or be made "dry" artificially.

The nutritive value of wines is small and they owe their stimulating properties to the presence of alcohol. Clarets and light wines are anti-scorbutics on account of the acids they contain. Sparkling wines are bottled during the process of fermentation, when carbonic acid gas is being given off. They may also be made by forcing in carbonic acid gas under pressure.

Clarets are French red wines from the South of France, they are less acid than other French wines. Burgundy is made from black or white grapes grown in the central district of France, it contains more saccharine matters than claret. Champagne is made from white grapes; the wine undergoes a second fermentation in bottle and is stored in very cold cellars. Sherry is a Spanish wine, its value depends on its age. Marsala is made in Sicily. Ports are grown in Spain and take their name from the town of Oporto.

Spirits are obtained by the distillation of alcoholic liquors; they include brandy, whisky, rum, and gin. The fermented liquor is boiled, and alcohol having a lower boiling-point than water and being more volatile comes off first. It is passed into a long pipe surrounded outside by cold water, which condenses the vapour into a liquid form again. To get rid of the remaining water it must be re-distilled. Brandy is made from the distillation of wine, it darkens with age, but is generally artificially coloured by the addition of caramel or burnt sugar. Whisky is prepared from malted grain; inferior kinds are prepared from barley, rye, or mashed potatoes, roughly distilled and burnt to give them a smoky flavour. Rum is obtained from molasses by distillation. It is chiefly made in Jamaica, and is often flavoured with slices of pineapple. Gin is manufactured from a mixture of malt and barley flavoured with juniper berries. It is sold sweetened and unsweetened; "Hollands" is a Dutch spirit.

Liqueurs are spirituous drinks artificially formed and flavoured with vegetable essences. The best known are: absinthe, a greenish liquid with an essential flavouring of oil of wormwood, much used in France, where it takes the place of the gin sold in England; noyau, flavoured with bitter almonds; ratafia, with black currants. Chartreuse contains essential oil of angelica and a peculiar form of turpentine.

PROCESSES OF COOKERY.

I. Roasting.

§ 92. *Roasting* is the method of cooking most commonly used in England and is effected by radiant heat. For roasting in front of the fire a "Jack" is required, which being wound up, causes the joint to revolve slowly before a bright clear fire.

The meat should first be wiped with a damp cloth and weighed.

Allow ¼ hour to the lb. and ¼ hour over for small joints, and 20 minutes to the lb. and 20 minutes over for large pieces of beef, mutton, veal, lamb and pork. For the latter it is usual to give 25 minutes as it is very unwholesome if at all underdone.

Sometimes meat is floured before roasting; but this is entirely a matter of choice.

The joint should be placed close to the fire for the first ten minutes to harden the *proteins*, which form a case to retain the juices of the meat.

The heat should then be lessened and the actual cooking carried on more slowly.

It is necessary to baste the joint every 10 minutes, i.e. the melted fat which has run from the meat should be poured over the surface to prevent it from becoming dry or from burning.

Rabbits and poultry, which have no fat, should have a slice of fat bacon laid over them, and sometimes even require to be protected by a piece of buttered paper, which is removed during the last ¼ hour.

Principle. The coagulation of Proteins, familiar to us in the poaching of an egg, takes place at a temperature of 160° Fahrenheit; therefore overheating is a waste and tends to destroy the nutritive value of the food.

Baking. Meat is sometimes baked in a well-ventilated oven, instead of being roasted in front of the fire.

This is a less wholesome method, as the air in the latter process develops certain flavours which render the joint more appetizing.

For baking, a special double tin should be used; the lower one is filled with water which prevents the dripping from burning.

The meat should be placed on bars, resembling part of a gridiron, in the upper tin to avoid getting sodden in the melted fat.

Neither roasting nor baking is an economical method of Cookery because:

1. The best joints must be used.
2. A bright clear fire should be kept up.
3. Considerable loss in weight, about 5 ozs. in the lb., takes place, from the melting of the fat and the evaporation of water.

II. Boiling.

§ 93. *Boiling* is cooking by immersion in water at a temperature of 212° Fahrenheit.

When water is heated, the air in the water and the steam shoot up in the form of bubbles.

These break beneath the surface of the water and the rising steam in the bubbles is turned again to water (condensed).

As the whole of the water becomes hotter, these bubbles rise higher and at last break on the surface of the water.

In this process of Cooking the principle on which the heat should be applied is exactly the same as in baking and roasting. The temperature should be high to begin with—212° Fahrenheit—to be succeeded by a lower one, 185° Fahrenheit, simmering point. If the water be allowed to boil the whole time, the protein in the meat will harden and render it tough and tasteless.

To ascertain that the water is at the right temperature, notice whether the surface of the liquid bubbles only at one point, near the edges.

With a still surface there is too little heat, with a bubbling one too much.

Fresh meat should be wiped and weighed before cooking, and 20 minutes to the lb. and 20 minutes over allowed.

Salt meat should be put into cold or lukewarm water, and gradually brought to the boil to draw out some of the salt.

Salt increases the density of water and raises the boiling point to 224° Fahrenheit.

Boiling is only suitable for the best joints; about 4 ozs. in the lb. are lost during the process.

The water in which fresh meat has been cooked should be kept, as it contains a certain amount of goodness from the meat. It is usually called "Pot Liquor" and forms a valuable basis for soups and gravies.

Steaming is cooking in the steam or vapour arising from boiling water.

In steaming the bubbles break beneath the surface and the steam is turned to water again at a temperature of about 185° Fahrenheit.

This is an economical and digestible method of preparing food, as none of the goodness is lost, and is especially useful in cooking Fish and Puddings.

Longer time must be allowed than for boiling.

A kettle of boiling water should always be at hand to replenish the water if an ordinary Fish Kettle or Steamer be used.

Steamers are now constructed in separate compartments, one above the other, so that several courses can be prepared at once.

III. Stewing.

§ 94. *Stewing* is cooking meat very gently in a covered pan with a little liquid.

In stewing the object is not to shut in the juices of the meat, but to extract them that they may flavour the gravy and vegetables of which the stew is largely composed.

Stewing may be carried on in an ordinary iron stew-pan, in a double pan known as a *bain-marie*, or simply in a covered earthenware jar. A *bain-marie* may be readily improvised by standing a jar in a saucepan of water.

Stewing is the most economical way of cooking, as the cheaper parts of meat may be used, but little fire is needed, and all the juices are either in the meat or in the gravy.

Vegetables or dumplings may be added, which render the stew more tasty and satisfying.

There are two classes of stews:

1. That in which a gravy or sauce is first made by frying vegetables and flour in hot fat and adding liquid before putting in the meat.

Example. Exeter Stew.

2. That in which the meat and vegetables are cooked together with the addition of stock or water, forming their own gravy.

Example. Irish Stew.

In stewing the protein is gently set, the juices are partly extracted and the fibres of the meat are softened.

IV. Frying.

§ 95. *Frying* is cooking in hot fat at a temperature of 380° Fahrenheit.

This temperature is of great importance and varies within certain limits according to the nature of the food to be cooked; such things as whitebait and chipped potatoes requiring a temperature of 400° Fahrenheit.

There is very little difficulty in recognising the heat required for ordinary frying purposes.

The surface of the fat should be smooth and still, bubbling denotes the presence of water, and until this has been driven off the fat will not be ready.

Then a faint blue smoke should arise all over the pan, and this denotes that the temperature of 380° Fahrenheit has been approximately attained.

Another method is to throw in a piece of dry bread, if it crisps and browns the fat is ready for use.

There are two kinds of frying:

1. *Dry Frying.* When only enough fat is used to cover the bottom of a shallow pan and to prevent sticking; it is used for pancakes, sausages etc.

2. *Wet Frying.* When the saucepan is half full of fat. For this a stew-pan 4—5 inches high and 7—8 inches across is required, into which a frying basket should fit.

The best frying mediums are olive-oil, dripping, butter, lard, albene.

The stew-pan should be two-thirds full and about 3 lbs. will be required for one 8 inches in diameter.

The fat, if properly treated, can be used over and over again; it should be left to cool a little after use, then carefully strained and put aside. From time to time this fat may be clarified.

Frying in deep fat is not an extravagant process: pieces of fat from the meat can be kept, rendered down and used for this purpose.

The preparation for frying is very various.

The food may be lightly floured, dipped in batter or rolled in egg and bread-crumbs.

When things are fried in a basket and in deep fat, lift out the basket and let them drain, and then remove them as quickly as possible and lay them on crumpled kitchen paper.

If this part of the process is neglected the food will look and taste greasy.

In frying bacon, the pan should be heated before the rashers are put in.

A frying-pan should never be washed, but wiped out carefully with pieces of soft paper.

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§ 96. *Broiling* or *Grilling*. Broiling resembles Roasting and is cooking by radiant heat; it is only used for small pieces of meat, such as chops and steaks.

The fire should be bright and clear, without smoke or flame.

One method is to hang a gridiron in front of the fire; but the result is not the same as when the gridiron is placed about four inches above a bed of glowing coals.

The gridiron should be heated, then slightly greased, the meat is held close to the fire for two minutes, then turned between the blades of two knives and the other side exposed to the heat for two minutes, it should then be turned every two minutes until cooked. It takes from 10 to 15 minutes, but depends greatly on the thickness of the chop or steak, and whether it is required well or underdone.

Braising is partly stewing, partly roasting. It is a suitable way of cooking small pieces of meat and tasteless joints of veal.

Special braizing pans are constructed with a sunk lid to hold hot charcoal so that both bottom and top heat may be applied; but an ordinary stew-pan will answer the purpose.

The meat to be braized should be placed on a bed of vegetables (carrot, turnip, onion, celery, bouquet garni) with enough stock to nearly cover the vegetables; the lid should fit the pan closely and be shut in over a sheet of buttered paper. The whole should simmer gently for about two to three hours, the meat being occasionally basted with a little of the gravy.

When the meat is done, take it out and place in a baking tin, brush over with a little butter, or glaze and let it brown in the oven.

Braised meat is generally larded with strips of fat bacon.

Re-Heating Cold Meat. Meat warmed up is more nourishing and digestible than cold meat, and can also be made to go much further.

Special attention should be paid to its preparation, and it is necessary to remember that the meat has already been cooked.

Underdone meat is more readily and tastily re-heated than dry, over-cooked pieces.

The gravies and sauces used in the concoction of the dishes must be *thoroughly cooked* and well-flavoured.

They should be carefully prepared and the meat only heated through, never allowed to boil.

While re-heating, meat should be protected from the direct action of the fire, and this can be accomplished by covering it with a sauce,—egg and bread-crumbs, batter, or with pastry or potato crust.

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§ 97. *Stock Making.* Stock, which is the foundation of all soups in which meat is used, is an infusion obtained by simmering meat, bones and vegetables in water.

The object is to soften the fibres of the meat and extract all the goodness of the bones by gradual cooking.

In preparing Stock, the bones should be broken up and the meat cut into small pieces and the whole placed in a pan, covered with cold water and brought gradually to the boil.

Vegetables and herbs may then be added and the whole simmered for four hours, carefully skimming from time to time.

The Stock should then be strained and left till cold when the fat can be easily removed.

The bones can be used again with fresh vegetables until they present a porous appearance, which denotes that the goodness has all been extracted.

In hot weather turnips should be avoided in Stock making, as they are apt to turn it sour.

Stock should never be left to get cold in the Stock-pot, but emptied into a basin and the pot carefully cleaned and dried.

There are four classes of Stock:

1. Brown Stock, made from beef and mutton.
2. White Stock, made from the bones of chickens, rabbits, veal.
3. Fish Stock, prepared from the bones and trimmings of fish.
4. Game Stock, made from the carcases and bones of any kind of game.

In all kinds of cooking stock is a necessity, and a supply should always be at hand.

The cost depends on the management of the person in charge of the kitchen; a good manager will always keep the stock-pot going and there are certain things which should always be set aside for this purpose.

Bones of meat, poultry or game, cooked or raw trimmings of raw or cooked meat, feet of sheep and lambs, necks, gizzards and feet of game and poultry, rind and trimmings of tongue and ham, water in which fresh joints or fowls have been boiled, known as "pot liquor."

Soup is a light, nourishing, economical form of food, easy of digestion and may be prepared from vegetables, milk, etc., without Meat Stock.

Beef Tea is not a soup in the ordinary sense of the word, but it may be reckoned in the preparation of Stock.

It is generally known as an extractive and is no longer regarded as a food; it acts as a *stimulant* and lessens the waste of tissue.

Beef Tea in the form of jelly is a no stronger nutrient than that given in the liquid form.

The stiffening or "setting" power is due to gelatine, a nitrogenous substance obtained through the slow boiling of bones, muscle, skin of animals or fish.

Isinglass, considered the purest form of gelatine, is obtained from the floating bladder of the sturgeon.

Although gelatine is classed as a nitrogenous product, it should not be looked upon as a Food. It prevents waste of tissue and contributes to nutrition when mixed with a due proportion of other products, such as milk, cream, etc.

In preparing Beef Tea with great care, as much as 6 % of the nutritive value of the meat may be retained, but as usually made, it hardly contains 3 %; it is erroneous to look on meat extracts as foods, they should be regarded as tonics and adjuncts to most other forms of nourishment.

CHAPTER XII.

The Teaching of Domestic Economy.

§ 98. The teaching of Domestic Economy is governed by general principles, and in a well thought out lesson on Cookery or Laundry manual dexterity and instruction should go hand in hand, thus supporting and helping each other.

Both the Science and Art of Education should have been thoroughly studied before any branch of teaching is taken up; it is only proposed here to present a few notes of lessons and blackboard sketches, as a practical application of the Science and Art of Education to the various subjects embraced under the title of Domestic Economy.

In the first place the teacher must bear in mind that, in these subjects as well as in others, he must not "only understand how to impart knowledge and dexterity, but also how to impart them both in such a manner that they may make for the mental development of the pupil."

Mind and body are closely interdependent, therefore in the arrangement of a lesson both should be considered.

The three special points to be impressed are :—

1. The cultivation of observation.
2. The cultivation of memory.
3. The formation of new ideas.

The subjects and methods of teaching must be adapted to the stage of mental development reached by the pupil, nor should physical surroundings be forgotten. The intimate association of brain and mind should never be lost sight of, nor the fact that the faculties of a growing body increase in power day by day.

It should ever be borne in mind that in order to give a successful lesson the *attention* and *interest* of the pupils should be secured.

Interest is "one of the most powerful agents which the teacher can employ to stimulate mental activity and train the attention."

Inattention in a class is often the fault of the teacher, and every effort should be made to remedy the defect.

To secure this object the teacher must himself be interested in the lesson, be ready to vary it, have a bright sympathetic manner, and know how to cultivate and develop the faculties of the children.

Attention, like other faculties, can only be attained by exercise, and each effort tends to make the next easier, thus the habit is gradually established.

The two methods of giving a lesson are :—

I. By *telling*—lecturing—instructing.

II. By *questioning*—leading the class to enquire and discover.

I. The first method is used for imparting fresh knowledge at a Demonstration Class, the second is used during all parts of a lesson.

In giving fresh information at a Demonstration Class, it is necessary to secure the interest and co-operation of the pupils, and the following ways as a rule are found most successful :—

A. By illustration.

B. By use of the blackboard.

Illustration.

A. The teaching of Domestic Economy affords many facilities for **Illustration.**

1. **The object itself.** The actual material can be shown.

Example. In a lesson on bread-making to children in Standard IV. samples of the various cereals may be shown, the varieties of flour, the action of yeast, etc.

2. **Pictorial Representation.**

Example. A picture may be displayed.

To a more advanced class in the same subject diagrams of starch-grains may be used, showing their varying forms in different plants.

3. **Description.**

Example. A verbal picture suitable only for older children, by which a graphic account of the various processes concerned in the conversion of wheat into the different kinds of flour can be related.

B. **The use of the Blackboard.**

Blackboard.

This is a very important part of a lesson and should never be omitted.

A blackboard sketch should display an epitome of the lesson given, and sum up in a short, concise manner the various points emphasized.

The blackboard appeals to the eye; by it a teacher can illustrate a lesson with drawings and enforce the meaning of technical terms, etc. It is absolutely essential to a lesson, and where not provided, a piece of American cloth or a sheet of brown paper will make effective temporary substitutes.

Questions.

II. The second method, **Questioning**, falls into three parts:

A. **Experimental Questions.**

These are used at the beginning of a lesson to find out if there is any previous knowledge.

B. Educative Questions.

These are used throughout a lesson.

They should be framed in simple language, clear and to the point, and be so constructed as not to require "Yes" or "No" for answer.

Let the questions be arranged in a definite order, and let that order be **progressive.**

Start with the first fact, and let the questions depend one upon the other like stones in an arch.

C. Examinative or Test Questions.

These questions are used towards the end of the lesson for the purpose of recapitulation.

They test the thoroughness of the teaching and, if well directed, have the advantage of impressing the lesson upon the minds of the pupils in a clear, consecutive, orderly manner.

Preparation.

No lesson can be efficiently given without careful *preparation*; the amount must depend on the skill and experience of the teacher.

Notes of lessons should be drawn up, and the key-note of a course should be *continuity*.

Notes of Lessons.

In giving a course in Domestic Economy it is possible to ground each lesson on a preceding one. A few well-directed questions at the beginning of a fresh class will serve to stimulate the children's memory and establish a link with the previous lesson.

Notes of lessons are, so to speak, the plan of campaign, which the teacher settles before beginning a course of instruction, so that there may be no failure or confusion.

Notes of lessons are a draft of the lesson in which all the important points, whether of method or matter, are clearly marked.

They should, however, leave the teacher free, as circumstances may arise during the lesson which will render a change necessary.

While actually engaged in the work, a better way of developing a point or overcoming a difficulty may present itself.

Every teacher should prepare his own Notes; those given here are only to indicate lines on which they may be drawn up and developed.

In arranging a lesson it is first necessary to ascertain if there is any previous knowledge; then the facts should be selected and arranged, and the best method of presenting them to the children considered.

To secure a good lesson the teacher will do well to rehearse it privately and try and find out how the facts are likely to strike his hearers. The great object to be attained is not only to impart fresh information, but to induce the class to *work with* the teacher.

To secure this co-operation a *line* of questioning must be thought out.

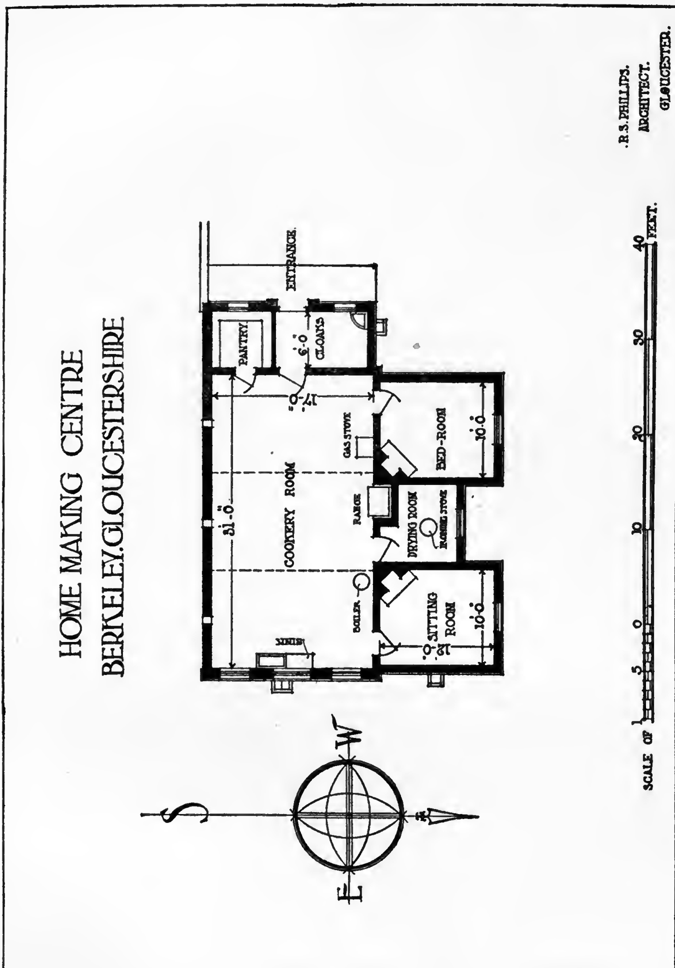
The notes should indicate the mental work the teacher wants the children to do, and what definite information they are likely to derive from the lesson.

Class Management.

The success of a class depends greatly upon the arrangements made for carrying out the work and for the proper exercise of discipline and control.

During the last ten years many alterations have taken place in the teaching of Domestic Economy in the Elementary Schools and much progress has been made. In the first instance it is now usual to provide accommodation for teaching what is known as "Combined Domestic Subjects," i.e. Cookery, Laundry and Housewifery, and when this is the case the Kitchen is fitted up for both Cookery and Laundry, and a sitting-room and bedroom are provided. See plan published by kind permission.

The Code-Schedule III. now allows 18 pupils only in a Class, and for Cookery, Laundry and Housewifery girls should be eleven years old, twelve for combined Domestic subjects. The value of Housewifery as a subject of instruction has been


HOME MAKING CENTRE
BERKELEY, GLOUCESTERSHIRE
ENTRANCE
PANTRY
CLOAKS
COOKERY ROOM
GAS STOVE
RANGE
BOILER
SINK
BED-ROOM
DRYING ROOM
SITTING ROOM
31'-0"
17'-0"
6'-0"
10'-0"
SCALE OF FEET
R. S. PHILLIPS.
ARCHITECT.
GLOUCESTER.
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S
E

more fully recognised, and in addition to its inclusion in the scheme of work known as Combined Domestic Subjects, a preliminary course extending over at least 20 hours is recognised. Home Making Centres have lately been started in various parts of the country, and afford valuable instruction for the elder girls, especially in view of the Memorandum on "Infant Care and Management," lately issued by the Board of Education (1910). The scheme of work provides that the girls are permanently attached to the centre during the last year of School life. Half the School day is devoted to general education, the other half to technical subjects such as Cardboard and Woodwork, Housewifery, Cookery, Laundry, Hygiene and the care and feeding of infants and young children. Attached will be found a syllabus of instruction and as far as possible the technical subjects and those given in general education are correlated. Arithmetic is taught with reference to household budgets, savings banks, etc., the calculations required for Needlework, Woodwork, etc., are included, and the children are taught to feel that the work of carrying on a healthy, happy home is one of the most important factors in their education.

Room.

The room set aside for the teaching of Domestic Economy subjects should be carefully planned. Where only a class-room is available, a little management will enable the lesson to be given satisfactorily.

Education Code.

The Education Code provides that a Cookery Class-room should contain at least 600 superficial feet and 8400 cubic feet, and that it should be so placed that smells from it cannot pervade other rooms. See Schedule VII. 17.

Range.

The question of the range is frequently discussed, but it should be remembered that the one in general use in the neighbourhood should be the one selected.

Now that cooking by gas is so common it is useful, in a town, to supplement the range by a gas-stove on the penny in the slot system; by these means the class can be shown the most economical methods of using both.

The oven should measure not less than 18 inches, and there should be a good supply of hot water.

At a permanent centre pictures relating to the various subjects taught may be hung upon the walls, and collections of different materials in various stages, such as starch, flour, cocoa, tea, soap, etc., will often prove useful in interesting the children.

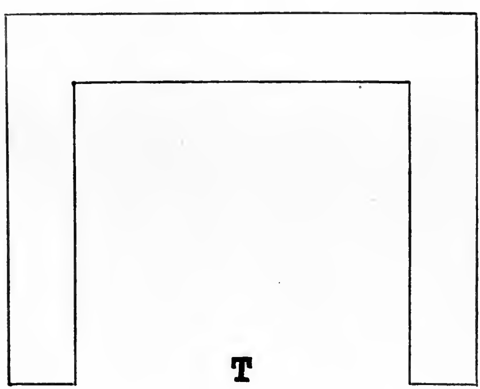
Every Class-room must be provided with a Blackboard, and should be furnished with sloping desks for writing purposes.

Tables.

The table for a Demonstration Lesson must be placed so that the class can see every movement of the teacher, and the range should be fixed at a convenient spot not too far away.

The sink and water supply should be in one corner of the room in full view.

At a Practice Class the arrangement figured below, the tables being placed with the teacher standing at T, gives full control over the pupils, and is a better way than putting them T-shaped or in one long line.



The classes usually last two to two and a half hours, and include both demonstration and practice. The method of taking the lesson depends on the nature of the instruction given; for example when the process being taught is one requiring long and gentle cooking such as stewing, the children prepare the dish as soon as the teacher has prepared hers, the blackboard sketch, questioning and writing being done at a later stage of the lesson.

Length of Lesson.

A teacher of Domestic Economy should be very careful to maintain law, discipline, and order, and the conditions under which the work is performed should be as bright and pleasant as possible.

Order.

Tact and decision are necessary factors in a successful teacher, and it should be remembered that true discipline is a matter of growth.

Steady influence must be brought to bear to induce each scholar to be amenable to the control and discipline which should characterize every class.

[*The Notes of Lessons which follow are given as examples of arrangement of the matter. They are* not *to be regarded as substitutes for the preparation of material by the teacher. Each teacher must devise her own ordering of subject-material.*]

(1) NOTES OF LESSON ON *FOOD.*

§ 99. **Aim.** To show:

I. What Food is.

II. Its classification and constituents.

III. Its absorption.

Time: 45 minutes.

Apparatus. Blackboard: some boiling and cold water: some cornflour or starch: a lump of sugar: a piece of butter: a piece of meat.

I. **Food** is the material taken into the body by which the structures are renewed and the vital processes maintained.

What do you see stokers doing with the engines in the stations?

This water and coal are the food of the engine: without them it could not move.

In the same way, we feed our bodies to give them strength, heat, and movement.

Do we eat only one kind of food?

Several kinds of food are necessary, each for its own special work.

II. There are Three classes of Foods.

Nitrogenous, which include the proteins and gelatine.

Non-Nitrogenous.

(*a*) Carbohydrates, e.g. sugars and starches.

(*b*) Fats.

Salts.

What is the special use of **Nitrogenous** *Foods?*

All living matter contains Nitrogen, therefore to build up living matter Nitrogenous food is needed.

We find this kind of food forming one of the constituents of

1. Meat—Fibrin.
2. Milk—Caseinogen which helps to form the curd.
3. White of eggs—Albumen.
4. Flour—Gluten.
5. Peas and Beans—Legumin.

What work do the **Non-Nitrogenous** *Foods perform in our bodies?*

They chiefly aid protein foods in building up tissues.

This group may be divided into:

A. Starchy Foods—Carbohydrates.

B. Fatty Foods.

Some of these foods are more heat-giving than others.

What do the people in Greenland eat?

What do the inhabitants of hot countries, say India, chiefly live on?

A. Starchy Foods include

Rice, Flour, Potatoes, Sugar, etc.

B. Fatty Foods,

Butter, Suet, Oil, etc.

What is the third class of Food, and what is its purpose in the body?

Salts are represented by

1. *Organic* salts, found in fruit and vegetables.
2. *Inorganic*—common salt.

In addition to these three classes of foods we must place **Water** as necessary to life.

III. How do these various foods become absorbed into the body?

The process of **digestion** is the way in which the food which is solid may be brought into a liquid condition and so enter the blood.

Take some lump sugar, show it to the Class as a solid, then dissolve it in water.

Explain that all food must be made soluble.

Put some starch or a small piece of cooked meat into water; it remains unchanged.

How then is this food to be rendered soluble?

Our bodies contain various juices that act upon different kinds of food, rendering their absorption possible.

Saliva. The saliva in the mouth turns the **starch** into a kind of sugar which dissolves in water.

The experiment with the lump sugar shows how necessary it is to bite food well in our mouths that the saliva may have time to work.

Gastric juice.

The teeth break the **meat** up into small pieces and when it passes into the stomach a juice called gastric juice acts upon it, softening the fibres, rendering them soluble and changing their nature.

Bile.

Drop a small piece of butter into some hot water, what happens?

In the same way in the small intestines a juice from the liver, called bile, causes the **fat** to break up into very small particles and thus aids its passage into the blood.

The blood passes all over the body, feeding the tissues and renewing the different parts worn away by work and exercise.

Recapitulation, and Blackboard Sketch.

(*a*) The Uses of Food:

1. It provides materials for growth.
2. It repairs the waste of the body.
3. It makes new tissue.

(*b*) There are three kinds of Food:

1. Nitrogenous or Flesh-forming.
2. Non-Nitrogenous.
3. Salts and water.

(*c*) 1. Each of these varieties is necessary, or loss of appetite, with defective nutrition, will ensue.

2. To nourish the body solid foods must be made liquid: first, by mastication; second, by digestion.

3. These processes render food soluble and capable of being absorbed into the blood.

(2) NOTES OF LESSON ON THE *PROCESSES OF COOKERY.*

§ 100. **Aim.** To show:

I. Necessity of cooking.
II. The functions of cooking.
III. The chief methods used in preparing food.

Apparatus. Blackboard: an egg: potatoes, one raw, one boiled: some corn-flour: a piece of freshly cooked meat or bacon.

I. In studying the value of food and its use in the body, we have seen preparation to be necessary.

Cooking is the art of preparing food to nourish the body.
It is carried out by the means of **Heat.**

What is the chief source of light and heat?

In old days, and even now in South America, beef and other foods were dried by exposure to the sun.

In winter where does our supply of warmth come from?

In most countries the fire takes the place of the sun for cooking processes.

II. *How may we arrange the results of cooking?*

(*a*) Cooking brings out new flavours.

Contrast a piece of freshly cooked meat or bacon with a piece in a raw, uncooked condition.

(*b*) Makes food digestible.

Show the difference between a raw potato and a boiled floury one.

(*c*) Bursts starch grains.

Experiment with some corn-flour and hot water and explain how the grains burst and run together, forming a sticky paste.

(*d*) Softens hard substances.

Refer again to the cooked and uncooked potato.

(*e*) Sets albumen.

Poach an egg in an open pan and let the class observe the change that gradually takes place.

(*f*) Kills germs of disease.

Specify advantage of boiling milk or water.

III. *What are the usual methods of cooking?*

Roasting, baking, grilling, boiling, steaming, stewing, frying.

How may we arrange these methods of cooking?

We notice two kinds of Heat employed.

(*a*) Dry heat or exposure to the fire.

(*b*) Wet heat or contact with boiling water.

(*a*) Processes of Cookery effected by Dry Heat or radiation.

Roasting, baking, grilling.

(*b*) Processes of Cookery effected by Wet Heat or by contact with hot water or hot fat.

Boiling, steaming, stewing, frying.

Recapitulation, and Blackboard Sketch.

I. Cooking is the means by which food is prepared so as to nourish the body.

II. It is effected by agency of Heat. (*a*) Dry Heat. (*b*) Wet Heat.

III. Its results are as shown above (*a*)—(*f*).

(3) NOTES OF LESSON ON *ROASTING, BAKING, AND GRILLING.*

§ 101. **Apparatus.** An open pan: roasting jack or diagram: an egg.

What is **Roasting?**

Cooking meat before a bright, clear fire.

In small houses, *baking* in a hot oven is generally used instead.

What article of food is largely composed of **Albumen?**

In poaching an egg the transparent, sticky, liquid white became, by the action of *heat*, opaque, smooth, solid. *Albumen* under the influence of heat sets or coagulates.

Meat contains **Albumen** and other Proteins.

In roasting or baking this must be *slightly* hardened on the outside to form a thin coat or covering to keep in the red juices of the meat; great heat is applied for the first ten minutes to effect this and is then reduced.

What kind of fire is required?

The bright, clear fire must be kept up by putting on small pieces of coal at the back.

When roasting is carried on in front of the fire a spit or jack is required.

If possible a jack should be shown and the simple mechanism explained.

After a joint has been before the fire for a few minutes what do we find in the tin below?

This melted fat, or dripping, is used to baste the meat.

By basting we mean pouring hot fat every quarter of an hour over the joint to prevent it from becoming hard and dry.

A joint roasted weighs less than it did when raw, why is this?

Besides the dripping, there is a loss of water in the form of steam, altogether about 5 ounces in the pound.

Only the best joints should be used for roasting and baking.

Time required for baking and roasting depends on the kind of meat:

Beef and mutton: 20 minutes to the lb. and 20 minutes over.

Veal and pork: 25 minutes to the lb. and 25 minutes over.

What apparatus is used for baking?

This tin is made double and the lower one holds water to prevent the fat from burning. The upper tin is furnished with a stand to prevent the meat from getting sodden in the dripping. The baking oven must be well ventilated.

What is another method of cooking by radiant heat?

The fire for grilling must be clear and smokeless and the chop or steak must be turned every two minutes. Grease the bars of the gridiron to prevent sticking.

Points to remember.

The fire should be bright and clear.

Only the best joints can be used.

Recapitulation.

(*a*) There are three ways of Cooking by radiant or dry heat.

1. Roasting, before a clear fire.
2. Baking, in the oven.
3. Grilling, on clear, hot coals.

(*b*) Meat for roasting is first put *near* the fire to set the outer coating of protein matters, then drawn further away.

(*c*) Meat loses about 5 ounces in the lb. through,

1. Melting of the fat—dripping.
2. Loss of water—steam.

(4) NOTES OF LESSON ON *BOILING AND STEWING.*

§ 102. *What processes of cookery are effected by wet heat?*

I. **Boiling** is cooking meat or fish in water.

What substance resembling the white of egg is found in meat and fish?

Is there any difference in the effect of cold or hot water on **Albumen** ?

Repeat here the previous experiment of poaching an egg; at the same time mix some white of egg with cold water and question the children as to the different results.

Albumen dissolves in *cold* water.
It coagulates or sets in *hot* water.

In boiling a piece of mutton should cold or hot water be used?

The hot water hardens the outside Albumen and forms a coat to keep in the juices.

If the meat were kept at boiling point the whole time, what would be the result?

Refer to the experiment of poaching the egg.

Meat simmered slowly should be juicy and tender.

When the juices are required to be drawn out, as in stewing or soup-making, should cold or hot water be used?

The cold water dissolves the Albumen and draws out the nourishment from the meat.

If instead of fresh meat, a piece of salt meat or fish is to be cooked, what plan of cooking should be adopted?

Cold or lukewarm water draws out some of the salt.

The salt hardens the protein matters on the surface of the meat and the juices are retained.

Time for boiling is a quarter of an hour to the pound and a quarter of an hour over.

Here let the Class reckon out the time required for:

1. A piece of mutton for boiling weighing 5 lbs.
2. A piece of salt beef weighing 7 lbs.

What is the name of the water in which meat has been boiled?

Pot Liquor, which should be kept for soups and gravies.

The second process of cooking draws out the juices; what is it called?

II. **Stewing** is cooking meat very gently for a long time in a covered pan, in moderate heat.

In roasting and boiling what was the action of heat on the albumen in the meat?

In **Stewing** the juices should be extracted.

Should hot or cold water be used in the process?

Cold water brought gradually to the boil softens the fibres and makes the meat tender.

This process is the most economical, because

1. The cheaper part of meat can be used.
2. Little fire is required.

What vessel is generally used for stewing?

Here show an ordinary stew-pan with tightly fitting lid.

Everyone does not possess a stew-pan; what can be used instead?

An earthenware jar makes an excellent substitute. It should be covered over and placed in a pan of boiling water or in a slow oven.

The water must boil, but not the stew.

N.B. 'Stew boiled is Stew spoiled.'

Recapitulation, and Blackboard Sketch.

I. **Boiling.**

Fresh Meat should be placed in boiling water for the first ten minutes:

1. To set the albumen.
2. To keep in the juices.

Salt Meat may be put on in lukewarm water and brought slowly to the boil.

After the first ten minutes the meat should simmer *only*.

Time *for boiling:*

$\frac{1}{4}$ hour to the lb. and $\frac{1}{4}$ hour over.

Pot Liquor is the name given to the water in which meat has been cooked.

II. **Stewing** is long, gentle cooking in a covered pan with a small quantity of liquid.

1. It draws out the juices.
2. It makes cheap pieces of meat tasty and nourishing.
3. It saves time—requires very little attention.
4. It saves fuel—only a small fire is needed.

(5) NOTES OF LESSON ON *FRYING.*

§ 103. The second process of cooking by wet heat is by contact with hot fat.

What is the name of this method of cooking?

Heat some fat in a pan, explain that the spluttering is due to the water in the fat.

When the fat is quiet, put in a piece of bread.

Let the class count 60.

If the bread is brown at the end of that time the fat is hot enough.

or,

Point out the faint blue smoke rising all over the pan; this shows that the fat is at the right heat.

There are two kinds of frying, known as

1. **Dry Frying.**
2. **Wet Frying.**

1. **Dry Frying** is so called when there is only enough fat to cover the bottom of the pan.

What is fried in this way?

2. Frying is called "wet" when the stew-pan is about half full of fat.

Rissoles and fish are fried in this way.

It is an economical method of frying because the fat can be strained and used over again.

When meat was roasted why was great heat applied for the first ten minutes?

To retain the juices in the process of frying, the food to be cooked is covered with flour, batter, or egg and bread-crumbs.

Frying is not a method of economical cooking, as only the best pieces of meat and fish can be used, and a quick, hot fire is needed.

If this lesson is given last, it is well to recapitulate, questioning the various processes from the children.

Points to remember.

1. The fat must be smoking hot.
2. Food to be fried must be dry.
3. Things fried must be drained on crumpled paper.
4. Fat should be strained and poured into a jar when finished with.

Recapitulation: Blackboard Sketch.

Frying is cooking in hot fat.

Two kinds of frying:

1. Dry frying—in a shallow pan with a little fat.
2. Wet frying—in a deep pan half full of fat.

Completed Blackboard Sketch.

I. **Cooking** is a necessity:

1. Without cookery civilized nations would starve.
2. Monotony of method would injure the digestive organs.

II. Cooking may be considered under:

A. The effects of cookery.

1. To develop new flavours.
2. To render food digestible.
3. To burst starch grains.
4. To set albumen.
5. To soften hard substances.
6. To kill germs of disease.

B. Processes by which this is effected:

1. **Radiant Heat:**
   Roasting, baking, grilling.
2. **Wet Heat:**
   Boiling, steaming, stewing, frying.

Special Points.

(*a*) Albumen coagulates or sets with heat.

(*b*) A high temperature renders it dry, hard and horny.

(*c*) Cold water dissolves albumen.

(*d*) When the meat juices are to be retained, the albumen should be allowed to set and form a coat.

(6) NOTES OF LESSON ON *STARCH.*

§ 104. **Aim.** To show what Starch is.
Its use as a Food.

Apparatus. Blackboard: corn-flour: sugar: water, hot and cold: diagrams of starch grains.

I. **Starch** is found in most plants, such as wheat—rice—potatoes—arrowroot.

Have you ever seen starch used? What does it look like?

This white glistening powder is made up of numbers of tiny granules or grains, each having a different shape, varying with the plant to which it belongs.

Here show diagrams of potato starch, rice starch, point out the difference in shape.

II. *Mix some starch with cold water and let it stand. What has happened to the starch?*

We see that starch will not dissolve in cold water. It is said to be insoluble.

Make some paste by pouring boiling water on the starch.

What has happened to the mixture?

Thus in warm water thickening is caused by the bursting of the walls of the starch cells, which have run together and form a paste.

Therefore, Starch mixed with boiling water becomes digestible.

To which class of Foods does starch belong?

In hot countries, such as India, Rice forms the principal article of diet, being less heating than fatty heat-givers.

Melt some sugar in water and contrast it with the starch and water.

What is the difference between the two?

Sugar is Soluble.
Starch is Insoluble.

III. Starchy Foods can be changed into a kind of sugar and rendered soluble.

1. By **Heat**—Crust of bread—Biscuit.

2. By the process of **Digestion**—in the mouth and small intestine.

Why should starchy food not *be given to young infants?*

Starch cannot be rendered soluble without the action of a certain ferment in the saliva of the mouth.

This is not present until a child is six months old.

Starch acted upon by *dry* heat, such as baking, is more soluble, example:

Biscuit 'twice cooked,' Baked Flour, etc.

Recapitulation and Blackboard Sketch.

1. Starch is obtained from Wheat—Rice—Potatoes—Sago, and other plants.

2. It is insoluble in *cold* water.

3. When mixed with *hot* water, the granules swell and thicken.

4. Starch is a Heat-giving Food.

(7) NOTES OF LESSON ON *FATTY FOODS.*

§ 105. **Aim.** To show:

1. Their sources.

2. Their food-value and use in the body.

Apparatus or Material: Butter: suet: olive oil: linseed: hot water.

I. We saw that Carbonaceous Foods fall into two divisions.

Question upon the Foods that fall within each of these classes.

We now consider the sources from which these Fatty foods are derived.

These sources are:

(*a*) Animal. (*b*) Vegetable.

Animal Fats may be arranged thus:

1. Suet, the animal fat generally used, is of two kinds:
   Beef suet—yellow and rich.
   Mutton suet—white and hard.

2. Lard, a pork product.

3. Butter, a milk product.

4. Margarine, an animal fat treated artificially by boiling and colouring.

5. Oil, e.g. from the Cod-fish, or Cod-liver oil.

The above may be obtained by questioning.

Vegetable Fats are the following:

These may be obtained by questioning.

1. Olive oil, from the olive berry.
2. Linseed oil, from the seed of the Flax plant.
3. Castor oil, from the Castor oil plant.
4. Palm oil, cotton-seed oil, etc.

II. There are two classes of Carbonaceous foods.

Which of these produces more heat?

To illustrate the answer, refer shortly to any well-known Arctic voyage; describing the foods used.

Make clear the connection between climate and food.

Now before food can nourish the body it must become soluble.

Is Fat soluble?

Drop a little fat into hot water contained in a glass.

The Class will point out the change in the fat.

Allow the water to become cold, and ask for the difference in the condition of the fat.

Fat must be made soluble.

Mix together fat and soda.
Result: a soapy substance.

Fat can therefore be made soluble, by being broken up and changed chemically, and so can be absorbed.

III. In the human body the work is performed by

(*a*) The Bile—a juice from the Liver.

(*b*) The Pancreatic Juice.

We see then that Fat as food

(1) is rendered soluble by certain juices of the body,

(2) can then be absorbed by the digestive tissues into the blood,

(3) and is a source of heat to the body.

Recapitulation and Blackboard Sketch.

Fatty Foods are non-nitrogenous.

There are two kinds of Fat:

Animal, such as Suet, Lard, Butter, Margarine, Fish oil.

Vegetable, such as Olive oil, Linseed oil, Palm oil, etc.

Fats and **oils** are largely eaten in cold countries to give heat to the body.

Fat is prepared for absorption by

1. The Bile from the Liver.
2. The Pancreatic Juice.

(8) LESSON ON *CLOTHING.*

§ 106. **Aim.** To show the best kind of Clothing materials.

Apparatus. New flannel: cocoon of silk and a piece of silk: cotton yarn: linen threads.

Name some of the materials used for clothing.

Which is the one chiefly used in winter?

Where does wool come from?

At what time of the year is it cut from the sheep's back?

I. Flannel.

The processes gone through in manufacturing wool into flannel are:

1. Washing—to cleanse thoroughly.
2. Pressing—to squeeze out the water.
3. Combing—to get the fibres smooth and straight.
4. Spinning—twisting into yarn or threads.
5. Weaving—making up into a piece of material.

Flannel is:

1. White
2. Soft
3. Light
4. Strong
5. Warm

} *Illustrate these properties by showing a piece of new flannel.*

II. Silk.

What material comes next to Wool in non-conducting properties?

Silk is the only animal *textile* fabric.

What is the name of the insect that produces silk threads?

Question the Class as to whether any of them have kept or seen silkworms.

Show pictures or draw diagrams of eggs and cocoons. Show some raw silk.

The raw silk is spun into threads.

Why are threads spun?

Experiment:—Let a scholar take a single thread and break it—Thread too fine to have any strength—Let two girls twist several threads into one string.

Show increased strength.
The threads are woven into pieces of silk.

Silk is,

1. A bad conductor of heat.
2. Does not shrink.

III. Cotton.

What material comes after Flannel and Silk as an article of clothing?

Calico is made from the Cotton plant.

What part of the plant produces the Cotton?

The seed pod bursts and shows a ball of white threads.
This is spun and woven like the silk.

Refer to experiment with silk threads and if necessary, repeat with cotton.

Show specimens of raw cotton and cotton yarn.

Calico is,

1. A good conductor—Bad property for clothing.
2. Durable.
3. Washes well.
4. Does not shrink.

IV. Linen.

The next material is **Linen.**

From what plant do we get Linen?

Flax has a thin stem and bright blue flowers, the seeds are known as **Linseed.**

Linen is made from the stem of the plant.

What is done to Wheat when gathered?

Flax stems are tied in bundles in the same way, soaked in water, and the fibres or threads beaten out, the long ones separated from the short ones.
These threads are spun and woven into Linen.

Refer to the spinning of cotton and silk.

Take a piece of calico and a piece of linen, compare the two, question the Class as to any difference.

1. Linen is stronger than Cotton.
2. It is colder than Calico.
3. Cotton is "fluffy" to the touch.
4. Linen is smooth.

Blackboard Sketch.

Chief materials used for Clothing are,

1. **Flannel**—a bad conductor, made from the wool of the sheep.

2. **Silk**—made from the threads spun by the silkworm.
3. **Calico**—manufactured from the cotton plant.
4. **Linen**—made from the stem of the flax plant; a good conductor of heat.

Clothing worn next the skin should be

1. A bad conductor.
2. A good absorbent of moisture.

(9) LESSON ON *SOME HYGIENIC RULES OF DRESS.*

§ 107. **Aim.** To show:

1. Necessity of changing Clothes.
2. Rules for wearing Clothing.

Apparatus. Blackboard: Diagram of body affected by tight clothes: a piece of black and of white material: eau de Cologne.

I. *What happens to clothes that have been worn?*

Underclothes become soiled and dirty from

1. Contact with the skin.
2. Perspiration from the body.

Outer garments get soiled from touching dirty things, from smoke, from dust in the air.

What should be done with soiled clothes?

Besides being washed, they should be aired.

What is meant by airing?

Unless clothes are thoroughly dried, they strike cold to the body and drive the blood back and a chill ensues.

Experiment with some eau de Cologne or salvolatile on the back of a warm hand.

Clothes that are worn by day should not be slept in at night.

All clothing and especially bed-clothes should be hung up and exposed to the air.

II. *Are light or dark clothes most worn in summer?*

Light clothes take in—absorb—less heat from the sun than dark ones, in the winter then we wear dark stuffs.

III. Tight clothes deform the body.

What happens to the feet when boots or shoes pinch?

The feet grow out of shape, and other parts of the body do the same.

Tight lacing presses on the internal organs, such as the lungs—breathing apparatus—liver, etc.

The body gets out of shape and breathing is short and difficult.

Tight garters prevent the blood from flowing properly and varicose veins are formed.

Blackboard.

1. Underclothing should be frequently changed and washed.
2. All clothing should be aired.
3. Light clothes are cooler in summer than dark ones.
4. Tight clothes deform the body.

(10) SUMMARY OF LESSONS ON *CLOTHING.*

§ 108. **Clothing** is a Necessity.

1. Without clothing, there is loss of heat.

2. Without the protection of clothes, injury to the body.

Clothing.

a. Keeps *in* the heat of the body.

b. Keeps *out* the heat of the sun.

Kinds of Clothing.

1. Bad conductors of heat.
2. Good conductors of heat.

   1. **Bad-conductors**: Fur, Flannel, Silk, Wool.
   2. **Good conductors**: Cotton, Calico, Linen.

Special Points to be pressed home:

a. Underclothing worn next the skin should be a **bad-conductor** and **absorbent.**

b. Light clothes keep *out* the heat of the sun.

c. Tight clothing deforms the body.

d. Clothes should be frequently changed.

e. After washing clothing should be thoroughly aired.

(11) NOTES OF FOUR CONSECUTIVE LESSONS ON *VENTILATION.*

Lesson I.

§ 109. **Aim.** To show:

1. The necessity for air.
2. The principles of true ventilation.
3. The chief systems in use, and how they fulfil those principles.
4. Special points with regard to class-rooms, dwelling-houses, etc.

Apparatus. Blackboard: lime water: tumbler: glass tube: clear glass bottle: candle: matches.

In learning about food values and food preparation, what article of consumption have you found to be most necessary?
How does water affect digestion and circulation?

It plays an important part in each.

So-called fasting men and women are allowed **water**, and it is this enables them to fast for a great length of time.

But we have a third great need, greater moment by moment than food or water. **Food** we may do without for three weeks; **water** we may do without for three days; but we could not live for three minutes without **air.**

Respiration, i.e. breathing **in** and **out**, takes place 15 to 17 times a minute; life ceases if this is not carried out.

Of what does air consist?

Ordinary air consists of:

Nitrogen, 79 parts,	} 100 parts.
Oxygen, 21	
Faint trace carbonic acid gas	

Which of these gases is essential to life?

Air from which oxygen is expelled cannot maintain life.

Example: **Drowning** is death from oxygen-starvation, although water contains some air and therefore some oxygen.

Fish placed in water recently boiled, die. Why?

In 1848 the Londonderry sailed to Liverpool with 200 passengers. Bad storm, to ensure safety, captain ordered all passengers below.

Steerage passengers in very small cabin; door tightly fastened on the outside.

First great discomfort, nothing more.

Presently to prevent inrush of water to this cabin, captain ordered large sheet of tarpaulin to be securely fastened *over the entire entrance.*

A scene of frenzy ensued: the wretched prisoners struggled and fought in useless efforts to escape.

The storm drowned the noise of their shrieks.

When the doors were finally opened 73 already dead, many others dying.

What was the cause?

Want of oxyen *one* cause, but *not* the chief.

What other cause?

Experiment. Show two filled bottles.

What difference, if any, between these bottles?

Both contain clear, clean water and look alike.

They look alike, but one contains clear water.

The other contains clear lime water.

If possible let the teacher or a scholar, in sight of the Class, hold the bottle of water out of a window, pour out the water and at once rapidly draw the bottle horizontally through the air and cork it.

Ask Class what it now contains.

Air, *where from?* Out of doors.

Add a little lime-water (not half full).

It now contains lime-water and air.

Shake vigorously. *Any change visible?* No change.

Pour lime-water into a tumbler: breathe into it through a tube.

Any change? Lime-water quite milky.

If a saucer of lime-water stands in a room, with the doors and windows closed, occupied by several people, in a few hours the lime-water will turn milky in the same way.

What do these experiments show?

Breathed air undergoes a change.

How can you find out if foods contain starch?

As iodine is a test for starch, lime-water is the test for carbonic acid gas, the turning of the lime-water milky proves the presence of carbonic acid gas.

Of which gas is there an excess in breathed air as compared with ordinary air?

It has gained carbonic acid gas and lost oxygen during respiration.

Expired air consists of:

Nitrogen,	80 parts,	= 100 parts.
Oxygen,	15	
Carbonic acid gas,	5	

Near Naples there is a cave or grotto which contains great quantities of carbonic acid gas. Men walking upright may enter and feel little or no discomfort. A dog drops instantly unconscious, and if not quickly withdrawn soon dies. So too would a man entering on his hands and knees.

What two things does this show?

Carbonic acid gas destroys life.

Carbonic acid gas is much heavier than air.

Now can you tell the causes of death on board the Londonderry?

1. Insufficiency of oxygen,

2. Excess of carbonic acid gas.

Besides carbonic acid gas, expired air contains organic or animal refuse matters proved by experiment to be deadly poison.

These decaying matters are being constantly thrown out,

A. By the lungs.

B. In moisture and vapour from the skin.

Excess of carbonic acid gas charged with organic refuse has evil effects even if life is not destroyed.

It 1. Causes languor, giddiness, headache, etc.
2. Makes the face pale (blood not oxygenated).
3. Lowers vitality and increases liability to disease.

Each adult gives out 14 to 19 cubic feet of carbonic acid gas besides organic matter in 24 hours.

What therefore happens in dwellings and places,

(Concert-halls, theatres, churches, chapels, work-rooms), *where many people gather together?* Air rapidly fouls, gets bad.

Rooms must be ventilated, fresh air brought in.

Blackboard Sketch.

Air is necessary to life (because):

1. Without air man starves for want of oxygen.

2. Without change of air, man is poisoned by the (*a*) carbonic acid gas in the air; (*b*) refuse organic matter.

LESSON II. VENTILATION *continued.*

§ 110. **Aim and Apparatus**, as in Lesson I.

What is ventilation?

Bringing in *fresh* air.

True ventilation a double process: it must constantly supply fresh, pure air and constantly remove used up and impure air.

This is the principle or law of pure ventilation:

1. Letting *in* pure air.
2. Letting *out* bad air.

What difference besides impurity is there between carbonic acid gas and ordinary air?

Carbonic acid gas is 52 per cent. heavier.

Where ought the **outlets** *to be?*

Near the floor.

A good answer *if it squares with all the facts.*

Explain that wherever combustion takes place carbon and oxygen combine and carbonic acid gas is given out.

Example. Bright fire burning, *where do the gases and smoke go?*

This effect is in obedience to what great natural law? Heat expands air, which becoming lighter ascends.

What do you feel if you breathe into the palms of your hands?

Heat.

Why is expired air hot?
What is the normal temperature of the body?

The blood of the inner organs, such as the heart, is even a little hotter.

Expired air comes direct to the lungs from the heart, and experiments prove *exhaled* air at the moment of expiration to be *no heavier than pure air at temperature* 90° Fahrenheit.

What is the usual temperature of an ordinary dwelling room?
What then happens to the air we expire?
Where should the outlets for it be placed?

Stand on a chair or table in a closed or ill-ventilated room containing several people, and the upper air will feel much hotter and be much more stuffy.

Galleries in theatres or churches afford other illustrations.

If in a room with a fire burning, the windows and doors closed, a lighted candle is held in front of the keyhole, or by the side of the door, you will see that air rushes in and extinguishes the candle or bends flame towards the fire.

Why?

Some of the hot spent air we exhale rises to the ceiling, but where there is an open fire-place much is sucked into the strong draught of heated gases passing up the chimney, fresh cold air rushing in at every crevice to supply the place of the hot air withdrawn.

Where should the **inlets** *be?*

Inlets near the floor would be the most effective, because fresh pure air rushing in at the lower part of a room creates a stronger draught and helps more rapidly to drive up and out the impure air.

Can you tell me any reason why **inlets** *should not be near the floor?*

Inlets must not be so low as to cause draughts and chills to the feet and body.

The same great principle—hot air rising and cooler air rushing in to take its place—causes the circulation of the air, breezes and winds, in nature's great ventilating system.

Blackboard Sketch.

True ventilation has a double action:

It 1. Brings *in* fresh pure air.

2. Drives *out* spent bad air.

Inlets about 5 feet above the floor.

Outlets near the ceiling.

LESSON III. VENTILATION *continued.*

§ 111. **Apparatus and Aim,** as in Lesson I.

Ventilation is of two kinds:

1. Natural.
2. Artificial.

Natural Ventilation is produced by the ordinary and natural interchange of air when windows, doors, and other openings are utilized.

Artificial Ventilation is produced by the help of heating apparatus or mechanical contrivances either for forcing air in, or sucking it out.

There is no hard and fast distinction between the two, but the nearer a system conforms to Natural Ventilation, the simpler and more effective it is as a rule.

Some chief features are:

A. By the windows.

1. Costless ventilation.

Raise the lower sash, fill open space by block of wood: air enters between the two sashes, the upward direction imparted diffusing it steadily through the room without perceptible draught.

2. Window itself can, and should be, thrown widely open at intervals to flush the room.

3. Lower the top sash and fasten zinc gauze across the open space. Air is diffused through gauze and an upward current admitted between the sashes.

4. An upper pane of a window is hinged to fall forward with side shields of glass to prevent down draught. Current is *upwards.* Often used in schoolrooms, churches, etc. Or upper pane of a window may be pivoted to swing like a looking-glass, but this is draughty in windy weather.

5. **Louvre** Ventilators.

Parallel slats of glass (like a Venetian blind) inclined upwards to direct the current of air.

Windows are *mainly* serviceable as *inlets*, with which separate exits near the ceiling should be combined.

B. By the walls.

1. **Tobin's Tubes.** Circular or oblong tubes 5 or 6 feet high, fixed against the inside wall of a room.

Outside air enters the tube through a grating in the wall at the floor level, current flows upward and diffuses gradually; there is little or no draught. Size and number of tubes should depend on the size of the room, and number of persons usually occupying it.

This is a good system for schools.

2. **Sheringham's Valves.**

An iron box fixed in the wall, the back of the box a grating through which the outside air enters freely. In front a valve on the same principle as a hinged window pane.

C. By ceiling and chimney.

1. **Ceiling outlets**, by which hot, foul air enters a shaft leading sideways to the open air, or a vertical shaft through the roof surmounted by a cowl to prevent down draught through the wind.

2. The chimney forms the best means of escape for foul air.

Every room should have an open fire-place. A bedroom chimney should *never be closed* or boarded.

There is an up-current as a rule, even when there is no fire.

When a fire is burning, 5000 to 15000 cubic feet per hour pass up the chimney, which thus becomes a powerful extraction shaft.

3. **Arnot's Valve.** Exit into chimney flue.

This consists of an iron box fixed into the wall of the chimney, near the ceiling, and fitted with a light metal flap to swing open towards the chimney, but not towards the room; thus providing an exit for foul air to pass into and off through the chimney.

Disadvantage. The metal valve is noisy in windy weather.

4. **Boyle's Ventilator.** This is on the same principle, but substituting thin talc or mica plates for the metal flap.

Disadvantage. The plates are almost too sensitive, they are affected by the least current and are not very durable.

Blackboard Sketch.

Ventilation is of two kinds:

1. Natural.
2. Artificial.

1. **Natural Ventilation** is produced by the ordinary and natural interchange of air when windows, doors, and other openings are utilized.

2. **Artificial Ventilation**: by means of hot air or mechanical force.

Chief Systems.

Inlets. Doors and windows.
Hinged window panes.
Louvre ventilators.
Tobin tubes.
Sheringham valves.

Outlets. Through the ceilings and roofs:
Arnot's valve, conducting foul air into chimney flue.
Boyle's ventilator.

LESSON IV. VENTILATION *continued.*

§ 112. **Aim and Apparatus**, as in Lesson I.

Special points.

How is air in our rooms spoilt by other means than respiration?

Every form of combustion uses up oxygen, increases carbonic acid gas, therefore air is spoilt by:

1. *Fires* used in heating rooms.
2. Candles, lamps, gas jets, used in lighting rooms.

Fires withdraw much oxygen, give out much carbonic acid gas, but most of the latter passes up the chimney without fouling the room.

Four candles or one lamp spoil as much air as *two men.*

Each *gas burner* spoils as much air as from 3 to 6 men. This must be remembered in ventilating rooms.

The lighting and heating of rooms increase the difficulty of ventilation, except in the case of *open* fire-places, which create a strong draught and carry off the carbonic acid gas.

What is meant by the cubic space of a room?

The length, breadth and height multiplied together.

3000 cubic feet of air per head per hour is a very liberal allowance, though less than $\frac{1}{100}$th part of the allowance provided by nature in the open air.

If 1000 cubic feet of space were allotted per head, then the air should be entirely changed three times per hour.

How would you find the floor space of a room?

The length multiplied by the breadth gives the floor space or superficial feet of a room.

Where space is limited, as in class rooms, frequent and complete change of air by ventilation and flushing must be ensured.

The amount of carbonic acid gas exhaled increases as the human being advances from 8 to 30 years of age.

It is *less* in a child, but:

1. Respiration is more rapid: more oxygen is needed in a given time.

2. The brain in exercise requires more oxygen to do its work.

3. Children are more liable to infectious diseases than adults and a free supply of oxygen helps to destroy the micro-organisms of such diseases.

4. Amongst the poor, persons and clothes are frequently not washed often enough, and so aid in polluting the air.

Bedrooms.

1. Draw the supply of fresh air direct from the open air, and not from the vitiated air of the house through the open door.

2. Open the windows in the early morning to flush out the impurities accumulated in the air during the night, leave them freely open during the day.

3. The incoming air should not pass direct towards the bed.

4. Avoid crowding sleeping or living rooms with furniture: each piece decreases space available for air.

Why should beds be stripped as soon as vacated, and night garments left unfolded for some little time while the bedroom windows are still open?

Blackboard. Special Points.

A. Lighting and heating make ventilation more difficult by:

(*a*) Diminishing oxygen.
(*b*) Increasing carbonic acid gas.

B. Furniture lessens air space.

C. *Ventilation in schools* is especially necessary:

1. Cubic capacity is limited.
2. Confinement long.
3. Respiratory vital processes are rapid.
4. Children more liable to infection.
5. Children often neglected in person and clothing.

Rub out the blackboard sketch and give the Class the following questions to be answered orally or (preferably) in writing.

A. *Where should impure air outlets be placed, and why?*

B. A man holding a child of 2 years old by the hand, walks into the grotto already named.

What would you expect to happen to each, and why?

C. Give the reasons why it is healthier to sleep on a bed 2 feet from the floor than:

(*a*) Upon a mattress on the floor.
(*b*) In a hammock swung near the ceiling.

D. *In what way do lighting and heating affect ventilation?*

E. Give the cubic feet of air and the floor space in:

1. A room 18 feet long; 10 feet wide; 12 feet high.
2. A room 10 feet long; 8 feet wide; 27 feet high.

Completed Blackboard Sketch.

I. Air a necessity:

1. Without air, oxygen starvation.

2. Without change of air, carbonic acid gas and refuse poisoning.

II. **True Ventilation** a double process:

1. Brings *in* fresh pure air.

2. Drives *out* spent foul air.

Governing Law.

1. Hot air rises—**Outlets** through ceiling at highest point.

2. Cold air descends—**Inlets** 5 feet above the floor.

III. A. Kinds of Ventilation.

1. Natural—by free passage of air through *In-* and *Outlets.*

2. Artificial—by use of hot air or mechanical force.

B. Chief Systems.

Inlets. Doors and windows.
Hinged panes.
Louvre ventilators.
Tobin's tubes.
Sheringham's valves.

Outlets. Exits through ceiling and roof.
Arnot's valves.
Boyle's ventilators.

IV. Special Points.

(*a*) Lighting and heat affect ventilation.

(*b*) Furniture lessens the air space.

(*c*) Importance of ventilation in schools.

1. Cubic space limited.
2. Confinement long.
3. Respiration rapid.
4. Brain in work needs more oxygen.
5. Children more liable to infection.
6. Children often neglected in person and clothing.

(12) NOTES OF A LESSON ON *THE CHOICE AND CARE OF LAUNDRY UTENSILS*[1].

§ 113. **Class.** Standard V.

Number. 14.

Average Age. 13 years.

Previous Knowledge.

1. Such facts as they may have acquired at home.
2. Facts gathered by observation.

Educational Aims.

1. To train the powers of observation.
2. To exercise the memory.

Practical Aim.

1. To teach the Class the best kind of utensils to buy.
2. How to take care of them that they may last as long as possible.

[1] The Notes would be drawn up in this method by an advanced student. The questions, etc., are omitted, the outlines of the lesson only are given.

Materials.	Utensils. (All dirty.)
1. Cloths for washing and drying.	1. Two enamelled bowls.
2. Dusters.	2. China.
3. Scrubbing-brush.	3. Wooden tubs.
4. Brick-dust.	4. Irons and stands.
5. Turpentine.	5. Spoons and knives.
6. Paraffin.	6. Clothes-line and pegs.
7. Small piece of dripping.	7. Mangle, wringer, copper, and wooden tubs.
8. Brown paper.	

Notes.

1. The above-mentioned utensils will be neatly ranged under the table, and a child will stand by the teacher and put them on the table, as named by the rest of the Class.

2. The copper and wooden tubs will be cleaned at Practice Class only by the methods stated at the Demonstration.

3. Specimens of all other utensils will be cleaned by the girls.

Purpose.

Tell the Class that they are going to learn how to choose laundry utensils, and how to take care of them.

Preparation.

Ask what utensils the Class has been in the habit of using at laundry lessons.

The child will produce each as named by the Class.

Presentation.

1. State that enamelled bowls are very suitable, as they do not break if allowed to slip through wet fingers.

Wash one in a bowl of soapy water: call attention of Class to chips and so elicit the reason for wiping dry to avoid rust.

Show rusty bowl and article stained by it.

2. State that china bowls are usually deeper than enamelled ones, hence are more suitable for making starch. From previous knowledge of starch-making elicit the reason.

3. State that wooden tubs should be scrubbed with soap and warm water, never with *soda*, for soda (1) removes paint, (2) makes plain wood a bad colour. State that clean water should be left in unpainted tubs to prevent shrinkage.

4. State that irons in sizes from 1 to 4 are the most useful and elicit the reason for keeping them very clean. Wash one iron in strong soda-water, dry, and polish with brick-dust. State that when put away, irons should be greased and wrapped in brown paper. Elicit that all irons must be similarly treated.

Show sizes.

Treat one in this way.

Show specimens.

5. Elicit reasons for using wooden spoons for stirring and iron spoons for measuring. Wash one of each before the Class.

6. State that clothes-lines and pegs must be frequently washed. Children name consequences of dirty ones being used. Elicit that pegs should be made of wood, no metal.

Show clothes with dirty line marks.

7. State rules for care of a mangle.

8. Explain the method of cleaning the copper and wringers, eliciting the action of paraffin on the copper and turpentine on the rubber of wringers.

Association.

By calling up past experience, elicit that otherwise good work is sometimes spoilt by want of care and cleanliness of utensils. Children will suggest cases, e.g. (1) clothes soiled by being put over the edge of a dusty tub, (2) clothes spoilt by dirty irons, etc., hence

Generalization.

Deduce that all laundry utensils must be kept as clean as possible and state that the best quality which can be afforded should be bought, for good things if taken care of last much longer than things of an inferior quality.

Write Blackboard summary as a Recapitulation.

Write prices on the board.

Application.

Girls should never take it for granted that utensils are clean, for dust and smuts are constantly settling. Therefore *wipe every utensil before use*, to ensure clean work.

Blackboard Summary.

Choice and Care of Laundry Utensils.

Utensil.	Price.	Care of utensil.
Enamelled Basins.	4*d*. to 1/-.	Wash and dry thoroughly.
China ,,	2*d*. to 6*d*.	Wash and dry.

Wooden tubs.	From 2/-.	Scrub with warm water and soap.
Irons.	9*d.* upwards.	Wash with soda-water and polish with brick-dust.
Iron stands.	3*d.* to 6*d.*	Wash occasionally.
Mangle.	30/- and upwards.	Unscrew and cover when not in use.
Wringer.	7/6 and upwards.	Rub rollers with turpentine. Wash afterwards.
Spoons.	2*d.* to 4*d.*	Wash frequently.
Knives.	From 6*d.*	Wash frequently.

APPENDIX.

NOTES OF LESSONS ON "WASHING AND STARCHING PRINT."

Previous Knowledge. White clothes and woollens.

Introduce lesson (the way depends on the Class). Elicit from the girls the main difference between white clothes and garments to be washed at the present lesson. Recall lesson on preparation for washing day and what was done to print clothes. Let Class reason starch must be ready and the reason.

N.B. The Class has made it at least twice.

Make starch from children's directions (or call out a girl and let her make it), recapitulate method and prices.

Elicit steeping of white clothes. Let the Class deduce the effect of steeping on colour, teach that print is not steeped, recall that woollens also were not steeped and let the children compare reasons for similarity of treatment.

Elicit starch ingredients and write on B. B.

Show specimens of the effect of hot water, soda, etc. on print.

Elicit method of washing white clothes.

Compare the texture of print and body linen; let the Class reason that the fabrics are similar. Recall specimen (or experiment) shown and let the Class deduce that hot water spoils colour.

Teach method of washing print. Recall similarity of the method used for washing woollens and let the Class compare reasons.

Elicit temperature of water used in washing woollens and reason.

Recall effect of heat on colour.

Let Class deduce the kind of water for rinsing.

Teach effect of friction on colour particles and uses of salt.

Let the class formulate the rule that cold water and salt set colour.

Recall starching of white clothes.

Teach similarity of method for print and difference of proportion.

Let Class state rules for drying white clothes. Apply this to prints, letting the girls deduce the differences and the reasons.

Elicit B. B. S. either as "rules for print" or general lines for preservation of colour.

Recapitulate at every stage, i.e. washing, rinsing, starching, etc., and vary form of recapitulation as much as possible.

Associate at every stage with previous lessons as regards temperature of water, use of soap, effect of soda (used in soap, etc.), of sun, etc.

Courses of Instruction in Household Management, Cookery, and Laundrywork*.

Synopsis of Syllabus of Three Years' Instruction in Household Management (combining Practical Cookery, Laundrywork, and Housewifery with Home Nursing) at Centres.

Junior Stage.

Cookery section.

Care and cleaning of utensils, use of balance, clock, thermometer. Cookery principles and primary methods illustrated by simple dishes. The choice and cost of materials. Homely measures. Simple tests for discovering temperature of oven, etc.

Housewifery section.

Choice and cost of cooking utensils for a working man's home. Care and cleaning of scullery. How to furnish a kitchen. Cleaning a kitchen. Combustion and fire lighting. Cleaning flues and grate. Laying and lighting fire. Construction of sink. Care and cleaning of sink. Disposal of kitchen refuse. Thrift. Using up scraps. Forethought. Planning meals. Marketing. Choice of Food. Season foods. Storage. Laying the table. Cleaning plated forks and spoons, etc.

Home Nursing section.

Invalids' diet, etc. Invalid dishes. Simple remedies for common ailments. Poultices, gargles, fomentations. Con-

* By kind permission.

valescents' diet. Dishes suitable for a convalescent. Infants and children's diet. Babies' food. Suitable dinners for young children. Laying Invalid's tray.

Laundrywork section.

Care and cleaning of utensils. Management of fire. Properties of materials used in Laundrywork. Disinfecting and removing stains. Steeping, washing, boiling, starching and ironing clothes. Pegging out. Airing.

Housewifery section.

Practical housework, including daily and weekly bedroom and parlour work, etc. Artificial light and care of lamps, etc. Ventilation. Marketing and preparing Cottage Dinners. Thrift. Washing and mending clothes.

Senior Stage.

Cookery section.

Functions of food. Cost, purchase and preparation of nourishing meals. More advanced dishes illustrating over again the primary methods taught in the Elementary course. Constituents and dietary value of the varied food stuffs. Digestion of albumen, starch, fat. Making preserves. Vegetarian dishes. Home-made bread. Dishes suitable for invalids and young children.

Housewifery section.

Choosing a house or lodgings. Choice and cost of furniture. Drainage. Ventilation. Personal Cleanliness. Skin. Hair. Baths. Practical housework, including Spring and Autumn cleaning. Preparing Cottage dinners. Washing and mending clothes.

Laundrywork section.

Use of Clothes. Structure and function of the skin. Source, nature and treatment of varied clothing materials. Source and properties of materials used in Laundrywork. Washing linen, woollen, cotton prints, muslins and laces. Starching and stiffening processes. Ironing and goffering. Polishing.

Home Nursing section.

Qualifications of a good nurse. Care of the patient. Arrangement of the bedroom furniture. Changing sheets. Bed-rests. Invalid Cookery. Common ailments and their remedies. Bandaging. Poultices. Fomentations. Practical Housework.

Housewifery section.

General structure and functions of the human body. The Laws of health. Fresh Air. Sunshine. Wholesome diet. Sensible clothing. Personal Cleanliness. Work and exercise. Rest and recreation. Thrift. Savings Banks. Building Societies. Clubs. Practical Housework.

Suggested Scheme for Home-Making Classes
(36 girls).

Total Number of Hours instruction, 1030, inclusive of
" " for Home-Making, 500.

Domestic Science, including Cookery, Laundry, and Housewifery	340
Domestic Handicraft	40
Needlework	60
Gardening	40
Care and Management of Infants and Young Children	10
First Aid	10
Total	500 hours.

Classes to be held as follows:—

Monday Tuesday Wednesday	Domestic Science, 2½ hours	Set A, Morning. Set B, Afternoon. Following week reverse the order.

Thursday—Gardening; Nature Study; Practical Mending.

First Two Weeks—Domestic Handicraft.

Third Week—Begin Housewifery, followed by Laundry; Revise Cookery.

Last four months, when Housewifery and Laundry principles have been learnt and Cookery Methods revised with simple experiments, apply the subjects to home life.

So many girls will cook, so many wash, so many do housework in the mornings. In the afternoons, sewing, ironing, etc. Reverse the following week.

Home-Making Centres.

Cookery Syllabus.

Revision of previous instruction.

Lessons.	*Theory.*	*Dishes.*	*Experiments and Illustrations.*
I.—Weights and Measures.	Use of Weights and Measures. Relation of Weight to Volume.	Weight of Liquids. Measuring Flour, etc., to get correct weight.	Show Evaporation of Water, by weighing after water has been boiled.
II.—Adjusting of Recipes.	Recipes changed to alter (*a*) Food Value; (*b*) Price; (*c*) Method of Cooking.	Pancakes. Yorkshire Pudding. Custard.	Write Recipes on B.B. to show changes.
III.—Roasting.	Changes Meat undergoes when heat or cold is applied.	Roast Beef. Greens. Potatoes. Gravy.	Hardening of Albumen with Heat. Extraction of Juices with Cold.
IV.—Proportions used when Cooking.	Proportions of (*a*) Pastry; (*b*) Milk Puddings; (*c*) Soups; (*d*) Cakes.	Jam Turnovers. Sago Pudding. Pea Soup.	Proportions written on B.B.
V.—Cooking of Starchy Foods.	Action of Heat on Starch.	Corn Flour Moulds. Soda Bread. Baked Flour.	Test for Starch (Iodine). Show different Starch Grains.
VI.—Cooking by Steam.	Effect of Steam the same as boiling water.	Steamed Potatoes. Currant Dumplings—boiled and steamed.	Show Temperature of Steam to be the same as Boiling Water.
VII.—Stewing.	Suitable Foods for stewing.	Porridge made in Double Saucepan. Beef Stew with Vegetables.	Show difference between a piece of Meat Boiled and Simmered.
VIII.—Cooking by Dry Heat.	Effect of dry heat on different food materials.	Baked Egg. Jam Tarts. Toasted Bacon.	Show use of Dutch Oven.

IX.—Preservation of Food.	Necessity for preserving foods. Different methods.	Jam. Bottled Fruit. Pickled Onions and Cabbage. Eggs.	Show Preserved Foods and Tests for Freshness.
X.—Cold Air as a Raising Agent.	Expansion of air and gas.	Flaky Pastry. Batter.	Balloon filled with cold air and exposed to heat.
XI.—Baking Powder as a Raising Agent.	Composition of Baking Powder: how it is made.	Cakes and Scones.	Baking Powder in Water. Test for CO_2.
XII.—Yeast as a Raising Agent.	Yeast: what it is, and action.	White Bread and Brown.	Active Yeast Tested for CO_2. Brewers' Barm.
XIII.—Dried Vegetables and Fruits.	Pulse Foods. Prices and food Value.	Pea Soup. Stewed Prunes. Stewed Haricot and Butter Beans.	Show difference after Soaking.
XIV.—Milk.	Scalding as a Preservative. Food Value. Contamination and Adulteration.	Milk Puddings. Junket. Reducing tinned milk.	Show Tinned and Fresh Milk.
XV.—Cheese.	How making of Cheese and its Food Value.	Cheese and Rice. Macaroni Cheese.	Show different processes in making Cheese.
XVI.—Expenditure of Wages on Food.	How to lay out a weekly average wage.	Potatoes. Boiled Pudding. Fish Pudding or Fish Cakes.	Give a list of Cheap and Nourishing Foods.
XVII.—A Mixed Diet.	Three Classes of Food.	Haricot Beans. Greens. Suet Pudding.	Show Specimens of the three different classes of Food.
XVIII.—Simple Dinner.	Preparation in order.	Boiled Meat. Vegetable. Sauce. Milk Pudding.	
XIX.—Simple Dinner.	Preparation in order.	Meat Pie. Potatoes. Stewed Fruit and Custard.	
XX.—Simple Dinner.	Preparation in order.	Fried Fish and Sauce. Pancakes.	
XXI.—Simple Dinner.	Preparation in order.	Cottage Pie. Greens. Bread Pudding.	

Home-Making Classes.

SUGGESTED TIME TABLE.

Sept. 12th to Sept. 26th.

Domestic Handicraft, Plant Labels, Dibbles, etc., for use in Garden.

1. Use of Tools and various kinds of Wood.
2. Making of Cookery and Laundry Utensils. Cardboard work may be included.

Sept. 26th to Feb. 1st.

Laundry Work two days a week—Tuesday and Wednesday.

Housewifery Work two days a week—Monday and Thursday. (See Syllabuses).

Monday afternoon every week devoted to Domestic Handicraft.

Feb. 1st to April 1st.

Revision of Cookery.

Set *A*—Special Syllabus on Scientific principles.

Set *B*—2nd Course Elementary Syllabus.

April 1st to end of July.

Subjects previously taught applied to Home Life.

Three Lessons a week—7½ hours.

Thursdays devoted to Mending and Needlework; Gardening.

N.B.—During the last three months Lectures will be given from time to time on Home Nursing, Temperance, Care of Infants, etc.

Application of Subjects to Home Life During the last Four Months.

Monday Mornings.

1. General cleaning of rooms after week end.
2. Collecting, sorting, and steeping of clothes.
3. Preparation for wash day.
4. Cooking of dinner and laying of table.

Monday Afternoons.

1. Clearing away dinner; washing up.
2. Sweeping kitchen, tidying grates, dusting, etc.
3. Laying boiler fire.
4. Prepare dinner as far as possible for wash day.
5. Domestic Handicraft.

Tuesday Mornings.

1. Straighten rooms.
2. Start dinner.
3. Begin washing.
4. Lay dinner tables.
5. Serve dinner.

Tuesday Afternoons.

1. Clear away dinner.
2. Wash up.
3. Tidy kitchen.
4. Finish washing.
5. Damp, fold, and mangle.
6. Trim lamps.
7. Prepare tea.

Wednesday Mornings.

1. Daily work in sitting-room; laying a breakfast table.
2. Daily work in kitchen.
3. Cook the dinner.
4. Weekly turning out of a bedroom.
5. Ironing.
6. Lay table and serve dinner.

Wednesday Afternoons.

1. Clear away dinner things.
2. Iron.
3. Trim lamps.
4. Cleaning of silver, tins, etc.
5. Prepare tea and clear away.

Thursday Mornings.

1. Daily work in the bedroom and kitchen.
2. Start the dinner.
3. Weekly work in the sitting-room and outhouses.
4. Lay table and serve dinner.

Thursday Afternoons.

1. Attention to dinner things.
2. Sewing and mending of clothes washed during week.
3. Mending and general renovation of articles in the centre.
4. Care of infants occasionally.
5. Preparation of afternoon tea.

Home-Making Centre.

Laundry Syllabus.

1. Preparation for Washing Day. Sorting and Mending Clothes. Removal of Stains and putting to Steep. Making Dissolved Soap, etc.
2. Washing Woollens. Hard and Soft Water. Ways of Softening Hard Water. Rules for Drying Woollens.
3. Washing Prints and Coloured Cottons. Making Boiling Water Starch. Rules for Drying.
4. Washing White Clothes. Softening of Boiler Water. Starching White Clothes and treatment of Unstarched things. Rules for Drying White Clothes.
5. Washing Kitchen Towels and Dusters. Uses of Soda.
6. Damping, Folding, and Mangling. Finishing Towels. Ironing Pillow Cases and Handkerchiefs.
7. Damping and Ironing Table Linen. Finishing by Mangling only.
8. Damping and Finishing Body Linen.
9. Damping and Finishing Print.
10. Washing and Finishing Silk and Ribbons.
11. Washing and Finishing Lace.
12. Starching and Ironing Collars and Cuffs.
13. Renovations. Black and White Hats, Black Lace, etc. Recapitulation of getting up Ribbons.
14. Getting up Cretonne and Chintz.

Directions to Teachers.

1. It may be necessary to interpolate washing lessons between some of the lessons given in syllabus in order to prepare the ironing necessary for another lesson.

2. The course should consist largely of recapitulation—
   (*a*) by a practice lesson being given on the preceding week's lesson, or
   (*b*) by the lessons being repeated from time to time at the Teacher's discretion.

3. Demonstrations need not be given when a lesson is repeated, as owing to the few principles in laundry work in comparison with cookery the children grow weary, though they love to repeat the practical work.

4. Polishing collars and cuffs or table linen may be taught; the time for this to be decided by the Teacher according to the dexterity of the class.

5. During the latter part of the course the girls should have as much practice as possible in ironing garments, body linen, blouses, etc., as these require greater manipulative skill.

HOUSEWIFERY SYLLABUS.

Morning Work.

1. Daily Work in the Kitchen: Cleaning Range, etc.
2. Care and use of various Brushes—Housemaid's Cupboard.
3. Daily Work in Sitting-room: Laying a Fire.
4. Cleaning and Care of Silver: Keeping Inventory.
5. Daily Work in the Bedroom: Making Beds.
6. Care and Cleaning of Floor Coverings: Staining.
7. Cleaning of Painted and Varnished Wood.
8. Cleaning Copper, Brass, and Zinc.
9. Setting Breakfast and Tea Tables: Household Linen.
10. Revision.

11. Cleaning Furniture.
12. Weekly Work in Sitting-room.
13. Cleaning of China, Glass, and Pictures.
14. Weekly Work in Bedroom.
15. Choice and Cleaning Wall Papers.
16. Daily and Weekly Work to Staircase and Hall.
17. Cleaning and Care of Boots and Shoes: Blacking.
18. Revision.

19. Cleaning Door Mats: Stone Steps and Offices.
20. Daily and Weekly Cleaning of Larder: Stores, etc.
21. Care of Kitchen Cupboards and Shelves: Lists, etc.
22. Spring Cleaning.
23. General Management of a House: Shopping: Buying new Furniture, etc.
24. Revision.

Afternoon Work.

1. Care and Cleaning of Sinks and Drains: Disinfectants.
2. Personal Cleanliness, Hair, Teeth, etc.: Cleaning Sponges.
3. Setting and Clearing of a Dinner Table: Washing up Dinner things.
4. Care and Cleaning of Clothing.
5. Care and Cleaning of Lamps and Candles: Evening Bedroom Work.
6. Cleaning Steel Knives, Forks, and Tins.
7. Mending China and Glass.
8. Home Remedies for Simple Ailments: Making Poultices.
9. Tea—how to make it; its properties and dangers.
10. Revision.

11. Rules for Bandaging.
12. Afternoon Work to Sitting-room: Preparation of Tea.
13. Simple Rules of Health.
14. Ventilation, how obtained, and its necessity.
15. Making Whitewash and Sanitary Water Paint.
16. Care of Infants: Substitutes for Cots.
17. Feeding of Infants: Comforters: Bottles.
18. Revision.

19. Necessity of Pure Water and Flushing of Drains.
20. Infection: Disinfectants and the Sick Room.
21. How to treat Cuts, Scalds, and Burns: Making Oils, etc.
22. Use and Abuse of Alcohol. Cleaning Windows.
23. How to Bind Magazines, etc., together.
24. Revision.

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