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FOOD

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ROBERT McCARRISON

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FOOD

A PRIMER FOR USE IN SCHOOLS, COLLEGES,
WELFARE CENTRES, BOY SCOUT AND
GIRL GUIDE ORGANIZATIONS,
ETC.,
IN INDIA AND PAKISTAN

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TO
THE CHILDREN OF INDIA AND PAKISTAN

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FOREWORD TO THE SECOND EDITION

THIS primer was first published twenty years ago. Since then much new knowledge of food-essentials, particularly in regard to vitamins, has accumulated. The book has accordingly been revised, and in this new edition an attempt is made to bring its Lessons up-to-date, while preserving their simplicity. Where it has seemed that some passages may be too detailed for younger pupils, though of interest to their teachers and older readers, these passages are printed in smaller type. Some rearrangement in the order of the Lessons has been made, and the Table of Food-Values has been somewhat extended. Otherwise the general scope, arrangement and size remain the same as in the first edition.

It is hoped that, in its present form, this little book will continue to be of service to young people—and their elders—both in India and in Pakistan.

R. McCARRISON

OXFORD.

15th March, 1948.

The "Foreword to the First Edition", written in 1928, is reproduced overleaf in its original form. It applies equally to the two parts—India and Pakistan—into which the sub-continent is now divided.

FOREWORD TO THE FIRST EDITION

NUTRITION is the most pressing of all present-day problems in India ; and although for many millions of the Indian people this problem is one of obtaining enough to eat yet it is well that the rising generation, amongst the more educated classes, should learn something of the simple truths of Nutrition and how to make the best use of such foodstuffs as are available. Thus may they derive benefit themselves and be in a position to instruct others.

The purpose of this little book is to teach young people what to eat and why they eat it, to make them realize that the greatest single factor in the promotion of good health is good food, and that we eat not only to live but to live well. For well-living consists in many things besides the satisfaction of appetite: it consists in the perfect growth of mind and body, in perfect health, and in the vigorous employment of both mind and body in useful work. And well-living necessitates the observance of certain rules of life, of which, from the point of view of Hygiene, there are six: to practise personal cleanliness; to live in clean surroundings; to breathe clean air; to drink clean water; to make use of the invigorating and cleansing qualities of sunlight; and, to eat, with restraint, clean food of the right kind.

The primer has been written in response to many requests for information regarding **food** received from missionaries, planters, school-teachers, child-welfare workers and others

throughout India. It had not been possible to reply individually to these requests, but it is hoped that this book may serve as a collective answer. In preparing it the simple foods which Nature provides have been alone referred to; for these, when properly combined, furnish all the body needs at every period of life.

Some may say that poverty will prevent the masses in India practising the principles laid down in this primer. This is, unfortunately, only too true. But it must be realized that normal nutrition and health cannot be maintained on many of the diets now used by millions of the Indian people. Their welfare demands the provision of food which will satisfy the physiological needs of the body; education is the first step towards the attainment of that end.

R. McCARRISON

PASTEUR INSTITUTE,
Coonoor,
15th March, 1928.

The internal activity and external muscular work of the body involve, also, constant wear and tear on its organs and parts; so that some amongst the myriad cells of which the body is composed are always in need of replacement or *repair*. **A third purpose of food** is to provide materials with which the body keeps itself in repair.

Growth, repair, and the production of energy and heat have to be regulated. **A fourth purpose of food** is to provide materials for the regulation of these and other functions of the body.

These purposes of food serve one great end : the perfect growth and development of the body and the maintenance of its health throughout life. We eat, therefore, not only that we may live but that we may live in perfection of manhood and womanhood.

The growth or building of the body. In some ways the growth of the body is like the building of a house. When we wish to build a house we first select the different **building-materials** that are needed : stones for the foundation ; bricks for the walls ; wood for the window-frames and doors ; and, tiles for the roof. But the stones, the bricks, the wood and the tiles are lifeless things : they cannot build themselves into the different parts of the house ; so **builders**, or workmen, whom we call stone-masons, bricklayers and carpenters, must be employed to prepare the building-materials and to put them together. According as the building-materials are good, bad or indifferent, and

according as we employ good workmen for each kind of work, so the house, when finished, will be well, badly or indifferently built. It is much the same with the building or growth of the body ; once badly built it needs continual patching.

The materials which the food provides for the building and repair of the body are **proteins, mineral salts, water,** and some fat-like substances. These **body-building materials** are as lifeless as those needed to build a house : they cannot build themselves into the different parts of the body, so builders are needed to do so. The great builder of the body is *the life-force* within us. It employs many assistants : some to prepare the building-materials for use, and some to convert, or help to convert, them into flesh and blood, bones and teeth, organs and tissues. Amongst these assistants are the **Vitamins**, so-called because they are *essential to life* and to growth. These, too, are provided in food ; and, like the workmen who build, or help to build, and repair a house, the vitamins are of different kinds and have their own particular names. They are named after the letters of the alphabet : Vitamin A, Vitamin B, Vitamin C, etc. Each vitamin has its own particular work to do, though each helps the others in the building of the whole body and in keeping it in good repair ; just as the workmen help each other to complete the whole house and to keep it in good repair. Thus : Vitamin A works principally on the eyes and the lining membranes of the

lungs , stomach, intestines, etc. ; Vitamin B on the nerves and muscles ; Vitamin C on the blood and blood-vessels ; and, Vitamin D on the bones and teeth. We shall learn, in later Lessons, that vitamins have much to do in enabling the body to grow and to be kept in good repair ; for the present it is enough to know that this is their chief function.

When food is of the right kind, and is eaten, digested, and absorbed in the right amount, all the vitamins are provided together with the necessary building-materials. But if it be of the wrong kind it may contain neither enough building-materials nor enough vitamins for the proper growth and repair of the body. So the body as a whole, or some part of it, may be badly built and fail to do well the work for which it is intended. Thus, the bones, whose duty it is to support the body may be frail or bent ; the teeth, whose duty it is to chew the food, may be poor and decay early in life ; the muscles may be flabby and the limbs not supple for movement, play and work ; the lungs, whose duty it is to provide the body with oxygen, may be weak and work imperfectly ; or, the stomach and the intestines, whose duty it is to digest and absorb the food, and to pass the waste products of digestion out of the body, may be too weak to do so properly. It is in this way that a great many illnesses are caused. Presently we shall learn what these illnesses are.

In other ways the human body is like the engine of a motor-car : an 'internal combus-

tion engine,' as it is called. Both need power or *energy* to enable them to move and do their work ; both procure this energy by the burning (*combustion*) of fuel inside them ; and, in both the production of energy gives rise to heat. The more work they have to do the more energy and, therefore, the more fuel they need. The fuel for the internal combustion engine is provided by petrol or oil ; that for the human body is provided by food. The materials which the food provide for the production of energy and heat are **carbohydrates** and **fats** ; they are spoken of as **fuel-foods**. They contain great stores of energy, the ultimate source of which is **sunlight**. **The proteins**, too, are sources of energy and heat ; those parts of them which are not used-up for growth and repair of the body, or for other purposes, being available as fuel. The fuel-foods are converted, in digestion, into forms which can be absorbed into, and used by, the body ; in these forms, together with those provided by the proteins, they are used as *body-fuel*.

There is in each one of us a kind of fire which we may call *the fire of life*. It burns in every living cell of our bodies. This fire is fed with the body-fuel, much in the same way as an ordinary fire is fed with coal or wood. Now a fire will not burn unless it has plenty of air. We all know how we blow on a fire or use a bellows to make it burn. It is the **oxygen** in the air which enables the fire to burn. It is much the same with the fire of life ; it, too, needs oxygen to enable it to burn, and our lungs are

the bellows which provide it. The oxygen combines with (*or oxidizes*) the body-fuel, enabling it to be burnt and to yield energy for the work, and heat for the warmth, of our bodies.

The materials which the food provides for the regulation of the functions of the body are the **vitamins** and the **mineral salts**. Regulators of these functions are also produced in the body itself, chiefly from the **proteins** provided in food.

The essential ingredients of food are thus of five kinds : **proteins, mineral salts, fats, carbohydrates,** and **vitamins**. Our food must contain them all in right amounts and kinds. Every foodstuff that Nature provides for our use contains *one or more* of them, but no single foodstuff contains them all in just the right amounts and kinds. So we must learn how to combine the different foodstuffs we eat in such a way that our daily food will contain all these essential ingredients in proper amounts and proportions one to another.

Four things are needed for the proper nourishment, growth, repair, health, and work of the body : **air, sunlight, water** and **food**. To these must be added **exercise** and **sleep** : exercise to keep the body agile and strong ; and, sleep to give it the **rest** without which it would wear itself out.

LESSON II

Food-star. The Frontispiece of this book is a coloured star which we shall call our *Food-star* because it is intended to guide us. It shows all the substances needed by the body for its proper nourishment, growth, repair, health and work.

In the centre of the Star there is a *small red* area marked **proteins** ; above the word 'proteins' there is the word 'animal' and below it the word 'vegetable.' This is to remind you that the proteins occur both in foods obtained from animals and in foods obtained from vegetables, and that it is best to use both kinds. Proteins are the **building-materials** needed to make the flesh, and organs such as the brain, liver, heart and kidneys ; and since flesh is red, the central area of the star is coloured red. *Animal proteins* occur in milk, meat, eggs and fish ; *vegetable proteins* occur in cereal grains, such as rice, wheat, oats, barley, maize, ragi, cholam, and cambu, and in pulses, nuts, vegetables and fruit.

Around the red centre of the Star there is a *narrow white circle* marked **mineral salts** : these are the second kind of **building-materials** ; they are needed to build the bones and teeth, to keep the blood pure, and for other purposes about which we shall learn in another Lesson (V). The circle showing the mineral salts is white because these salts are usually white. They are things like lime (*chunam*) and common salt (*nimuk* ; *oopoo*). They occur in most foodstuffs, but vegetable foods, such as

fruit and green leafy vegetables, are particularly rich in them.

Around the white circle there is a *narrow yellow one* marked **fats**. At the sides are the words 'animal' and 'vegetable.' This circle is coloured yellow because fats are often yellow. The words 'animal' and 'vegetable' are to remind you that **fats**—which are one kind of **fuel-food**—occur both in foods obtained from animals and in foods obtained from vegetables and that it is well to use both kinds. Examples of *animal fats* are butter, ghee and fish-oils; examples of *vegetable fats* are coconut oil, red palm oil and gingelly oil.

Around the narrow yellow circle there is a *broad brown one* marked **carbohydrates**; on one side is the word **starches** and on the other the word **sugars**, to show that these are the two kinds of carbohydrates. The carbohydrates are **fuel-foods** like fats; but the brown circle is much broader than the yellow one because the body uses more carbohydrate than fat; for carbohydrate provides energy for muscular work more readily than fat. The carbohydrate circle is coloured brown because the earth is brown, and because we get carbohydrates from foods which grow on the brown earth: *the starches* from such grains as rice, wheat, oats, barley, maize, ragi, cholam, and cambu, and from tubers and roots like potatoes, yams and tapioca; and *the sugars* from sugarcane, fruit, beetroots, and other plants.

Around the broad, brown circle there is a

large pale-blue one marked water. It is large because the body needs so much water, and it is coloured pale-blue because water, by reflecting the blue of the sky, so often appears to be of this colour.

Coming out of the **Food-star**, but really running through it if this could be shown in the picture, there are five large rays : two yellow, two brown, and one green. These represent the more important classes of **vitamins**—A, B, C, D, and E. ; and they are so coloured to remind you of the kind of food in which the vitamins are found. A and D are coloured yellow because they both occur in yellow foods of animal origin, such as milk, butter, egg-yolk, and fish oils ; and because yellow-coloured vegetable foods such as carrots, tomatoes, and yellow root-vegetable are also good sources of Vitamin A. B and E are coloured brown because they are present in vegetable foods (cereal grains, pulses, nuts, seeds) which grow on the brown earth. C is coloured green because it is plentiful in green vegetables, such as cabbage, turnip tops, bamboo shoots, and spinach. We shall learn, in other Lessons, that the different vitamins occur also in many other foods, but for the present the colours by which they are represented in the **Star** will serve to fix some of their chief sources in the memory.

You will notice that the five vitamin rays of our **Food-star** are all connected ; this is to remind you that they all work together in building and nourishing our bodies and in keep-

ing us in good health, just as they work with all other substances comprising the body of the Star.

Now this Star is made up of the same substances which compose our bodies—water, mineral salts, proteins, carbohydrates, fats and vitamins. If one of them be missing or too small in amount the Star will be imperfect, and so will the food : so also will our bodies be imperfect if we live on the imperfect food.

If you remember how the **Food-star** is made and arrange your food so that it contains all the substances in the Star, then your bodies will always get the right materials for their growth, and health, whatever your age may be. In other Lessons we shall learn how to do this ; but first we must know something more about air, sunlight and water.

LESSON III

Between the vitamin-rays of our **Food-star** there are five smaller ones, the sides and tips of which are colourless, and the bases of which are coloured yellow. The sides and tips are colourless to represent the **air**, and the bases are coloured yellow to represent the rays of **sun-light** coming through the air to our bodies, and to the plants which, under the influence of sunlight, make essential ingredients of our food.

Air. When we breathe (*inspire*) we take air into our lungs with every breath. The air contains the gas, **oxygen**, which must be continuously supplied to the living tissues in amounts proportionate to their need for it : more, when more is needed ; less, if less be needed. Our lungs are lined with a delicate membrane whose outer surface is in contact with the inspired air and whose inner surface is in contact with the thinly-spread-out blood-stream flowing through them. The oxygen in the inspired air is passed through this membrane into the blood-stream, where it is taken up by the colouring matter (*haemoglobin*) of the red cells of the blood, and carried—together with food-materials absorbed from the intestines—to all the tissues of the body. The living tissues have a craving for oxygen, and take it from the blood. In the tissues the oxygen meets the body-fuels (Lesson II) and, by combining with or *oxidizing* them, enables them to be burnt-up and to yield heat for our bodies and energy for their work. Oxy-

gen is also needed to enable the waste products of muscular work to be burned. The more muscular work we do, the more oxygen we need. So in order to get an extra supply of it we breathe more quickly and more deeply during, and for some time after, muscular exertion.

In the process of burning the body-fuels and the waste products of muscular work a gas is given off, just as gases are given off when petrol is burnt in an internal combustion engine or when coal or wood is burnt in an ordinary fire. This gas, called *carbon dioxide*, is poisonous and must be removed from the body as soon as it is formed. So the red cells (*corpuscles*) of the blood, as they part with their load of oxygen to the tissues, pick up from the tissues a load of carbon dioxide and carry it to the lungs, where it is discharged with the air we breathe out (*expire*) and carried away, by movement of the outside air, to be used by plants. If we sleep or work in rooms of which the windows and doors are tightly shut and through which no current of fresh air is passing, this gas collects in, and pollutes, the air we breathe. Harmful bacteria may be present in the polluted air, especially in towns, schools and workshops, where people are crowded together. Now the delicate membrane lining the lungs is easily affected by poisonous gases and bacteria ; so we should, as far as possible, live and sleep in the open air or in rooms through which fresh air is always passing, otherwise we may get dangerous diseases of the lungs. This is the more likely to happen if we are not

eating the right kind of food, for then the lungs are less resistant to infection by bacteria (Lesson X). Always breathe deeply, through the nose and not through the mouth. The nose and the passages behind it are so formed as to trap dust and bacteria and to prevent them entering the lungs.

Sunlight. All animal life depends on plant life and all plant life on sunlight. Animals and man must either live on plants or eat the flesh or other parts of plant-eating animals ; for it is plants which manufacture the *organic* ingredients of food (carbohydrates, fats, proteins, vitamins) from *inorganic* substances which their leaves extract from the air and their roots from the soil. This they can do because of the action of sunlight on the green colouring matter (*chlorophyll*) of their leaves. Thus, they take up carbon dioxide from the air and, with the help of water, build up carbohydrate in the form of *sugar*. From the sugar they make *starch* which they store in their stems, roots and seeds ; and, from the starch they make *fat*. The sun is the source of the energy which enables them to do this work ; and plants provide, in the carbohydrates and fats they make, stores of energy of a kind that can be used by plant-eating animals and by man. Proteins and other organic constituents of food are made by plants in similar ways. The sun is thus the great life-giver : first to plants and then, through them, to animals and man.

The sun's rays are of two kinds : those we

can see and those we cannot see. Amongst the latter are some called *ultra-violet rays*. When we expose our bodies to sunlight a vitamin (D) is produced in them by the action of these ultra-violet rays. This vitamin is necessary for the building of our bones. Children who run about in the sun rarely suffer from weak or bent bones because this vitamin is made in their own bodies by the action of the sun's rays. But if children are kept indoors all day, in houses and rooms into which sunlight does not penetrate, then their bones are likely to become weak and bent. And if girls remain always in purdah they may suffer in the same way : as, indeed, many young purdah women do. We shall learn in a later Lesson (XIV) that this weakness of bones may be prevented by eating foodstuffs containing vitamin D. But as these are not always easy to get, the simplest thing to do is to bask in the sun for some period of each day.

Too great exposure to strong sunlight is harmful and our bodies have to be protected against it. Nature does this in Indian children by making their bodies brown, so that they can go out into the bright sunshine quite naked without much harm. Fair skinned children, living in India, who are not so protected, cannot do this without risk of sunstroke. They must have most of their bodies clothed to protect them.

From this section of to-day's Lesson you may learn two things : (1) how great a friend

we have in the sun ; and, (2) how to use the sunlight for our health and well-being.

Water. Strange as it may seem to you the greater part of our bodies is made up of water. Nine-tenths of the blood is water, and nearly three-quarters of our flesh. It is the water in the blood and tissues which carries the things that nourish us to every part of the body, and removes from the body soluble waste materials that are produced in the course of its work. The body is porous like an earthenware jar (we see that this is so when we get hot and perspire). Being porous it is always losing water, which appears as sweat on the surface of the skin, where it evaporates, keeping the body cool. Children in India know how water can be kept cool in a *gurrah* by the evaporation of the moisture which soaks through its porous wall. We also lose water from the lungs, as any child can see who breathes on a piece of cold glass. Water also passes out of the body through the kidneys, carrying with it soluble waste materials. It also passes out of the body by way of the bowels, together with the waste materials from our food. It flushes from the body things that are harmful to it and keeps it clean inside. As the body is so largely made up of, and is so constantly losing water, it constantly needs to be given more. The need for water is shown by the sensation which we call *thirst*. Many people do not drink nearly enough water, and so their appetite may be poor, their food not properly digested and their bowels not kept in proper working order.

Everyday, first thing in the morning and between each meal, we should drink a glass or two of water whether we feel thirsty or not. Taken in this way, in the early morning, it helps in making the bowels act properly. More water is needed when the weather is hot, more by people of active habits, by those doing heavy work, and by those who sweat much. Women who are going to have babies or who are nursing their babies need more water than other women. Infants should be given sips of water, preferably in the form of diluted orange or other fruit juice, between their feeds of milk ; for they are as likely to be thirsty as older children. Sufferers from diarrhoea and fevers should be given plenty of water.

The water we drink must be pure, and not soiled by dirty matter passing into it ; otherwise we may get from it dangerous diseases such as dysentery, typhoid fever and cholera—which are due to *microbes* present in dirty water—or become infected by parasites such as *bilharzia*. Water is very likely to be impure and to cause illnesses when it flows in open channels through villages and fields, or when it is taken from wells or tanks that are not properly protected from pollution. When in doubt as to the purity of the water we have to drink, we should boil it before use. When water is drawn for use in our homes it must always be kept well protected in clean vessels.

Not counting the water which is contained in every foodstuff we eat, we should drink two,

or three pints of pure water everyday. It will give you an idea of how much water there is in some foodstuffs when you are told that three-quarters, by weight, of a potato is water ; about one-eighth part of all cereal grains is water ; more than three-quarters of an egg is water, and by far the greater part of a tomato is water. Indeed, if we were to add up the amount of water in everything composing our daily food we should find that more than half of it is water ; from which you will understand how very important a constituent of our food water is, and how very necessary it is for our health and well-being.

Besides the water we drink and that contained in the food we eat, a considerable amount of water is produced in our own bodies as a result of chemical processes.

LESSON IV

The Proteins. These are substances like the *albumen* in white of egg, and the *casein* in milk. Next to water they are the most abundant constituents of the body, of which they form about a sixth part. They are the principal materials from which the blood and tissue cells are made; and, they form the framework of these cells. They are needed for making the billions of new cells formed during the period of growth of the body, and, throughout life, for the renewal of worn-out cells. They are essential constituents of the fluid part of the blood (the *plasma*, which is a thickish solution of proteins, sugar and mineral salts in water). They enable the blood to clot when the body is cut or wounded, and so prevent excessive bleeding (*haemorrhage*). They provide materials from which the body makes regulators of its various processes. They are sources of energy and heat and stimulants of bodily vigour, and, they increase the resistance of the body to disease. The word "protein" means "holding the first place" and proteins are so-called because they hold this place amongst the essential constituents of food.

Proteins, as we have learned in the previous Lesson, are made by plants from elements which they procure from the soil and the air. Animals obtain them from plants, and man obtains them both from plants and from those parts (flesh, organs) and products (milk, eggs) of animals

LESSON IV

19

which he uses as food. They are complex organic compounds containing **Nitrogen**, an element essential to the life of plants, animals and human beings; most of them contain *sulphur*, and those of milk and egg also contain *phosphorus*.

Proteins are present in all things, that live or have lived, and therefore in all animal and vegetable foodstuffs. They are of many kinds. All are made up of a number of units, called *amino-acids*, and they differ from one another because of the different kinds and combinations of the amino-acids composing them. Those present in vegetable foodstuffs differ from those in animal foodstuffs. Both vegetable and animal proteins differ from human proteins; the proteins in food have, therefore, to be *re-made* by the human body into those needed for its growth and for the repair of its different parts. When food is eaten, the proteins it contains are split up, in digestion, into their different amino-acid units. These units are absorbed into the blood-stream from which the different tissues pick up those needed to make their own particular proteins. The amino-acids not expended in this way are split up in the liver and made available for use as body-fuel.

All, or nearly all, the amino-acids composing the animal proteins can be used in making human proteins; but only some of those composing the vegetable proteins can be so used. Thus, about 95 to 100 per cent of the proteins in milk, egg, fish, and lean meat can be *re-made*

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All, or nearly all, the amino-acids composing the animal proteins can be used in making human proteins ; but only some of those composing the vegetable proteins can be so used. Thus, about 95 to 100 per cent of the proteins in milk, egg, fish, and lean meat can be *re-made*

into human proteins, while only about 50 per cent of those in wheat and dhal can be so *re-made*. More vegetable than animal protein has, therefore, to be eaten in order to make the same amount of human protein. Moreover, animal protein is more readily absorbed in the body than vegetable protein. So the *quality* of the proteins (that is, their ability to maintain life and to promote growth) varies in different foodstuffs ; those in animal foodstuffs (milk, egg, meat, etc.) being of higher quality than those in vegetable foodstuffs (cereal grains, pulses, etc.). It is very important, therefore, that during childhood and adolescence, when the growth of the body is rapid and much new tissue is being formed, the food should contain adequate amounts of animal protein ; adequate amounts being from *one-third to one-half* of the total proteins needed. When the body is fully-grown and well-nourished there is not the same need for animal protein ; since new tissue is not then being formed and only the repair and upkeep of the fully-grown tissues have to be provided for. Even then, *not less than one-fifth* of the total protein needed each day should be of animal origin, because it supplements the vegetable proteins in food and enables the body to make the best use of them.

It is a good plan to include in our diets more than one of the cereal grains, for the proteins of one cereal supplement those of another. Thus, a mixture of rice *and* wheat provides better

proteins than those either of rice or of wheat alone.

The principal part of Indian children's food is made up of the cereal grain or grains (rice, ragi, wheat, etc.), which grow best in the part of India in which they live. These cereals are the **staple articles** of their diet. Many children eat only a little dhal and perhaps some vegetables, fruit and ghee or vegetable oil with their staple article of diet ; so their food provides not only too little proteins but proteins of relatively poor quality. These children cannot grow so well nor be as strong and healthy as those whose food also contains a sufficient amount of milk, or egg or fish or meat, the proteins of which are of high quality and best able to promote growth and vitality.

Some children are not allowed by their caste or religion to eat the flesh of animals ; but all are allowed to take milk and milk-products. So no matter what their caste or religion may be and no matter what their staple cereal may be, their diet will always contain the right kind of proteins if they include enough milk (about a pint a day) and/or products of milk such as curds, soured milk, skim milk and buttermilk. Unfortunately, milk is scarce in India and Pakistan and children cannot always get enough of it ; but when it is realised how necessary milk is as a food for children, then more and better milk may be produced.

It is very important that the diet should contain *enough* protein : its *quantity* as well as its

quality must be adequate. An adult man living in the hotter parts of India or Pakistan needs *at least* 65 grammes (about $2\frac{1}{2}$ ounces) of protein a day, of which, as we have seen, not less than one-fifth should be animal protein. An adult woman needs not less than 55 grammes. Boys between the ages of 10 and 16 need slightly more than a man; and girls of the same age slightly more than a woman. Pregnant and nursing women need more than other women, and their food should contain a higher proportion of animal protein (not less than one-third to one-half of the total protein). These requirements are on the low side ; they can be increased with advantage, and often are in the diet of some races living in the colder parts of Northern India. But, because of poverty and dietary habits, the diet of millions of people in India and Pakistan fall far short of these requirements. Protein is heat-producing and less is needed during the hot weather.

Since proteins supply materials necessary for the building and repair of the body, it follows that if the food does not contain enough of them, our bodies will be badly built, badly repaired and will not wear well. The **ill effect** of this will be seen in stunted growth; poor physique, poorly developed muscles, lack of vigour, low powers of endurance and incapacity for hard-work both physical and mental. The power of resisting diseases, such as tuberculosis, cholera, dysentery, malaria, and leprosy, will also be reduced, and convalescence after acute illness will

be slow. It often happens when proteins are deficient in the food that vitamins and mineral salts are also deficient. In that case other illnesses are likely to arise : ulcers, skin diseases, swellings (*oedema*), and diseases due to want of vitamins.

LESSON V

The Mineral Salts. These are substances like lime (*chunam*) and 'common salt' (*nimuk*). They are the ash left after the burning of food in the air, like the ash left after the burning of wood. They are sometimes spoken of as *the ash constituents* of food.

There are fifteen, or more, mineral *elements* in the human body of which ten are known to be essential to its structure and functions and must be provided in the food. Together they make up nearly one-twenty-fifth part of the whole body : about six pounds. The following Table gives a list of the essential elements, the approximate amount of each in the body, and the part or parts of the body in which each element is principally found :—

Element	Amount in body in grammes	Principally Found in :
Calcium	1400	Bones, teeth, blood and body-fluids.
Phosphorus	770	Bones, teeth, cells, blood and body-fluids.
Potassium	245	Cells, blood, and body-fluids.
Sulphur	175	Cells, blood and body-fluids.
Sodium	105	Blood and body-fluids.
Chlorine	105	Blood and body-fluids.
Magnesium	35	Bones, teeth, cells, blood and body-fluids.
Iron	2.8	Cells, red blood corpuscles.
Iodine	0.028	Thyroid gland.
Copper	Very small amount	Red blood corpuscles.

Some elements—calcium, potassium, sodium, magnesium—are *base* or *alkali-forming*; others—phosphorus, sulphur, chlorine—are *acid-forming*. The base-forming and acid-forming elements are combined to form *neutral* compounds called *salts* and these are *the mineral salts* found in the food and in the body.

The mineral elements have very important functions in the body. Some are constituents of the bones and teeth and give to these structures their rigidity and strength. Some enter into the structure of the cells composing the body (muscle, nerve, gland, blood-cells, etc.) and take part in all cellular activities—oxidation (energy-production), growth, secretion. And some are dissolved in the blood and body-fluids and take part in the regulation of vital processes.

The soluble salts in the blood and body-fluids give to these fluids their solvent properties and consequent ability to carry nutrients to the tissues; they supply material for the acidity or the alkalinity of the digestive juices and for the composition of glandular secretions; they control the movement of the body-fluids; they help to ensure the tranquil action of the heart, the muscles and the nerves; and, they keep the blood and body-fluids *neutral*, neither acid nor alkaline.

You will notice from the given Table that each mineral element functions in several ways. Thus, phosphorus, which is a constituent of the bones and teeth, is also a constituent of the cells and of the blood and body-fluids and is essential to their functions. Iron, which is a constituent of the red blood cells and takes part in the transport of oxygen from the lungs to the tissues and of

carbon dioxide from the tissues to the lungs (Lesson III), is also a constituent of the cells and essential to their functions. Iodine is an essential constituent of the thyroid gland, whose secretion acts on all tissues. The mineral elements work together as a team: a team which is a part of the greater team made up of all essential components of the body—components provided by the food (Lesson II).

If we were starved of all mineral salts, life would be as impossible as if we were starved of all food or of all water; and unless our food contains all the essential mineral elements in sufficient amounts good health is impossible.

The mineral elements are present in different foods in widely different amounts and proportions. Thus, milk is relatively rich in calcium and poor in iron; wheat and cambrum are relatively rich in iron and poor in calcium. Protein is the source from which the body gets the sulphur it needs, but not all proteins contain sulphur and diet poor in sulphur-containing protein will be poor in sulphur.

The mineral constituents of foods vary in amount according to locality, to the nature of the soil, and to the way in which the soil is manured and cultivated. Thus, vegetable foodstuffs grown on soil containing little or no iodine will also contain little or none, and those grown on soils poor in phosphorus or iron will be poor in these elements.

Some foodstuffs, such as green leafy, root and other vegetables, are *alkali-forming foods* because they are richer in alkali-forming elements; and

some, such as meat, dhals, and cereal grains, are *acid-forming foods* because they are richer in acid-forming elements. There should be no excess of the latter over the former in the diet. So when it consists largely of such cereal grains as wheat, rice or ragi, or of flesh-meat, we should include in it adequate amounts of the green leafy and other vegetables (Lesson XV). When we suffer from any kind of fever the blood tends to become acid. It is, therefore, important that during attacks of fever we should drink plenty of water with vegetable or fruit juices, such as lemon and orange juice, and avoid acid-forming foods. Many people think that lemons and other fruits which taste acid are acid-forming foods. This is not so. The acid taste is due to vegetable acids (*citric, malic*) which are quickly oxidized, and do not form acids, in the body.

The mineral elements in the staple food grains—wheat, rice, etc.—are mostly contained in the outer layers of the grains. When these outer layers are removed, as when *paddy* is made into polished rice or wheat into white flour, much of the mineral salts originally present in these grains is lost. In another Lesson we shall learn that much of the vitamins in the grains are also lost in this way ; so is much of their protein. To avoid these losses we should always include the whole grains in our diet rather than their refined products. Certain mineral salts in food, such as the phosphates in rice, dissolve to some extent in water ; so when rice is cooked in water

and the water thrown away, a considerable amount of phosphorus is thrown away with it ; so also is a considerable amount of water-soluble vitamins (Lesson XI). For these reasons the rice-water should always be used either to make soup or as a drink.

From the point of view of constructing our diet four mineral elements are of chief importance : calcium, phosphorus, iron and iodine. For if the foodstuffs we use contain enough of these four then they will contain enough of all the others, with the possible exception of sodium chloride (common salt), provided the foodstuffs are produced on soils which are not deficient in mineral elements. In our next Lesson we shall learn what foodstuffs are rich in these elements and what foodstuffs are poor in them ; and we shall learn, too, of the effects to which their deficiency in our diet gives rise.

LESSON VI

Calcium (lime, *chunam*) is the most abundant, as well as one of the most important, of the mineral constituents of the body. Nearly one-half of the total mineral elements in the body is calcium. Over 98 per cent of it is contained in the bones and teeth ; the remainder being in the blood and body-fluids. It is needed for many purposes : for the building of the bones and teeth and the proper growth of children ; for the repair of broken bone ; for maintaining the tranquil action of the heart, the muscles, and the nerves ; for the clotting (*coagulation*) of blood ; and, for the production of satisfactory milk.

Calcium is more often deficient in the food than any other mineral element except iron, and its deficiency is a common cause of ill-health both in children and older people. It gives rise in children to poor growth and general bodily weakness and is *one cause* of softening of bones, of rickets, and of the decay of teeth. In older people it may cause brittle bones and rheumatic pains. If for any reason the amount of calcium in the blood falls below a certain level a condition (*tetany*) results in which there is irritability of the muscles and nerves with twitchings and convulsive movements of the limbs. This condition is common in certain parts of the Himalayas, especially in pregnant and nursing women and in children.

A breast-fed baby needs about 5 grains of calcium a day which it gets, or should get, from its mother's milk. It is very important that the mother's food, both before and after her baby's birth, should contain enough calcium for her own and her baby's needs; otherwise the calcium in her own body (bones, teeth, etc.) is drawn upon in an effort to satisfy her baby's need for it. In that event her health will suffer and her baby may develop rickets. Children need more calcium in proportion to their body-weight than grown-up people, because their skeletons and teeth are growing. The best way to supply it, both for pregnant and nursing women, and for children, is in milk and green leafy vegetables.

Foods rich in calcium are milk, skim milk, buttermilk, dried milk, cheese, crab (muscle), egg, the flesh of very young animals such as veal, green leafy vegetables (especially amaranth, fenugreek, turnip-tops, curry and drumstick leaves), ragi, gram, soya bean, and tamarind. Hard water is another source of calcium.

Foods poor in calcium : (1) Most cereal grains : wheat, rice, cholam, bajra or cambu, barley, maize and white flour. (2) Tuber and root vegetables : potato, sweet potato, yam, parsnip and tapioca. (3) Flesh foods in general, excepting veal and crab. (4) Fruit in general. Refined sugar, animal fats and vegetable oils contain no calcium. Jaggery contains a little.

When the diet is made up mostly of the

foodstuffs mentioned in the second class, it will not contain enough calcium for the best health.

Milk is the best of all sources of calcium for children not only because it is rich in it but because milk-calcium is well utilized in the body. A pint of milk a day provides all the calcium a child needs in addition to that in the rest of its diet. We shall learn in a later Lesson (XIV) of the important part which Vitamin D plays in the absorption and utilization of calcium (and phosphorus) in the body.

Phosphorus is the next most abundant mineral constituent of the body. More than one-quarter of the total mineral elements in the body is phosphorus. It is, with calcium, a chief constituent of the bones and teeth ; these contain about 90 per cent of the total phosphorus in the body. It enters into the structure of all cells, is necessary for their chemical activities, for their multiplication, and for the growth of the body. It is an essential component of the blood and body-fluids and plays an important part in the general functions of soluble mineral salts (Lesson V).

Foods rich in phosphorus are milk, cheese, skim milk-powder, egg, fish, liver, flesh-foods, cereal grains in general (especially cambu, cholam, ragi, oatmeal, raw unpolished rice, and whole wheat), gram, dhal, peas, beans, and soya beans, nuts and seeds, parsley and bitter gourd.

Foods poor in phosphorus are milled and polished rice, white flour, tapioca, sago, tuber

and root vegetables, most other vegetables, and fruit generally.

Seeds and cereal grains contain, as a rule, more phosphorus than calcium ; leaves more calcium than phosphorus. Foods rich in phosphorus should always be combined in our diet with foods rich in calcium, so as to keep a proper balance between these two elements.

Deficiency of phosphorus in the food of children leads to stunting of growth and poor muscular development, and is *one cause* of imperfect construction of the bones and teeth.

Phytic acid. This substance is a compound of phosphorus. It occurs in the bran and outer layers of cereal grains, particularly in oatmeal. A small amount is present in whole wheat flour (*atta*). It has no nutritive value and is passed out of the body in the *fæces*. But in its passage through the digestive tract it combines with some of the calcium in other foodstuffs and so calcium may be lost to the body, and the occurrence of rickets favoured. There is no risk of this happening if the diet contains enough milk, milk-products (butter, ghee) and green leafy vegetables.

Iron is present in the body in relatively small amounts. About one-thousandth part of the total mineral elements in the body is iron ; about 70 per cent of it is in the blood. It is present in all cells, is an essential constituent of the red colouring matter (*haemoglobin*) of the blood, and is needed for blood-formation. It enables the red blood corpuscles to carry oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs, and is essential to

the production of energy from the body-fuel. Its adequate supply in the food is, therefore, very important, particularly for pregnant and nursing women and for children. Iron is lost from the body whenever bleeding occurs. Women have a greater need for iron than men because they lose blood periodically.

Foods rich in iron are liver, eggs, lean meat, pulses, (dhals, gram, peas) ; some nuts (ground-nut, cashew, walnut, almond) and seeds (gingelly, mustard) ; some cereal grains (whole wheat, oatmeal, ragi, cholam, cambu) ; dates, green mango, bitter gourd (small variety), and leafy vegetables (amaranth, fenugreek, cress, neem, coriander, curry leaves, spinach, kale, parsley). Of animal foods yolk of egg, liver and lean meat are amongst those richest in iron, while milk and curds are amongst those poorest in iron. Sugar, white flour, animal and vegetable fats, contain little or none.

The iron in certain foodstuffs is less "available" (that is, less well utilized by the body) than the iron in others ; that in egg, milk, whole wheat, and green leafy vegetables is well utilized. An adequate supply of calcium in the food helps the body to utilize iron.

Deficiency of iron is the cause of *one form* of a blood disease called *anaemia*. Sufferers from chronic malaria and hook-worm disease, in which there is much destruction of the red cells of the blood, need an abundant supply of iron.

Copper, which is present in the body in very small amounts, helps in building iron into the

red colouring matter of the blood. If the food contains enough iron it will probably contain enough copper.

Iodine. The amount of iodine in the body is small (less than half a grain) but its importance is great. Most of it is contained in *the thyroid gland*—an organ situated in the neck on either side of the wind-pipe (*trachea*). An adequate supply of iodine in the food or drinking water or both is necessary for the maintenance of the structure and function of this gland. Only a very small amount is needed each day to keep the gland healthy and efficient.

The *thyroid gland* produces a secretion of which the active principle is a substance called *thyroxine*. Iodine is an essential constituent of this principle.

The thyroid secretion controls the rate of chemical changes within the cells of the body (*metabolism*) and is essential to the normal growth and development both of the body and the mind. Its deficient production gives rise in children to a condition (*cretinism*) in which the body is stunted and the mind undeveloped ; and in adults to a similar condition (*myxoedema*) in which the body is swollen and sluggish and the mental processes dulled because of diminished oxidation and excretion of waste products. Its excessive production gives rise, on the other hand, to a condition (*hyperthyroidism*) in which there is a great increase in the rate of metabolism, excessive stimulation of all bodily processes, and resultant wasting of the body.

In most parts of the world the locally produced foodstuffs and the drinking water provide

an ample supply of iodine. But in others, particularly in mountainous regions—as in parts of the Himalayas—there is a deficiency of iodine in the soil. The foodstuffs grown on this soil and the drinking water derived from it do not contain enough iodine for the needs of the thyroid gland and, through it, of the body. In that event the gland swells, sometimes to a great size, causing the disease called **Goitre**. In regions where goitre is prevalent (*endemic*) the disease may be prevented by using *iodized salt* instead of ordinary salt. Iodized salt is common salt to which iodine is added in the form of potassium or sodium iodide : one part of the iodide to 100,000 parts of salt.

More iodine is needed during pregnancy when the child is developing in the womb. If pregnant women do not get enough iodine they are likely to develop goitre and their children may develop cretinism after birth. More iodine is needed also during childhood, especially at the time of puberty when physical and mental development is rapid ; iodine-deficiency in the food or drinking water or both is likely to result in goitre at this time. More is needed, too, by people living in insanitary conditions and whose drinking water is contaminated with human and animal excreta, and more by people whose diet are ‘unbalanced’ (Lesson XXII). The more perfect the constitution of the diet, with respect to other food-essentials besides iodine, the less likely is goitre to occur.

In regions where goitre is endemic, domestic

animals (pigs, sheep, goats) may be affected in the same way as human beings.

Iodine is present in the sea, so foodstuffs obtained from the sea (fish, shell-fish, etc.) are good sources of iodine for man. Fish-liver oils (cod-liver oil, etc.) are particularly rich in iodine. The iodine-content of other foodstuffs varies within wide limits, depending on locality and the amount of iodine in the soil. Thus, potatoes grown in regions where goitre does not occur may contain three times as much iodine as those grown in regions where it does occur.

Potassium and Sodium together make up about one-eighth part of the total mineral elements in the body ; the former being rather more than twice as abundant as the latter. Potassium is needed for the construction of cells, and specially of the red blood cells and muscle cells. Sodium is needed for the proper constitution of the blood and body-fluids ; these fluids contain about 0·9 per cent of sodium chloride and it is essential for life that this amount be maintained. Sodium and potassium salts play important parts in the general functions of soluble mineral salts (Lesson V). Vegetable foods are richer in potassium than in sodium ; animal foods are richer in sodium than in potassium. An additional source of sodium is the common salt (*sodium chloride*) which we take with our meals.

Common Salt. People who live only or mainly on vegetable foods, need to take 'salt' with these foods because they contain more potassium

than sodium and the 'salt' (*sodium chloride*) helps to maintain the normal balance between these two elements. People who live mainly on meat do not need to add 'salt' to their diet since it contains enough sodium already. Those who take a 'mixed diet' of both animal and vegetable foods rarely need to take more than about four grammes (60 grains) of 'salt' each day ; some people take much more than they need.

The body loses 'salt' in various ways, as in sweat. People living in hot climates, who sweat much even under normal conditions of life and work, need more 'salt' than those living in colder climates. Men doing heavy work in hot places, as in mines and the engine-rooms of ships, lose much water by profuse sweating and with it much 'salt' contained in the sweat. This loss may cause severe *cramps* unless the men, during the course of their work, drink water containing a little 'salt'.

Chlorine, in the form of *Chlorides*, is needed by the body to help in maintaining the right composition of the blood and body-fluids and the right distribution of water in the body-tissues, to stimulate chemical processes and secretion, and to make *hydrochloric acid* which is an ingredient of the gastric juice. Chlorine is present, as chlorides, in most articles of food. Common salt is an additional source of it.

Fluorine is present in the body in small quantity, chiefly in the bones and teeth. Vegetables and cereal grains are its chief sources. In

parts of India and Pakistan the drinking water contains considerable amounts of fluorine. People who habitually drink this water may have mottled teeth, and some of them may develop crippling deformities of the bones.

The whole of this, and the previous Lesson, may be summed up in a few words : All the mineral salts the body needs for normal nutrition and health are present in a well-balanced diet (Lesson XXIII) made up of any whole cereal grain or mixture of whole cereal grains, milk and its products, dhal, root vegetables, green leafy vegetables, fruit, and a pinch or two of salt, provided the soils on which these foodstuffs are produced are not lacking in mineral elements.

LESSON VII

The Carbohydrates. These include, as we have learned in previous Lessons, **sugars** and **starches** and are the first class of energy-bearing or **fuel-foods**.

Sugar is the soluble form of carbohydrate—the form in which it circulates in the human body for use as fuel ; starch is the insoluble form of carbohydrate, which has to be converted into the soluble form, sugar, before it can be used as fuel.

A small amount of carbohydrate is present in milk, buttermilk, cream, cheese, liver, shell-fish and fish-roes ; of these milk contains most—about 5 per cent in the form of milk-sugar (*lactose*). Apart from these animal sources we get all our starches and sugars from vegetable foods : the former chiefly from cereal grains, tubers and roots ; and the latter chiefly from sugar-cane, sugar-beet, fruit and honey. Honey contains over 80 per cent of sugar. Sprouted cereal grains (Lesson XIII) also contain sugar.

The foodstuffs containing carbohydrates are arranged in order of value, from those containing most to those containing least, in the following eight classes :—

- (1) Sugars and starches : white and brown sugars, syrups, jaggery or goor, molasses and honey ; tapioca, arrowroot, and sago.

- (2) Cereal grains : rice, millet, maize, barley, wheat, oats, cholam, and cambu.
- (3) Dried Fruit : banana, currants, dates, raisins, tamarind.
- (4) Dried peas and beans, soya bean, dhals and grams.
- (5) Potatoes, sweet potatoes, beetroot, yams, artichokes, other root vegetables ; and, bananas.
- (6) Nuts.
- (7) Fresh Fruit.
- (8) Green leafy and other vegetables.

As with every other ingredient of our food—proteins, fats, mineral salts and vitamins—so with carbohydrates : it is best to mix the sources from which we obtain them. We could not use sugar as their chief source because it furnishes nothing but carbohydrate to the food. Nor could we, with comfort to ourselves, obtain all the carbohydrate we need from green leafy vegetables and fresh fruits, because we would have to eat a large amount of them and our stomachs and intestines are not designed by Nature to receive and deal with so much vegetable food. Nor can we rely on peas, beans and dhals as the chief source of our carbohydrate because we would then be taking too much protein, which would go bad in our bowels and do us harm. So a mixture of the different classes of foodstuffs is best, both from the point of view of carbohydrate and of the other essential ingredients of our food.

The carbohydrate contained in cereal grains and tubers consists mostly of *starch* ; that contained in fruits, as well as that in milk, honey, sugar-cane, sugar-beet and sprouted grains, consists mostly of *simple and complex sugars*. The starch and complex sugars in our food are changed, in digestion, into the simple sugar—*glucose*—in which soluble form carbohydrate is absorbed from the intestine into the blood. After its absorption most of it goes to the liver where it is converted into animal starch (*glycogen*) and stored. As the muscles and other tissues use up the sugar supplied to them by the blood, the liver replenishes the blood with more ; some of its store of glycogen being reconverted into sugar for this purpose, and its own store being replenished by the sugar reaching it from the intestines after food is eaten and digested. In this way the supply of sugar in the blood is kept at a more or less constant level ; the liver being a kind of fuel-tank which supplies carbohydrate-fuel as required. The muscles are the chief users of sugar, and they take from the blood considerable amounts which they convert into glycogen and store ; using it, as they need it, to provide energy for their work. Carbohydrate in excess of what is burnt in the tissues or of what is stored in the liver and muscles is converted into fat and deposited in different parts of the body, thus providing a more concentrated, and a larger store of body-fuel than glycogen. The amount of glycogen which the body can store is small and only enough to last

about a day ; but the amount of fat it can store is relatively large and is enough to last for several weeks, if and when the need for its use arises.

It is well that we do not have to rely on carbohydrate as the only source of body-fuel ; for if we had to, we would be obliged to eat large quantities of starchy foodstuffs, such as rice, in order to provide for the fuel needs of our bodies. Such excessive consumption of starchy foodstuffs has harmful effects. When the food contains all five essential ingredients,—proteins, fats, carbohydrates, mineral salts and vitamins—in proper amount and proportion one to another, then the carbohydrate part of it is easily and completely digested, and none is left over in the intestines. But when there is too much carbohydrate in the food, some is left over in the intestines, where it ferments and produces gas and irritating acids. This may result in flatulence, indigestion, and even diarrhoea. Moreover, the great bulk of carbohydrate-rich food in the stomach and intestines may interfere with the absorption of other essential ingredients of food—proteins, mineral salts and vitamins— and, if diarrhoea is set up, greater or lesser amounts of these substances may be passed out of the body before it can make use of them. People whose diet consists almost wholly of rice are very likely to be affected in this way. Diet which contain too much carbohydrate also tend to cause decay of the teeth, as we shall learn in a later Lesson (XVI). The habit of eating largely of rice and sweetmeats is, with bad teeth and want

of sufficient exercise, a common cause of a disease called *diabetes* ; and, since carbohydrate is so easily converted into fat, over-indulgence in carbohydrate-rich foodstuffs is a cause of *obesity*.

Vitamin **B₁** is necessary for the proper combustion (burning) of carbohydrate in the body (Lesson XI). The more carbohydrate the food contains the more Vitamin **B₁** is needed. The amount of carbohydrate needed each day depends upon the amount of work the body has to do ; for the adult male it is usually between 400 and 500 grammes, or about 14 to 17 ounces (Lesson XV).

LESSON VIII

The Fats. These are substances like butter, ghee, mutton fat (*charbi*) and gingelly oil. They occur, in variable amounts, in all our foodstuffs except sugar, jaggery or goor, and honey. They are plentiful in the following foodstuffs obtained from animals : the fatty part of flesh meats, the marrow of bones, milk, butter, ghee, cream, cheese, liver, egg-yolk and fish-oils. Fats derived from animal sources are spoken of as “animal fats”.

Amongst the vegetable foodstuffs, fats occur chiefly in nuts and seeds, from which they are expressed to form the “vegetable fats” or oils : olive oil, coconut oil, red palm oil, gingelly oil, groundnut oil, mustard oil, cotton seed oil and linseed oil. In comparison with nuts and seeds, cereal grains and pulses contain relatively little fat. Among the grains, cambu and oats are exceptions to this rule, the former having three times and the latter five times as much fat as cereal grains in general. And among the pulses, soya bean and Bengal gram are exceptions, the first being rich in fat and the second containing considerable amounts. Cereal products, such as polished rice and white flour, tubers and roots, vegetables and fruit contain in general very little fat. Coconuts and avacado pear are rich in fat.

Fats are, as we have already learned, the second class of **fuel-foods**. They provide, weight for weight, rather more than twice as

much energy as carbohydrate. They are thus a concentrated source of energy, and we do not need so much of them as we do of carbohydrate. In our last Lesson we saw that if we had to rely entirely, or almost entirely, on carbohydrate as a source of body-fuel, we would suffer from digestive disturbances. So, too, would we suffer from digestive disturbances—feelings of sickness, desire to vomit, diarrhoea, and sometimes other more serious symptoms—if we had to rely on fats as the sole, or almost the sole, source of body-fuel. We must, therefore, use *both* carbohydrate and fat in proper amounts and proportion one to the other in our diet. The proportion of fat to carbohydrate varies widely in the diet of the people of India and Pakistan, depending on the part of the country in which they live, their food habits and their means. Amongst the poorer classes the proportion of fat to carbohydrate is often as low as one part by weight of the former to twelve or more parts of the latter ; and amongst the well-to-do, and certain races living in the colder parts of Northern India, it may be as high as one part of fat to four or five parts of carbohydrate. It should not be higher than this nor lower than one to eight in the colder, and one to ten in the hotter, parts of the country. The total amount of fat in the diet should not be *less* than 50 grammes a day ; providing about one-sixth of the total calories required each day (Lesson XV).

Fats enable our food to stay longer in the stomach and so we do not feel hungry so soon

as we would were the food to contain little or no fat. It is the muscular contractions of the empty stomach which give rise to the feeling of hunger.

When food is eaten and digested the fats it contains are split up into their component parts ; this makes their absorption easy. As these components are being absorbed through the wall of the intestines they are *re-formed* into tiny particles of fat which find their way, by special channels (*the lymph vessels*), into the blood-stream. About three or four hours after a meal rich in fats has been eaten the blood contains quantities of these tiny fat particles, and if it were drawn and allowed to stand without clotting these fat particles would rise to the surface and form a layer, just as the fat particles rise to the surface of milk, and form a layer of cream, when it is allowed to stand.

The fat distributed to the tissues is either burnt up as body-fuel or, if there is more of it than is needed for immediate use, it is deposited, together with the fat formed from a surplus of carbohydrate (Lesson VII), in various parts of the body as a reserve of fuel for times of need. This body fat (*adipose tissue*) serves useful purposes: it collects under the skin where it acts like a blanket preventing too great loss of heat from the body when it is exposed to cold. It also collects around delicate organs, such as the kidneys, and protects them from injury.

Animal and vegetable fats are equally good as fuel-foods, but they are not equally good for

nourishing the body nor for protecting it against disease ; animal fats being the better of the two. This is because they are good sources of Vitamins A and D, whereas most vegetable fats are not. These vitamins are important constituents of our food and, as we shall learn in later Lessons, their insufficient supply has serious consequences. So our diet should always contain adequate amounts of animal fats—not less than one-third of the total fat needed each day.

Nowadays vegetable oils are manufactured, by a process of hardening, into vegetable ghees and butters : examples of them are *cocogem* and *margarine*. The hardening process destroys any small amount of vitamins which the natural vegetable oils may have contained, and to that extent reduces their nutritive value. Sometimes these vegetable ghees and butters have vitamins or fish-oil concentrates added to them. These “vitaminized” margarines are excellent foods ; almost as good as natural butter, and even better than ghee which is frequently adulterated with vegetable oil and contains little Vitamin A. They have the further merit of being clean, which butter and ghee do not always have. Fish-oils, which are rich in both Vitamin A and Vitamin D, should be produced in large quantities by the various Fishery Departments and sold to the people at a cheap rate. The addition of a little fish-oil to the diet of people, whose principal source of fat is vegetable oil, would greatly improve them.

Fats have other uses in the body besides being fuel-foods and sources of Vitamins A and D: (1) Some of the fats in food contain a substance, called *linoleic acid*, which is essential to the normal development and functioning of the body. It is sometimes called *Vitamin F*, and is needed only in small amounts. The body cannot make this substance for itself and it must be supplied by the fats in food. (2) Fat-like substances, either present in the food-fats or made in the body from fats and other materials in food (carbohydrate, phosphorus, nitrogen) are constituents of the body-tissues and essential to their functions. Thus, together with proteins, they form the material (*protoplasm*) from which the cells of the body are made. Some are present in the blood; and some, of special composition, are present in active tissues like the brain, the nerves, and the liver. Still others (*sterols*) are present in the body-fat, and it is from these that Vitamin D is made by the action of the sun's rays on the body. So fats and fat-like substances are to some extent body-building materials.

We have seen that the amount of fat in the food should not be less than 50 grammes a day, and that not less than one-third of this amount should be animal fat. These amounts are small and may be increased with advantage. More fat is needed in cold than in hot climates and more (per unit of body-weight), particularly in the form of animal fat, by children than by older people. Too little fat in the food gives rise, especially in colder climates, to a hunger for it; and for want of fat there is a lack of "staying" power, difficulty in sustaining effort both physical and mental, and a tendency to disease—parti-

cularly to tuberculosis. This last effect is due, in some part, to want of the vitamins which animal fats contain. Deficiency of fat is often associated with deficiency of other food essentials, and too often with an inadequate amount of food and consequent starvation of lesser or greater degree.

Over-eating of fat-rich and carbohydrate-rich food, together with lack of exercise, leads to the excessive accumulation of body-fat in the belly and other parts of the body, causing the unhealthy stoutness (*obesity*) so often seen in over-indulgent and sedentary people.

LESSON IX

The Vitamins. It used to be thought that protein, fat, carbohydrate, mineral salts, and water provided everything the body needed for its growth and repair and for the generation of energy and heat. It was not until the beginning of the present century that vitamins were definitely known to exist in natural foodstuffs and to be essential constituents of food. It was then found that if pure protein, fat, carbohydrate and mineral salts were mixed together in the right amounts and proportions and the mixture given with water to young rats, as their sole food, they did not grow and many became ill and died. But if the protein, fat, carbohydrate and mineral salts were provided by natural foodstuffs, then the young animals grew and flourished. There was 'something' in the natural foodstuffs, besides protein, fat, carbohydrate and mineral salts, which was necessary for the growth, health and life of the animals. This 'something' was called **Vitamin** because it was *essential to life*.

Now if these natural foodstuffs were treated in certain ways, they lost their power, either wholly or in part, of enabling young animals to grow and remain in good health. If, for instance, the fat in their diet were butter that had been heated in a stream of air for some time, then the animals did not grow and they developed disease of the eyes and other parts of the body. This treatment of the butter destroyed 'some-

thing' necessary for growth and health. This 'something' was found, by experiments on animals, to be present in animal fats generally. It was called **Vitamin A**.

A few years before these discoveries were made, it was noticed that if pigeons or fowls were fed only on polished rice and water they lost their appetite, got diarrhoea, became very thin, developed paralysis, and died. The paralysis was due to an affection of the nerves (*polyneuritis*), which resembled a disease in human beings called *beri-beri*. But if, instead of *polished* rice, the birds were fed on whole, unmilled rice, they remained well ; or if, together with the polished rice, they were given the 'polishings,' removed from the whole grains in the process of milling, then they also remained well. Moreover, the 'rice polishings' not only prevented the birds getting polyneuritis but cured them if they had got it. It was found, too, that when human beings lived mainly on polished rice they often got beri-beri, but did not get it when they lived mainly on whole, unmilled rice. It was evident, therefore, that milling and polishing removed 'something' from the whole rice grains which prevented polyneuritis in birds and beri-beri in man. This 'something' was a vitamin and was called **Vitamin B**. By means of experiments such as these, this vitamin was found to be present in many other natural foodstuffs and to be particularly abundant in yeast.

For some years after its discovery Vitamin B was thought to be a single vitamin. It was then

found that when yeast was heated to a high temperature it lost its power to prevent beri-beri but still retained 'something' which was necessary for growth and health. This 'something' was another vitamin. So the part destroyed by heat was called **Vitamin B₁** and the part not destroyed by heat was called **Vitamin B₂**. Both were soluble in water and, therefore, different from Vitamin A which was soluble in fats. Both were present in plants used as food by animals and man: vitamin **B₁** principally in their seeds (cereal grains, nuts and pulses) and vitamin **B₂** principally in their growing shoots and young green leaves.

It had for many years been known that sailors who lived for long periods on salted or dried foods were likely to suffer from a disease called **Scurvy**. But nobody knew why this was so, though it was known that lime juice or fresh vegetable juices prevented it. It was not until animals, in this case guinea-pigs, were fed on such dried foods, or on a diet of dried oats and boiled milk, that the cause of this disease was discovered. Guinea-pigs fed in this way developed scurvy, but if they were given fresh green vegetables they did not. If the vegetables were boiled the guinea-pigs got scurvy just as they did when they had no fresh vegetables. The boiling destroyed 'something' which prevented and cured the disease. This 'something' was also a vitamin, and was called **Vitamin C**. By experiments such as these, this vitamin was also found to be soluble in water and to occur in many

natural foodstuffs, particularly in fresh vegetables and fruit.

While these discoveries were being made it began to be thought that the disease called **Rickets**, prevalent in children in many parts of the world and the cause of which was then unknown, might be due to 'something' in the nature of a vitamin. It was noticed that this disease usually occurred in children who lived in dark and gloomy houses into which bright sunlight never penetrated. It was noticed, too, particularly in India, that children who ran about in the sun all day did not suffer from it, and that in less sunny countries it occurred chiefly in children whose food contained little or no milk, butter or animal fats. So, again, by experiment on young growing animals, it was found that there was 'something' in milk, butter, animal fats and fish-oils which prevented the disease and cured it in young animals or in children who suffered from it. This 'something' was a vitamin which, like Vitamin A, is soluble in fats. It was called **Vitamin D**. And a curious thing about it was that it was formed by the action of the sun's rays on the body. That was why children who ran about in the sun, and whose food contained enough building-materials (calcium and phosphorus) for their bones, did not suffer from rickets, although their food might not contain any, or only a very little, of the natural foodstuffs in which Vitamin D occurred.

In the same way—by experiments on animals—it was found that there was a vitamin

in many natural foodstuffs, particularly in cereal grains, without which human beings and animals could not have healthy young. This vitamin was called **Vitamin E**.

Besides these Vitamins—A, B, C, D, and E, represented in the rays of our Food-star (Lesson II)—others have been discovered during recent years. It is now known that Vitamin **B₂** is not a single vitamin but a group or family of vitamins; that there is more than one Vitamin D; more than one Vitamin E and at least two other vitamins called respectively **Vitamin K** and **Vitamin P**. It is probable that still more vitamins remain to be discovered, but it does not greatly matter to us how many there are so long as we remember that they are all—those discovered and those still undiscovered—present in the foodstuffs which Nature supplies for our use, provided we eat them as Nature supplies them and do not spoil them by removing the vitamins from them by refining, cooking and other processes.

Vitamins are present in food in very small amounts. They contribute nothing to the energy-value (Lesson XV) of food nor to the structure of the body itself. Yet they make it possible for the living tissues of the body to utilize the other essential constituents of food. Without their adequate supply normal growth and health are impossible.

LESSON X

Vitamin A. This vitamin is formed in the bodies of animals and man from certain yellowish pigments, called *carotenes*, present in vegetable foods. Carotenes are found among the yellow, orange-yellow or reddish-yellow colouring matters of such plants as carrots, sweet potatoes and yellow maize. They are also mixed with the green colouring matter of plants; the young shoots and growing parts of plants being particularly rich in them. It is easy to remember that all fresh edible plants or parts of plants having these colours contain the carotenes from which Vitamin A is made in the human and animal body.

Herbivorous animals (cows, sheep, etc.) get the carotenes they need, for conversion into Vitamin A, from the grasses, herbs and shrubs on which they graze. Birds get them from similar sources, as well as from berries. Fish get them from lowly forms of vegetable life living on the surface of the sea or in ponds, lakes and rivers.

When vegetable foods are eaten by animals or by man, *some* of the carotenes they contain are converted into Vitamin A. The vitamin is soluble in fats; and so it dissolves in the fats of the body, where it is stored for day-to-day use. Its chief store-house in the body is the liver. Vitamin A passes into the milk of animals suckling their young and of women suckling their infants. It passes also into the

eggs of birds, where it is needed for the development of the young chick.

So it is that *ready-made* Vitamin A is present in certain animal foods : milk, butter, liver, egg, animal fats and fish-oils. There are, therefore, two sources from which children, as well as grown-ups, may derive Vitamin A : (1) green and yellow or orange-yellow vegetable foods containing the carotenes from which Vitamin A is made in their own bodies ; and, (2) fatty foods of animal origin containing ready-made Vitamin A. Although the latter is the better of the two, it is best to use both sources—vegetable and animal. It is best, too, to think of the common foodstuffs in terms of the amount of Vitamin A they yield ; whether as the ready-made vitamin or as carotene from which it is made in the body. The approximate Vitamin A-values of the commoner foodstuffs are shown in the Tables at the end of the book. But here some examples may be given of good, fairly good and poor sources of the vitamin, and of foodstuffs yielding little or none :

1. **Good sources of Vitamin A.** Halibut oil, cod-liver oil, liver, butter, cream, cheese, red palm oil, carrots, apricots, mangoes, papaya, and green leafy vegetables such as spinach and turnip tops.
2. **Fairly good sources of Vitamin A.** Whole milk, egg, animal fats, ghee, green gram and young green peas, amaranth, yellow root vegetables, yel-

low maize, soya bean, brussels sprouts, bamboo-shoots, tomatoes, red and yellow pumpkins, pomeloe, jack fruit, oranges, limes, guava, plantain and chillies.

3. **Poor sources of Vitamin A.** Lean meat, cereal grains, black gram, dhal, nuts and seeds, white root vegetables, most fruit, and vegetables other than green leafy ones. Vegetable fats (other than red palm oil), polished rice, arrowroot, white flour, tapioca, sugar, honey and molasses contain little or none.

If the diet is made up of the foods mentioned in the last class it will not yield enough Vitamin A for the best health. But with the addition to it of whole milk, butter, yellow root and green leafy vegetables, plenty of Vitamin A will be provided.

Ordinary cooking does not destroy carotene nor Vitamin A to any great extent. But Vitamin A is destroyed when cooking is prolonged and by exposure of the food to air. The fresher the foods are the better.

Vitamin A is essential to the growth and development of children and to the maintenance of health at all ages. It is, therefore, necessary that the food of pregnant women should be rich in foodstuffs yielding it ; if it is not their babies will be weak at birth, and their milk will be scanty and contain little Vitamin A; the infants will not thrive on the breast-milk and will be

prone to serious illnesses from which they may die. This is one of the reasons why so many children in India and Pakistan do die in infancy.

After weaning, children should, if possible, be given cow's, goat's or buffalo's milk ; care being taken that it is clean and does not come from diseased animals. The amount of Vitamin A in cow's milk depends on the way the cows are fed. If they are fed on dried-up and parched fodder, as they so often are during the dry season in tropical countries, then they do not get enough carotenes in their food and so their milk contains little Vitamin A. Such milk is not the best for children.

As children grow up, and throughout life, they should, if they can get them, eat enough of the animal foods containing Vitamin A and of vegetable foods containing carotenes. If they do so, and provided their diet is right in other respects, they will grow tall, strong and lithe of limb, with well formed bones and teeth, sleek skin and well developed muscles ; and if they continue throughout life to eat this kind of food they will be healthier and longer lived than those whose food is not rich in this vitamin.

Children who do not get enough Vitamin A grow badly and are poorly developed. Their eyes, blood, teeth, bones and skin, and sometimes even their nervous systems, are not as perfect as they should be. They may—as may older people—suffer from **night-blindness** and be unable to see clearly in the dusk. The poorer their food is in Vitamin A the worse this night

blindness is likely to be. It is a common complaint in India and other parts of the world.

Vitamin A is needed to help in maintaining the resistance of the body to infections of various kinds. There are, as everyone knows, or should know, certain small organisms called *microbes* which, on entering the body, may cause disease. Now one of the ways in which microbes can get into our bodies is through the skin, or through the velvety *mucous membranes* which line the inside of the eyelids, the mouth, the nose, the wind-pipe, the bowels and the bladder. If the skin be healthy, clean and whole, microbes either do not grow upon it, or if they do they cannot flourish; nor can they get through it except by such means as cuts, injuries or the bites of insects.

Nor can microbes flourish upon or get through the mucous membranes if these be healthy and whole. It is true that some microbes (called *viruses*) are so small that they find their way into the body somehow; but the healthier the mucous membranes the more difficult it is for them to do so. The great way to keep the skin and mucous membranes healthy is to eat food of the right kind, containing an adequate supply of Vitamin A and of the carotenes yielding it. If this is not done the skin loses its smooth, sleek texture, and the mucous membranes become dry and lose their powers of resistance to microbes which will then grow on, in, and sometimes through them. In this way many diseases, particularly of the eyes, the lungs and the bowels, are produced or favoured in their occurrence.

Chief among diseases caused in this way is a state of dryness and inflammation of the eye-balls and eye-lids (*Xerophthalmia*) which, if left uncured, may cause softening of the cornea (*Keratomalacia*), destroy the eyes, and produce total blindness. Blindness due to this cause is common in some parts of India, particularly in young children. In much the same way the powers of resistance of the lungs to infection by microbes may be so lowered that such diseases as pneumonia and tuberculosis are favoured in their occurrence, or those of the intestines may be so lowered as to favour the occurrence of diarrhoea or dysentery.

Another disease which may occur in children and older people whose food is poor in Vitamin A and in other food-essentials is *toadskin* ; so-called because the skin becomes like that of a toad. It is dry, rough and scaly, and around the roots of the hairs there are little dry, hard, pointed pimples, which may be very itchy. This condition occurs chiefly on the backs of the forearms, the front of the thighs, and behind the neck and shoulders.

Deficiency of Vitamin A is also one of the causes of *stone-in-the-bladder*, especially in people whose food consists mainly of whole wheat-flour.

From all this it will be seen how very important Vitamin A is for the growth, development and health of children as well as for the health of older people, and how necessary it is that their food should contain an abundant supply of it. For there may be enough Vitamin A in the food to prevent night-blindness or toadskin, or even to maintain fair health, and yet not enough for the best possible health.

LESSON XI

Vitamin B₁, also called **Aneurin** or **Thiamine**, is the *anti-neuritic* or *anti-beri-beri* vitamin. It is made by plants (Lesson III), and is stored in their seeds or fruits ; it is also present, though less abundantly, in their green leaves. When the seeds and leaves of plants are eaten by man and animals the vitamin passes, ready-made, into their blood and tissues. Much of it goes to such organs as the liver, the kidney and the heart, and these parts of animals, when used as food by man, are good sources of it. The flesh of animals contains relatively little, so flesh-foods are poor sources of it for man. It passes into the eggs of birds and is stored in their yolks ; white-of-egg contains little. It also passes into the milk of animals and of women who are nursing their babies. The amount of Vitamin **B₁** present in the milk of cows, buffaloes and goats is relatively small ; at best, milk contains, weight for weight, only about one-tenth part of that contained in whole wheat flour. When the food of milk-yielding animals is poor in Vitamin **B₁**, as it often is in India and Pakistan, their milk will contain less still. Milk is thus a poor source of Vitamin **B₁** for man, though of great value in other respects. The food of women who are nursing their babies should contain an abundant supply of this vitamin, otherwise their infants will not get enough of it and will become ill in consequence.

Vitamin **B₁** is soluble in water and does not

occur in fats or oils, whether of animal or vegetable origin.

The chief sources of Vitamin B₁, arranged in descending order of value, are :—

1. *Whole* cereal grains ; whole wheat flour, oatmeal, barley, cholam, cambu, ragi, maize and home-pounded rice.
2. Liver, kidney, heart-muscle and egg-yolk.
3. Pulses : peas, beans, soya bean, dhals and grams.
4. Nuts, seeds, and the kernels of fruit stones such as those of apricots.
5. Root vegetables such as artichokes and parsnips ; and, tomatoes.
6. Green leafy vegetables such as lettuce, cress, spinach, cabbage ; other vegetables such as cauliflower, leeks, onions ; and, milk.
7. Some fresh fruit such as oranges and bananas, and dried fruits such as raisins.

Yeast and yeast preparations (*marmite*) are very rich in B-Vitamins (**B₂** as well as **B₁**), and may be used as supplements to the diet when supplies of foodstuffs containing these vitamins are scanty. They are useful in the treatment of maladies caused by want of B-Vitamins.

It is upon cereal grains that we have mostly to rely for adequate supplies of Vitamin **B₁** ; not only because they are rich in it but because they make up the bulk of our diets. In a well-constituted diet (Lesson XV) whole cereal grains

will supply more than half of the total amount of Vitamin **B₁** it contains. But these grains are often subjected to processes which remove most of the vitamin from them before they are used as food ; as when rice is milled and polished, or when wheat is made into refined white flour, or maize into refined cornflour, or when par-boiled rice is subjected to much washing. The refined products of cereal grains contain relatively little Vitamin **B₁** and are poor sources of it for man. Thus, *atta* contains about six times as much of the vitamin as white flour and home-pounded rice about eight times as much as polished rice. Tapioca contains very little Vitamin **B₁** ; sago and arrowroot contain practically none.

Foodstuffs such as liver, dhal and groundnut are rich sources of the vitamin but we do not, or should not, eat as much of them as we do of cereal grains and so they contribute much less of the vitamin to our diet. Vegetables, though containing only about one-quarter of the amount of Vitamin **B₁** that is present in whole cereal grains and pulses, are nevertheless good sources of it provided we eat enough of them. This is another reason, besides those given in previous Lessons, why our diet should contain an abundance of fresh vegetable foodstuffs.

If, then, our diet be made up of any whole cereal grains or a mixture of whole cereal grains, with some pulses, and an abundance of fresh vegetables and fruit, together with milk and butter or ghee—to supply other essential ingredients of food—they will contain all the Vitamin

B₁ (and, indeed, everything else) we need for normal nutrition and health.

Vitamin **B₁** is needed for the growth of the body and the maintenance of the body-weight ; its adequate supply during infancy and childhood is most important. Young children are very sensitive to want of it, and rapidly fall ill in consequence. It is needed, also, to maintain the appetite, and the functional efficiency of the nerves, the muscles, the heart and the gastrointestinal tract. And it is needed, too, for the proper burning-up (combustion) of, and the liberation of energy from, carbohydrate, ; when it is deficient in the diet the products of incomplete combustion of carbohydrate collect in the body and cause illness.

When the food contains an ample supply of Vitamin **B₁**, it is—if otherwise properly constituted—eaten with relish, well digested, and the waste products of digestion are regularly discharged from the bowels. When the food does not contain an ample enough supply of it, the appetite and digestion are poor, there is loss of weight and strength, nervousness, irritability, digestive disturbances and irregular action of the bowels. Children often suffer in these ways for want of sufficient Vitamin **B₁** in their food.

When the vitamin-deficiency is greater or protracted over long periods **Beri-beri** is very likely to occur, particularly in those subjected to chills, fatigue or attacks of fever or diarrhoea.

Beri-beri is a disease, occurring chiefly in the Tropics amongst rice-eating peoples, in which

there is weakness, numbness and tingling of the limbs, particularly of the legs. When squeezed the legs are tender. People suffering from beri-beri find it difficult to sit down or stand up. They walk with a high-stepping gait and have to use a stick, well placed in front of them, for support. There is difficulty in picking up small objects and they fumble over doing such things as buttoning a coat. In severe cases, the heart may be affected, and there may be great swelling of the body due to fluid collecting in it (*oedema*) ; the disease is then called *wet beri-beri*. In other cases there is much wasting of the body, which becomes thin and dried-up ; the disease is then called *dry beri-beri*.

Infants at the breast are very likely to get beri-beri if the mother's milk is poor in Vitamin B₁, even though the mothers may not themselves be suffering from any serious symptom of the disease. When it occurs in infants it is called *infantile beri-beri*. The disease comes on quickly in infants and, if not treated quickly, they are likely to die suddenly. They have a peculiar whining cry ; their bodies are rigid ; they are constipated and pass little water ; the heart's action is disordered and they may become swollen (*oedema*). It is very necessary both for their own sake and that of their infants that expectant and nursing mothers should have an abundant supply of Vitamin B₁ in their food. If they cannot get enough of it from natural foodstuffs they should take dried yeast, and give their infants sips of yeast-water (dried yeast soaked in water for 24 hours and strained) between breast-feeds, or sips of the water in which rice-polishings have been soaked for 24 hours.

Ordinary cooking does not destroy Vitamin B₁ ; but great or prolonged heat does.

Since it is soluble in water, washing of food, as of rice, dissolves much of it out. It may be lost in this way unless the rice-water is used as a drink. When vegetables are boiled, especially in water to which soda is added, the vitamin is largely destroyed. But the chief reasons why so many people, particularly those whose staple article of diet is polished rice or white flour, do not get enough Vitamin **B₁** are these : (1) their staple article of diet is a poor source of the vitamin ; (2) they do not eat enough of other food-stuffs containing it ; and, (3) the amount of Vitamin **B₁** in their diets is deficient relative to the large amounts of carbohydrate they contain ; for, as we have learnt in Lesson VII, *the more carbohydrate in the diet the more Vitamin B₁ is needed.*

Persons who suffer from disease of the stomach or bowels, or who drink much intoxicating liquor, are likely to develop *neuritis* because they cannot digest their food properly nor make proper use of the anti-neuritic vitamin it contains.

LESSON XII

Vitamin B₂. When this vitamin was first discovered it was thought to be a single vitamin. But later it was found to be a group or family of several vitamins, all of which were soluble in water and resistant to heat. One member of the family was a greenish-yellow pigment, called *flavin*, found in plants particularly in their young shoots and growing leaves. To it the name **Riboflavin** was given. Another was a substance which prevented, or helped to prevent, the disease called *pellagra*, and to it the name **Nicotinic Acid** or **Niacin** was given ; it is not to be confused with the nicotine of tobacco. It is sometimes called *Vitamin PP* : one 'p' standing for 'pellagra,' the other for 'preventing.'

Besides these two, several other members of the Vitamin **B₂**-family have been isolated within recent years and shown to be necessary for health, particularly of the skin, the blood and the alimentary tract. We need not concern ourselves with them ; for if our food contains enough Riboflavin and Niacin it will contain enough of these other members of the Vitamin **B₂**-family.

The **B₂**-Vitamins are made in the young shoots and growing leaves of plants. When the plants are eaten by animals, the vitamins pass, ready-made, into their flesh, organs, eggs and milk ; these animal foods, as well as the young shoots and growing leaves of edible plants, are good sources of them for man.

Since all members of the Vitamin **B₂**-family

are present in the same kind of foodstuffs—though in some foodstuffs one member may be more abundant than others—it will serve our purpose best to learn what foodstuffs are rich in all of them, and what foodstuffs contain them only in moderate or in small amounts, or do not contain any at all.

Good sources of Vitamins B₂ are yeast, liver, kidney, fresh lean meat, whole milk, cheese, milk-powder, egg, fresh green peas, and fresh young green leafy vegetables such as spinach, broccoli and turnip-tops.

Fairly good sources of Vitamins B₂ are grams, dhals, soya bean, groundnut, tomatoes, potatoes, sweet potatoes, avocado pear, apricots and coconut.

Poor sources of Vitamins B₂ are cereal grains in general, carrots, and most root vegetables and fruit. White flour, polished rice, tapioca and arrowroot contain little ; butter, ghee, animal and vegetable fats and oils, and sugar contain none.

The diet will contain too little Vitamin B₂ if it is made up for the most part of the foodstuffs mentioned in the last two classes, but if it contains a sufficiency of one or more of the animal foodstuffs mentioned in the first class *and* of fresh green leafy vegetables there will be no risk of deficiency of any of these vitamins.

The distribution of Vitamin B₂ in animal and vegetable foodstuffs differs somewhat from that of Vitamin B₁. Thus, whole cereal grains which are rich sources of Vitamin B₁, are poor sources

of Vitamin **B₂**; green leafy vegetables are richer sources of Vitamin **B₂** than of Vitamin **B₁**; milk contains more **B₂** than **B₁**; and white-of-egg which is poor in Vitamin **B₁** is relatively rich in Vitamin **B₂**.

Like Vitamin **B₁**, Vitamins **B₂** are not stored to any considerable extent in the body; a daily supply of them in the food is, therefore, necessary. This supply should be abundant, especially for growing children, and for expectant and nursing mothers; for while the food may contain enough of these vitamins to prevent obvious signs of their deficiency, a liberal supply of them is needed for the best health.

Vitamins **B₂** are essential to growth of the young and to the maintenance of health and vitality at all ages. They play a part in the production of energy, and in maintaining the health of the skin, the normal constitution of the blood-cells and the normal operation of the digestive processes. The effects of their deficiency in the diet are as follows :—

Deficiency of Riboflavin causes the tongue to be sore and inflamed at its tip and edges. It may be of a purple or magenta colour and is often cracked. It is painful when the food is hot or contains hot things like chillies. The corners of the mouth may be swollen, inflamed, cracked and covered with a crust. The *lips* may be red and swollen and their margins cracked. The eyelids and the nostrils may be affected in the same way. The skin may have rashes, round the eyes, the ears and nose, on the cheeks and forehead, and on parts of the body which rub one

against the other, as at the bends of the elbows and knees and on the inner surface of the thighs. The eyes are usually burning and bloodshot ; bright light hurts them. There may be dimness of vision ; children who suffer in this way are often given reading glasses when what they need is a well-balanced diet.

Deficiency of Nicotinic Acid (Niacin) causes, or helps to cause, **Pellagra**. The word 'pellagra' means 'rough and inflamed skin', and it is because this condition of the skin (*dermatitis*) is the chief symptom of pellagra that the disease is so-called. The rash occurs on both sides of the body at once, particularly in those parts exposed to the sun: the backs of the hands, lower forearms, neck, the back of the feet and lower part of the legs in people who go bare-legged and bare-footed. A second sign of pellagra is digestive disturbances, particularly diarrhoea ; and a third is depression, sometimes so great that the sufferers may lose their reason.

In addition to these three signs of pellagra—dermatitis, diarrhoea and depression—which in severe cases are present together, there may be, and often are, others due to deficiency of riboflavin, particularly in the tongue, lips and corners of the mouth. And there may also be others due to deficiency of Vitamin B₁ : numbness, tingling, tremors, cramps, pains in the limbs and difficulty in walking.

Children who suffer from pellagra are under-sized and under-weight. They are backward at school. In addition to the rash, they may have sore tongues and digestive disturbances. The signs of pellagra in infants are sore mouth, a red rash on the face, hands and legs, diarrhoea and some oedema.

It usually happens when diets are deficient in Riboflavin or Niacin or both that they are deficient also in other food-essentials—particularly in protein of good quality—and ‘ill-balanced’ (Lesson XXIII). These other defects enhance the disease-producing potency of the Vitamin **B₂**-deficiency and must be corrected at the same time that the vitamin-deficiency is corrected, otherwise the health of the users of the diets cannot be fully restored. The way to correct the faulty diets (and to prevent the diseases to which they give rise) is (1) to include in them adequate amounts of one or more of the animal foodstuffs (milk, egg, liver, lean meat), which provide both **B₂**-Vitamins and proteins of good quality ; (2) to include in them an ample supply of fresh green leafy vegetables; and (3) to ‘balance’ the diets in accordance with the rules set out in Lesson XV.

In a book of this kind it is not necessary to say much more about the function in the body of the other members of the Vitamin **B₂**-family, nor to mention their chemical names. It may, however, be said that they appear to be concerned in preventing—and in their manufactured, or synthetic, forms to be useful in curing—a severe form of *anaemia*, and a disease of the gastro-intestinal tract and blood, called *Sprue*, which is common in India and Pakistan especially amongst Europeans who live there.

LESSON XIII

Vitamin C, also called **Ascorbic Acid**, is the *anti-scorbutic Vitamin*. It occurs in all fresh green vegetables, in edible green leaves and in most fresh fruits, though some contain more of it than others. It is not present in the seeds of plants such as rice, barley, wheat, maize, pulses and nuts. But when grains are soaked in water and allowed to sprout the sprouts contain it. A good way to obtain Vitamin C when green vegetables and fruit are scarce is this :

Dhal, gram, unsplit peas, wheat, or any other grain is first soaked in water for 24 hours and is then spread out on damp earth or on a damp blanket and covered with a moist cloth or sack (gunny bag) which is kept moist by sprinkling water upon it from time to time. After two or three days the grains will have sprouted and be ready for use. The sprouted grains should be eaten raw or after cooking in boiling water for not more than a few minutes ; they also contain Vitamins A and B.

When fresh vegetables and fruit, containing Vitamin C, are eaten by animals the vitamin is absorbed into the body where it is present in the blood and in organs such as the liver. There is not much Vitamin C in the flesh of animals ; to obtain enough of it from this source the flesh has to be eaten raw and in considerable quantity. The vitamin is passed into the milk of animals who suckle their young, and is, therefore, present—though not in large amount—in the milk

of buffaloes, cows, goats and other animals provided they are fed on fresh green grass or leaves. If they are fed on dried-up grass their milk contains little Vitamin C.

It is mainly on fresh vegetables and fruit that human beings rely for an adequate supply of Vitamin C. The approximate Vitamin C-values of the commoner foodstuffs are shown in the Tables at the end of the book. But here some examples may be given of good, fairly good and poor sources of the vitamin and of foodstuffs containing little or none :

1. **Good sources of Vitamin C.** Fresh raw cabbage, amaranth, turnip-tops, and the *young* green shoots of edible plants, fresh lemon, lime and orange juice, grapefruit, guava (country), parsley, drumstick, knol-khol, green chillies and young green peas.
2. **Fairly good sources of Vitamin C.** Sprouted grains, cress, lettuce, tomatoes, apples, pineapple, apricots, papaya, cape gooseberry, spinach and potatoes.
3. **Poor sources of Vitamin C.** Cow's, buffalo's and goat's milk, meat, liver, kidney, root vegetables, grapes, pumpkin, water-melon, egg-plant, ash and snake gourds, cooked vegetables and vegetables kept for a long time before eating. Milk-powder, cheese, cereal grains (rice, wheat, millet, maize), dried pulses, nuts and

seeds, tapioca, animal fats, vegetable oils, honey, sugar and jaggery, contain none.

It is not to be understood that foodstuffs containing small amounts of this vitamin are of no use as sources of it; they are of use, but to get enough of it from them we have to take a good deal of them. Thus, we would have to take 3 or 4 pints of fresh milk, or two pounds of grapes, or nearly a pound of carrots, or half a pound of bananas, to get as much Vitamin C from them as from one ounce of lemon or orange juice or of raw cabbage leaves.

Vitamin C is the most easily destroyed of all vitamins. Prolonged heat, especially in the presence of air, destroys it. Ordinary cooking causes a loss of about 60 per cent. The longer the time of cooking and the greater the heat the more rapidly it is destroyed. If soda is added to the water in which vegetables are cooked the vitamin is destroyed more quickly still. Potatoes, if boiled in their skins, retain a considerable amount of their original content of Vitamin C. There is a ferment (*enzyme*) associated with Vitamin C in vegetables which destroys the vitamin when the vegetables are cooked, minced or grated. They should be put into boiling and not into cold water for cooking; the boiling water destroys the enzyme and lessens the loss of the vitamin. Vitamin C is soluble in water and some is lost if the water in which vegetables are cooked is thrown away and not used, as it should be, as a drink or for making soups.

Because of the comparative ease with which the amount of Vitamin C in vegetables is reduced by cooking, we should include a certain amount of *raw* vegetables and fruit in our diets every day ; care being taken to cleanse them thoroughly.

Vitamin C is needed by the body (1) to prevent the blood leaking out of the blood-vessels ; (2) to help in the building of the body, especially of the bones and teeth ; (3) to help in keeping the bowels healthy ; and (4) to help the body to resist infection by microbes. People who are suffering from fevers, injuries and wounds need more Vitamin C than healthy folk. A good way to give it to them is in fruit and vegetable juices, diluted with water. In this way they not only get the Vitamin C but also the mineral salts and water they need.

When food containing little or no Vitamin C is eaten for any length of time—as it often is during the hot, dry season when fresh green vegetables are scarce—then the Vitamin C stored in the body is soon used up and **Scurvy** is likely to arise.

Scurvy is a common disease in India and Pakistan. Its chief sign is bleeding from the gums, under the skin, and into the muscles. The gums are spongy, blood oozes from them and the teeth become loose. Bleeding under the skin occurs mostly in the limbs and trunk, especially round the roots of the hairs ; it is difficult to see in dark-skinned people. Bleeding into the muscles occurs most often in those who use them much, as in labourers, soldiers, and people who are always standing or walking about. Because of it the legs may be

swollen and feel hard. Bleeding may also occur in the joints and cause them to be painful; and there may be bleeding from the bowels. Broken bones and wounds are slow to heal.

It is not necessary that all the signs of *severe* scurvy should be present before we know that there is not enough Vitamin C in the food ; for many signs of ill-health are present long before the severer signs of scurvy appear. When our food contains too little Vitamin C for perfect health, we may have poor appetites, be pale, anæmic, short of breath, lazy and irritable, and lose weight or not gain in weight ; the heart may beat too quickly ; the gums may be spongy and unhealthy, the teeth bad and the breath offensive ; the joints may ache and the ankles swell ; and, wounds and broken bones may be slow to heal.

Infants who suffer from scurvy cry a great deal when they are handled because their bodies are painful. It is very important that the diet of women who are nursing their babies should contain an abundant supply of foodstuffs rich in Vitamin C, and that infants be given diluted fruit or vegetable juices, such as orange juice, swede juice or tomato juice, between their feeds of milk. Older children, also, should take plenty of fresh fruit or vegetable juices.

LESSON XIV

Vitamin D. This is the *anti-rachitic vitamin*, so called because it is concerned in the building of the bones and teeth and in the prevention of the disease called *Rickets*.

It is produced in the bodies of animals and man by the action of the sun's rays on the skin. There are in the fats of the skin certain substances called *sterols* (Lesson VIII) ; some of these are converted into Vitamin D when acted upon by sunlight. The vitamin so formed is absorbed from the skin into the blood. It is soluble in fat and is stored in the fats of the body, and in the liver. It also passes into the milk of animals suckling their young and of women suckling their babies, and into the eggs of birds in the yolks of which it is abundant.

Plants, both those growing on land and those growing in rivers, lakes and seas, also contain sterols, and Vitamin D is made from them in the same way—by the action of sunlight. The vitamin is present in the green leaves of plants, but not in amounts sufficient to satisfy the human body's need for it. Fish obtain it from river, lake and sea plants. It is abundant in fish-liver oils, particularly those of sea-fish : cod-liver oil, etc.

There are thus two sources from which we can obtain Vitamin D: (1) by exposing our bodies to sunlight ; and (2) by including in our diets one or more of the foodstuffs containing it—fish-liver oil such as cod-liver oil, sea-fish,

eggs, butter, cheese, liver, and milk—together with green leafy vegetables. It is a good plan to make use of both sources ; for milk, butter, egg-yolk and liver will not contain much Vitamin D unless the animals from which they are obtained are fed on green pastures and exposed to sunlight. It is mainly on sunlight that millions of children in India and Pakistan have to rely for their supplies of this vitamin; foodstuffs containing it being often scanty or unobtainable.

In some parts of India, and other tropical countries, people occasionally rub their bodies over with some vegetable oil and then sit about in the sunlight. Infants and young children who are poorly grown and weakly are often treated in this way. The practice is a good one, because Vitamin D is produced in the oil and consequently there is a greater absorption of it into the body.

The Vitamin D in foodstuffs is not destroyed by ordinary cooking processes, nor is there any serious loss of it when these foodstuffs are stored.

The functions of Vitamin D in the body are (1) to enable the calcium and phosphorus contained in food to be absorbed ; and (2) to enable these mineral elements to be utilized in the building of the bones and teeth.

Children who do not get enough Vitamin D fail to grow properly and sooner or later develop **rickets**. In a previous Lesson (VI) we learnt that deficiency of calcium in the food is *one cause* of softening of the bones and of rickets and that deficiency of phosphorus is

another cause of imperfect formation of the bones. Now we learn that rickets may also occur if the food does not contain enough Vitamin D or if the body does not get enough sunlight. It is easy to understand why rickets may be caused in these different ways. For if the food does not contain enough building-materials—calcium and phosphorus—and in the right proportions, the bones cannot be properly built ; and, even if there are enough of these building-materials in the food they cannot be properly absorbed nor built into the bones without the help of Vitamin D.

Rickets. Children who suffer from rickets are nervous, cross, restless and sleep badly. Their muscles and joints are slack and their bones are soft. They cannot stand or walk as early in life as healthy children. When they do begin to stand and try to walk they become bow-legged or knock-kneed. Their arms and spines may become crooked and their pelvis malformed. Their blood is poor and they look pale and pasty (*anaemic*). They are constipated and their bodies bulge in front. Many have 'fits' (*convulsions*) and are liable to catch 'colds', or to suffer from diseases of the lungs from which they may die. Even if they survive their bodies may be mishapend, dwarfed and stunted. Malformation of the pelvis in girls may be a source of danger to them and to their babies when the time comes for them to marry and have children. Adult rickets (*osteomalacia* : softening of bone) is not uncommon in certain parts of India and Pakistan, particularly in purdah women who do not enjoy the benefits of sunlight and whose food is deficient in calcium, phosphorus and Vitamin D.

Pregnant and nursing women are more apt to suffer from it than other women. It may give rise to crippling deformities of the bones.

Want of sufficient Vitamin D is also *one of the causes* of bad teeth and of their early decay. But as there are many causes of bad teeth and as it is so important to our health to have good ones and to take proper care of them, we shall return to this subject in another Lesson.

The manufactured, or synthetic, form of Vitamin D is called Vitamin D₂ or **Calciferol**; the latter name reminds us that this vitamin helps to calcify the bones. It is made by exposing one of the sterols (*ergosterol*) to ultra-violet light (Lesson III). Vitamin D₂ can also be produced in foodstuffs, such as vegetable oils, by exposing them to sunlight.

Vitamin E. Vitamins of this class are soluble in fats. They occur in many different foodstuffs: the oils from cereal grains (wheat, rice, maize, etc.), are good sources of them; the fats of meat, eggs and vegetables also contain considerable amounts. Wheat germ oil is especially rich in them. They are rapidly destroyed when the oils or fats containing them become rancid. The work they have to do in the human body is still uncertain, but they are known to be necessary for growth and normal reproduction.

Vitamin K and Vitamin P are not of any practical importance to us, so far as our choice of food is concerned. For if our diet contains enough of the fat-soluble vitamins—A, D and E—it will contain enough Vitamin K; and, if it

contains enough water-soluble Vitamins—C and B—it will contain enough Vitamin P. Vitamin K helps the blood to clot and so to prevent bleeding (*haemorrhage*). Vitamin P helps, together with Vitamin C, to prevent blood leaking from the minute blood-vessels (*capillaries*).

The Protective Foods. Remembering what we have learnt in previous Lessons about the distribution of the various vitamins we now know that we can obtain them all from comparatively few foodstuffs : whole cereal grains, milk, egg, liver, meat, fish, pulses, fruit and green leafy vegetables. We have learnt, too, that we can obtain all the mineral salts we need from comparatively few foodstuffs : whole cereal grains, milk, egg, pulses, fruit and green leafy vegetables. Indeed, it may be said that if the staple article of our diet be one of the whole cereal grains, or a mixture of whole cereal grains, we will get all the vitamins and all the mineral salts we need, as well as adequate amounts of good quality protein, if with the staple food grains and dhal we take enough milk and milk products, green leafy vegetables and fruit. *Milk and its products, green leafy vegetables and fruit* are thus very important components of our diet because, when taken together, they provide all the food-essentials in which other ingredients of the diet are likely to be poor. For this reason they have been called **the Protective Foods** : they protect us from illnesses caused by want of vitamins, mineral salts and proteins of good quality.

Synthetic Vitamins. Nowadays vitamins are made artificially. These synthetic vitamins are used in the treatment of diseases caused by deficiency of natural vitamins in the diet. They are not needed by people who can obtain enough vitamins from natural sources. It is on natural sources of vitamins that they should rely and not on the artificial products.

When synthetic vitamins are used, either to cure diseases caused by deficiency of natural vitamins or to prevent such diseases, the diet to which they are added should always be *well-balanced* with respect to the other essential ingredients of food : protein, fat, carbohydrate and mineral salts (Lesson XV).

LESSON XV

The Amount of Food Needed. The greater part of our food is needed as fuel : that is, for the production of the energy necessary for life. Even when we are asleep, and completely at rest, energy is being expended in keeping the temperature of the body at a normal level, in breathing, in the beating of the heart, in digestion and in other bodily activities of which we are not conscious. More than half of our daily food is used up in the production of the energy required for these activities. When we wake up and move our bodies, even when sitting up in bed, more energy is expended and more food is needed to provide it ; more still when we begin to move about and to use our muscles in play or work. So the amount of food needed for energy-production varies with the work the body has to do, and even with its posture. It varies, also, with the age, sex and size of the individual, and with the climate in which he lives. More is needed by growing children, in proportion to their body-weights, than by grown-up people ; more by men than by women and by boys than by girls ; more by big than by little people. Women who are pregnant or who are nursing their babies need more than women who are not. More is needed in cold than in hot climates ; and more in winter than in summer. Those who lead an active life in play or in work need more than those of less vigorous habits ; an amount of food which is enough for a child of inactive habits

may not be enough for one whose habits are active.

The various foodstuffs differ in their power to yield energy : their *energy-value*, as it is called, varies. This depends on the amounts of protein, fat and carbohydrate they contain ; these being the substances, as we have learnt in previous Lessons, from which energy is produced in the body. Now the energy-value of any foodstuff can be measured. Just as we measure a thing and record its length or breadth in inches, or weigh a thing and record its weight in ounces, so we can measure the energy-value of a foodstuff and record it in what are called **calories**. A calorie is the amount of heat required to raise the temperature of one kilogramme (2·2 pounds) of water one degree centigrade.

By analysing foodstuffs chemists can tell us how much protein, fat and carbohydrate they contain (see Tables at the end of the book). Now one gramme (15·4 grains) of protein has an energy-value of 4 calories ; one gramme of fat an energy-value of 9 calories ; and one gramme of carbohydrate an energy-value of 4 calories. So when we know how many grammes of protein or of carbohydrate or of both a foodstuff contains, all we have to do is to multiply these amounts by 4 ; this gives the number of calories produced by these two ingredients. Similarly, when we know the number of grammes of fat it contains, we multiply this number by 9 : this gives the number of calories produced by

the fat. The sum total of those produced by the carbohydrate, the fat and the protein in any given foodstuff is its *energy-value in calories*.

The average man, living in the hotter parts of India and Pakistan and doing ordinary easy-going work, needs about 2,500 to 2,600 calories a day. If he is doing heavy work he needs 3,000 or more, according to how hard the work is. To provide these calories the food should contain, after allowing 100 calories for waste, 65 to 75 grammes of protein, yielding 260 to 300 calories ; 50 to 60 grammes of fat, yielding 450 to 540 calories ; the balance being made up of from 450 to 480 grammes of carbohydrate, according to the amount of protein and fat in the diet. Thus, if the diet contains 65 grammes of protein and 50 grammes of fat, 480 grammes of carbohydrate will be needed to bring its energy-value up to just over 2,600 calories ; and, if it contains 75 grammes of protein and 60 grammes of fat, 450 grammes of carbohydrate will be needed.

For a man living in the colder parts of Northern and Himalayan India, and leading an energetic life, the amounts of protein and fat may be increased by about one-third : protein, 90 to 100 grammes ; fat, 70 to 80 grammes ; the carbohydrate being adjusted accordingly.

The amount of food needed each day by the average man is the standard by which we measure the amounts for women and children. Thus, (a) a woman, who is not pregnant nor nursing a

baby, and girls over the age of 14 need about eight-tenths of the amount needed by a man ; (b) a boy over 14 needs as much as a man ; (c) children aged 10 to 13 years need about seven-tenths ; (d) those aged 6 to 9 need about one-half ; (e) those aged 2 to 5 years about one-third ; and, (f) a child aged 2 years about one-fifth. Pregnant women need as much as a man, and nursing women need rather more ; this is because they have to nourish a child in the womb or at the breast.

In a previous Lesson (IV) we learned that the protein requirements of boys and girls between the ages of 10 and 16 are, per unit of body-weight, greater than those of adult men and women.

The Tables at the end of the book give the analyses of the commoner foodstuffs used in India and Pakistan, with their calorie and approximate vitamin-values. From these Tables the energy-value of any diet can be calculated, and **well-balanced diet** constructed for people of different races, castes and religions. In constructing diets the following rules have to be remembered :—

- (1) *Provide enough calories ; and, maintain a right balance between the energy-producing ingredients (carbohydrate, fat and protein) of the diets.*
- (2) Allow 100 calories for the waste which occurs both in the preparation of food and in its utilization by the body ; in institutions, where food is being

cooked for large numbers, allow 200 or more.

- (3) Allow for differences in activity of different individuals and for the work they have to do ; giving those who are very active or who are doing hard work 10 to 15 per cent more than others.
- (4) Allow for differences in age, sex and climate.
- (5) Use a mixture of cereals, rather than a single cereal : rice *and* wheat or rice *and* millet, rather than rice alone.
- (6) Always use the *whole* cereal grains and not the refined products made from them : unpolished and *not* polished rice ; whole wheat flour and *not* white flour.
- (7) See that not less than *one-fifth* of the *protein* in the diet is animal protein, and that not less than *one-third* of the *fat* is animal fat.
- (8) See that fruit and green leafy vegetables, form *at least one-quarter* of the total weight of foodstuffs in the diet.

We need not concern ourselves about the amount (as expressed in figures) of each mineral element and of each vitamin needed in a well-balanced diet. *It is more important to remember the natural foodstuffs in which these essential ingredients of food are abundant ;* for, if these food-

stuffs be present in the diet in sufficient amounts, there will be no lack either of mineral elements or of vitamins. So, if we follow the above rules, and choose the foodstuffs composing our diet aright, the amounts of protein, fat, carbohydrate, mineral salts and vitamins will be adequate and the diet will be *well-balanced* (Lesson XXIII).

LESSON XVI

We must now learn something about the special organs—the teeth, and the alimentary tract—with which Nature has provided us for the proper chewing and digestion of food. For you will readily understand that if these organs are not doing their work properly we cannot get full benefit from our food, no matter how good that food may be.

Teeth. These structures are amongst the most important in the body ; on their proper development and care good digestion and good health largely depend. The ‘centres’ or buds from which the first set of teeth grow are laid down in the jaws, and the teeth themselves have begun to form beneath the gums, before the baby is born. So it is that anything which disturbs the health of the mother before the birth of her child will interfere with the proper development of the child’s teeth. Illnesses of the mother can do this ; but another important cause of bad teeth in children is the wrong food eaten by the mother before the birth of her child, and while she is breast-feeding it. We have learnt in previous Lessons that the chief ‘building-materials’ used in making the teeth are calcium and phosphorus, and that Vitamin D is needed to build these materials into the teeth. Vitamins A and C have also important parts to play in ensuring that the teeth are soundly built, and remain sound. For the proper development of her child’s teeth it is necessary, therefore, that

the mother's food should contain liberal amounts of mineral elements—particularly calcium and phosphorus—and of vitamins. This it will do if, with the cereal grain to which she is accustomed, she takes each day about a pint of milk and four to six ounces of green leafy vegetables. If she lives too much indoors and does not enjoy plenty of sunshine she should also take a teaspoonful or two of cod-liver oil or other fish-oil each day in order to provide Vitamin D and to make up for lack of sunlight. Unless she eats this kind of food her baby's jaws are likely to be small and badly formed, its teeth slow to appear, to be crowded together when they do appear and to decay early. As the child grows up its food should be such as will provide liberal amounts of calcium, phosphorus and Vitamins D, C and A ; otherwise dental decay (**caries**) is likely to arise.

The teeth are intended by Nature to tear and chew the food ; this chewing keeps them in good order, healthy and strong, provided the food be of the right kind and the teeth be properly looked after. Soft foods, which do not require much chewing nor exercising of the jaws, are likely to cause dental decay. Such foods are composed mainly of starch which may collect around the teeth or between them and the gums. There the starch ferments and produces acids which may erode the teeth. After starchy foods have been eaten the teeth and gums should always be washed with cold water, using the first finger as a tooth-brush.

An even better plan is to end up a meal of starchy food with some raw fruit or vegetable into which the teeth have to be sunk. The biting and chewing of the raw fruit clear away any starch which may be clinging about the teeth, and the fruit or vegetable juices prevent the fermentation of the starch and the formation of harmful acids.

The next rule in the care of the teeth is to keep the mouth clean. It should be washed out with cold water first thing in the morning and last thing at night as well as after every meal. There is no better way to cleanse the teeth than by the use of a chewed stick of acacia ; this is a common practice in India and Pakistan. If acacia is not available the first finger may be used instead ; either is as good as, if not better than, the modern tooth-brush.

Failure to keep the mouth and teeth clean, together with the habitual use of food which is too rich in starch and too poor in vitamins, favours the growth of microbes in the mouth and around the teeth. The margins of the gums may become inflamed and septic matter (*pus*) may collect between the teeth and gums, giving rise to a condition called **pyorrhoea**. This septic matter may find its way into the lungs and cause disease there (bronchitis, etc.), or be swallowed and set up inflammations of the stomach (gastritis) and bowels (enteritis). Poisonous substances (*toxins*) may be absorbed into the blood and cause general ill-health, low fever, anaemia, pains in the joints and diseases of the skin. So you see how very important it is to

keep the mouth and teeth clean, and always to eat food which does provide all things needful for normal nutrition and health—for the whole body as well as for the mouth and teeth (Lesson XV). For faulty and ill-balanced food deficient in vitamins, together with the infection by microbes which so often results from it, is a frequent cause of disease in any part of the body.

LESSON XVII

The Alimentary Tract. This tract is made up of the mouth, the gullet, the stomach, the small intestine, the large intestine and the rectum. In a full-grown man it is about 30 feet long. It is lined throughout its whole extent by a velvety lining called 'mucous membrane.' When we take food into *the mouth* it is, or should be, thoroughly chewed and mixed with the saliva (or spittle) produced by glands near the mouth. This saliva, contains a ferment which starts off the process of digestion. So when we bolt our food, and do not chew it properly, we give the digestion a bad start. The food thus mixed with saliva passes through *the gullet* into *the stomach* where it becomes mixed with the gastric juice. This juice contains hydrochloric acid. The hydrochloric acid has an anti-septic action and kills microbes coming into contact with it. This is another reason for chewing our food well; for if it be swallowed in lumps these may contain microbes which the hydrochloric acid cannot get at. The food stays in the stomach long enough for it to be thoroughly mixed with the gastric juice; and to ensure its thorough mixing the walls of the stomach contain muscles which, by contracting and relaxing this way and that, churn up the food and mix it with this juice. The muscular action of the stomach is a very important part of the digestive process. After the food has been thoroughly mixed with the digestive juice of the stomach, it is passed

into the next portion of the alimentary tract: *the small intestine*, which is about 20 feet long. There it meets other juices which carry the digestive process still further and ultimately reduce the food to a liquid state. From this liquid food, the cells covering the mucous membrane of the intestine then proceed to absorb the nutritive materials needed by the body: the digestion products of proteins, fats and carbohydrates; and the mineral salts, vitamins and water. At the same time, the muscular walls of the small intestine, by their contractions, propel the food along its course through the tube; and by the time it has reached the end of the small intestine much of the material needed by the body has been taken out of it, provided the food eaten contained all essential substances. The residue then goes into the *large intestine* where further absorption of digestion products takes place, and more water is squeezed out of it and absorbed into the body. Finally, what remains is passed into *the rectum*, and so out of the body (as *the faeces*) once or twice a day.

You will realize now that the alimentary tract has a lot to do: (1) it has to do its best to kill disease-producing microbes swallowed with the food; (2) it has to produce the juices which will digest the food and turn it into a liquid mass; (3) it has to mix the food with the digestive juices by the action of its muscular walls; (4) it has to absorb all the things the body needs from the liquid mass of food; (5) it has to extract a great part of the water from it; and, (6)

is has, by the action of its muscular walls, to pass the food from one part of the tube to the next, and the residue out of the body. *Every one of these things depends to a great extent on the food being of the right kind.*

If, for instance, there is not enough Vitamin **B₁** in the food, the appetite becomes poor, the muscles of the tract become weak and the stomach, instead of contracting as it should, becomes flabby and distended by the food which remains in it for too long a time. When this happens we become aware that we have a stomach because it begins to be uncomfortable or even painful on account of this distension. This muscular weakness of the digestive tube prevents the various events in the digestive process happening just at the right time; so, instead of its running like clockwork it goes slow, and pain, discomfort and bowel ailments are the result. Finally, the waste products of digestion are not passed out of the body as regularly as they should be and constipation arises, with headache, slackness, uncomfortable feelings and bad breath. If this constipation goes on for years it may cause constant ill-health.

You will remember (Lesson X) that, when the food is deficient in Vitamin A, the mucous membranes may lose their powers of resistance to infection by microbes, and that, in consequence, such maladies as diarrhoea and dysentery may be caused. You will remember, too, the effects produced on the lips, mouth, tongue and bowels by deficiency of Vitamin **B₂**

(Lesson XII); how Vitamin C helps to keep the gums and bowels healthy (Lesson XIII); and, how Vitamin D controls the absorption of calcium and phosphorus from the intestine (Lesson XIV). Proteins and mineral elements are also concerned in maintaining the normal processes of digestion: the ferments (*enzymes*) in the digestive juices are made from the former, and the latter provide materials for the acidity of the gastric juice or the alkalinity of the intestinal digestive juices. We have seen how important it is to drink enough water (Lesson III), how an excess of fat in the food may give rise to digestive disturbances (Lesson VIII), and how too much carbohydrate may cause flatulence, diarrhoea and interference with the absorption of essential constituents of food (Lesson VII). So it is that the appetite, the proper digestion of the food, the proper absorption of food-essentials, the normal action of the bowels, and the freedom of the alimentary tract from disease, all depend to a large extent on the *habitual use of a well-balanced diet*. (Lessons XV, XXIII.)

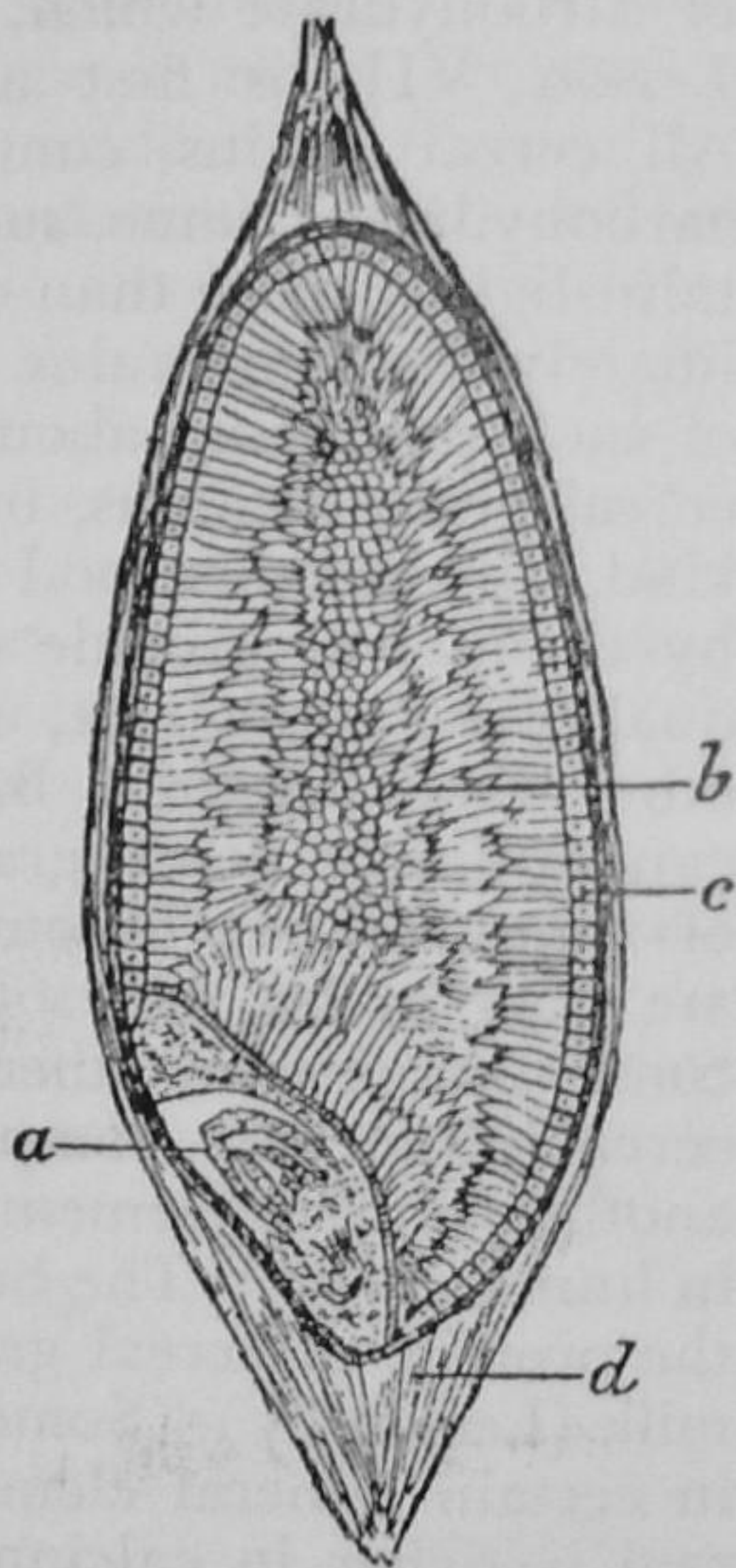
LESSON XVIII

The Cereal Grains. It is on these grains that we rely for the main bulk of our food. They are the cheapest as well as the chief source of carbohydrate which, as we have learnt in Lesson VII, is first amongst the fuel-foods. All cereal grains contain large amounts of carbohydrate ; some, such as polished rice, contain slightly more than others. All have approximately the same value as fuel-foods (an ounce of each producing about 100 calories) ; but no cereal grain contains, in sufficient amounts and kind, all the other food essentials. They do not by themselves provide enough protein of high quality nor enough fat, mineral salts, or vitamins other than Vitamin B₁. For this reason we cannot live on cereal grains alone for any length of time without becoming ill. Cereal grains are poor in fat, but some—cambu and oats—contain more than others. The proteins of one cereal differ in composition from those of another, and supplement each other when mixed in human diets. The best of all supplements to the proteins of cereal grains are the proteins of milk (Lesson IV). Some cereal grains are richer in certain mineral elements than others : thus, ragi is richer in calcium ; and cambu, cholam and wheat are richer in iron. This difference in the mineral constituents of different cereal grains is another reason why we should include more than one of them in our diet. All, except yellow maize and cambu, are poor sources of *carotene*

from which Vitamin A is made in the body (Lesson X). All, in their whole state, are rich sources of Vitamin B₁; rice being less so than other cereals. All are poor sources of the other B-vitamins. All lack Vitamins C and D. Vitamin E is contained in their fat, particularly in that of wheat-germ.

The cereal grains used by different races in India and Pakistan are those that grow best in the part of the country in which they live, and, in general, it may be said that these are the most suitable grains for them. But all cereal grains have the defects mentioned above, in lesser or greater degree; and, it is in proportion to the degree of these defects and to the way in which they are remedied by the use, with the cereal grains, of other foodstuffs that the physical development and well-being of the different races depend.

If we cut any of these grains in two, from top to bottom, and look at it under a magnifying



glass, we find that it is composed of the parts shown in the figure on page 98 :

‘ a ’ is the germ from which the young plant grows. It contains most of the proteins, mineral salts and vitamins that are present in the whole grain ; both ‘ building-materials ’ and vitamins being needed for the growth of the seedling. It also contains some fat and carbohydrate. ‘ b ’ comprises the bulk of the grain. It is made up chiefly of starch with some sugars and proteins, which are intended as foods for the young plant when the grain germinates. ‘ c ’ is the bran-coat surrounding ‘ a ’ and ‘ b. ’ It consists of several layers containing more proteins, vitamins and mineral salts, for the use of the young shoot until it has grown leaves and roots with which to find its own food. Surrounding the whole grain is the husk ‘ d. ’

When we use any of the cereal grains we first remove the husk, since it is of no use as food. Then we treat the husked grains in various ways in order to make them into palatable and appetizing foods. Some, like wheat and barley, are ground into flour which can be made into *chapattis* or bread because it contains a protein, called *gluten*. Gluten becomes viscid when mixed with water and binds the bread together. Others, like rice, cannot be made into bread because they do not contain enough gluten, so these are boiled, or cooked in other ways, and then eaten as they are. Now so long as this is all we do to the grains we do not harm them

much and we get out of them most of the good they contain. Fortunately, it is all we can do to some of them, such as ragi, cholam and cambu, which are usually eaten in their natural state. But we often treat others in ways which cause much of their nutritive value to be lost.

Wheat. People are not always content to eat wheat in the form of whole wheat flour (*atta*), which is made by grinding the whole wheat grains to powder and sifting off the coarser particles of bran. This is by far the best way to use wheat because we then get all the proteins, fats, carbohydrate, mineral salts and vitamins which the whole grains contain. This is the way in which people living in the wheat-growing areas of Northern India prepare wheat for use as food. Because the germ ('a') and *outer* layers of the wheat grain ('c') contain some proteins of good quality, because wheat is rich in Vitamin **B₁**, phosphorus and iron, and because these wheat-eating races are accustomed to use milk, milk-products, green vegetables and fruit with the *atta*, these races are amongst the tallest, the strongest and the most vigorous in India and Pakistan. Those amongst them who do not take enough milk and milk-products, and green leafy vegetables are, however, liable to suffer from certain illnesses because the *atta by itself* does not contain enough proteins of high quality, nor enough fat, calcium and Vitamins of the A, **B₂**, C and D classes.

Whole wheat flour should always be freshly made ; it soon goes bad when kept and

is not, therefore, suitable for sale in the bazaar. So wheat is nowadays usually made into white flour or *maida*, which keeps better. *Maida* is manufactured in India and Pakistan and is also imported from abroad in a highly refined and bleached form.

White flour consists only of the central part of the grain ('b') (see figure). In its manufacture the other parts ('a' and 'c') are removed ; and as these parts contain the best of the proteins and most of the mineral salts and vitamins, little is left but the carbohydrate and the poorer proteins contained in the central part of the grain. White flour is thus inferior to whole flour as the staple article of diet. It is inferior also to whole rice, ragi, cholam or cambu, and it should not be used instead of these grains. But nowadays white flour is being more and more used in India and Pakistan by people who do not grow their own wheat and by those who live in towns. It is convenient to buy in the form of loaves, which saves the trouble of grinding wheat into *atta*, or of making bread. But we often pay dearly for things that are convenient and save trouble, and we often pay dearly in health for using white bread as our staple food unless we are rich enough to buy other foods containing the very things—proteins, mineral salts and vitamins—which are thrown away when wheat is made into white flour.

Yeast is used to make white flour into loaves of bread, and yeast is rich in B-vitamins. Some

people think that they get enough of these vitamins from the yeast in the white bread. This is a mistake; the amount of yeast used to make the bread is small, and the amount of B-vitamins to be got from a loaf of white bread is not so great as that to be got from the same amount of whole wheat flour. Unless we can afford to take adequate amounts of the 'protective foods'—milk, fruit and green leafy vegetables—with white bread, it is best not to use white flour at all but to use *atta*, whole rice, ragi, cholam or cambu, or a mixture of two or more of them, instead.

Wheat is a 'heating food'; it is more suitable for cold climates, or for climates that are cold during part of the year, than for climates that are hot all the year round. It is very suitable, therefore, for people who live in the North of India and Pakistan, and for them it is a strengthening food; but it is less suitable, as the only cereal food, for those who live in the southern and hotter parts of India. For these, it is a good thing to take some *atta* with their rice each day or to have *atta chapattis* at one meal and rice at another, because the *atta* provides the Vitamin **B₁** which is wanting in white rice. In this way they will be protected against beri-beri.

The best of all the diet used by Indian races is one composed of *atta*, or of *atta* and home-pounded rice, milk, milk-products, dhal, root vegetables, fruit and green leafy vegetables, with flesh meat two or three times a month. No diet eaten by the races of India and Pakistan is

capable of producing greater physical perfection, strength and vigour than this.

Millet. There are many kinds of millet (ragi, bajra or cambu, cholam and jowar). They are the staple food grains of a majority of the Indian people. They all grow on rather poor soils, and they vary in nutritive value according to their kind and to the nature of the soil on which they are grown. They have the faults of cereal grains in general, are less nutritious than wheat but more nutritious than polished rice. Bajra contains more protein and fat, ragi less protein and more calcium, than other millets. All are rich in carbohydrate and have about the same calorie-value. Like wheat, they contain some *carotene*, and are rich in Vitamin B₁ but are poor in other B-vitamins. The whole grain is always used : either ground into meal, or boiled to make a kind of gruel or porridge. This use of the whole grain ensures that the diet of millet-eaters is rarely lacking in Vitamin B₁ and in consequence they rarely suffer from beri-beri. Millets, either alone or with home-pounded rice, together with a sufficiency of milk and milk-products and or fish, green leafy vegetables and fruit, make up quite a good diet.

LESSON XIX

Rice. This is one of the commonest of the food grains used in the sub-continent of India ; indeed, it is the chief food of more than one-half of the human race. About one-quarter of the whole population of India and Pakistan live on rice. It is grown in places where the climate is hot and humid and where the fields can be irrigated. It is the staple article of food in parts of the Madras and Bombay Presidencies and in Lower Bengal, Burma and Kashmir.

There are many kinds of rice all differing from one another in their nutritive values. All have the same general defects as the other cereal grains. But rice has other faults besides : (1) it contains less proteins than any other cereal grain, and when it is their main source, it has to be eaten in large quantities in order to provide enough of them. The bulkiness of the rice-eater's diet gives rise to two important consequences : (a) it tends to prevent the proper absorption from the intestines of the proteins and vitamins contained in the other foods eaten with it, such as dhals ; and, (b) it is apt to cause distension of the stomach and bowels, with fermentation of their contents and resultant indigestion and bowel complaints. This only occurs when the great bulk of the diet is composed of rice. When it is eaten in lesser amounts, as when one meal of the day consists of *atta* and another of rice, it is an excellent food. (2)

Whole rice, as it comes from the paddy fields, is less rich in Vitamin **B₁** than other whole cereal grains. When rice is the sole or the main source of this vitamin, it only provides enough of it for the needs of the body—and only just enough—if the rice used be home-pounded or unpolished ; it provides barely enough if the rice be parboiled and unpolished. It does not provide enough Vitamin **B₁** if it be white, polished rice or if it be parboiled rice that has been subjected to much washing. It is because rice is so commonly used after milling and polishing or parboiling and washing—which remove much of the Vitamin **B₁** contained in the whole rice grains—that beri-beri is common amongst rice-eating races. Rice in its whole state is poorer in calcium than any other cereal grain; and white, polished rice is poorer still. White polished rice contains very little Vitamin **B₂**, and none at all of the Vitamins A, C and D ; it is also poor in iron and phosphorus.

For all these reasons the too exclusive use of rice as the staple article of diet should be avoided. It is for these reasons also, that the rice-eating races of India are of slighter build, less well developed physically, less robust, and less capable of hard work than wheat-eaters or ragi-eaters. But if the rice-eater uses home-pounded or unpolished rice and can supplement it with enough milk and milk-products, dhal, green leafy vegetables and fruit then he will have a diet which is well suited to the climate in which he lives and to preserve him in good health.

Those who can afford to do so should also include some *atta* or *ragi* in their diet every day.

Oatmeal is the most nutritious of the cereal foods. It is not much used in India or Pakistan except by Europeans. It is a 'heating' food and is more suitable for temperate than for hot climates ; being in the former a very valuable article of diet. It is, or was formerly, the staple article of diet of the Scots, and when taken with plenty of milk there is none better. It contains *phytic acid* (Lesson VI) and is apt to cause rickets unless adequate amounts of foods containing Vitamins A and D, such as milk and fat fish, are eaten with it. Oatmeal, herrings, milk, milk-products, potatoes and green leafy vegetables, make up an excellent diet for people living in temperate regions.

Barley has about the same nutritive value as whole wheat, but it contains less *gluten* and so it is not so easily made into bread. It is used mainly as an addition to, and not as the staple article of, the diet.

Maize, or Indian Corn. There are two varieties of maize—the 'yellow' and the 'white.' The former contains some *carotene*, the latter little or none. For this reason yellow maize is the better food. Both have the faults of cereal grains in general, but in somewhat greater degree, for one of their proteins is of very poor quality, though others are equal in value to those of wheat. Maize is poor in the pellagra-preventing (**B₂**) vitamins (Lesson XII). When

badly stored or 'spoiled' it may contain traces of a poisonous substance called *durrin*, which some people think may be a contributory cause of *pellagra*; however this may be, it is the improper constitution of the diet, together with its deficiency in pellagra-preventing vitamins, which enables the disease to occur (Lesson XII).

Maize is used in various ways : in the raw green state ; as a vegetable after light boiling ; roasted ; as a sweetmeat with other ingredients ; pounded and made into a kind of porridge ; or ground into a flour and made into cakes. Maize flour is often mixed with other flour for bread-making. It is also manufactured into refined 'cornflour' which has all the faults of the white flour made from wheat, only more so.

Suji, or semolina, is the coarser part of the wheat grain which is sifted off when wheat is ground. It contains a fairly high proportion of proteins and mineral salts and is rich in Vitamin **B₁**. It should be more widely used as a source of this vitamin by both rice-eaters and white flour-eaters.

Of the **Seeds**, other than cereal grains, used as food in India and Pakistan, *mustard*, *gingelly* (sesame) and *linseed* are the most important. They are all rich in fat and are of value chiefly as sources of the vegetable oils on which so many people depend both for edible fats and for cooking purposes. Oils made from these seeds are lacking in Vitamins A and D and are, therefore, inferior to animal fats (Lesson VIII).

Some of the grains and seeds here mentioned contain *carotene* from which Vitamin A is made in the body, but none contains enough of it to provide for the body's need for Vitamin A. Indeed, all the cereal grains must be supplemented with milk or milk-products or egg and green leafy vegetables in order to provide plenty of Vitamin A, otherwise various illnesses are likely to arise. One of these is *stone-in-the-bladder* ; a disease which is common in parts of India where whole cereal grains, particularly wheat, are the staple articles of diet of people who cannot afford to take enough milk and other Vitamin-A-rich foodstuffs.

Storage of rice and other food grains.

It is very important that paddy, rice, maize and, indeed, all food grains, should be stored in dry godowns away from damp, and protected against rats, mice and other vermin. Unless this is done, maize is apt to 'spoil' ; and rice, especially if it be milled or parboiled, is apt to become mouldy and diseased and to lose much of its nutritive value ; substances harmful to the human body may also develop in it. Mouldy rice is often purchased by poor people because it is cheap, but it has to be washed in many changes of water before it is fit to be eaten. This excessive washing dissolves out of the mouldy rice much of the good that remained in it. *Paddy* and other whole grains do not go bad so quickly as milled or parboiled rice ; nevertheless, care must be taken to store them properly.

The important points to remember about

cereal grains are *first* that the whole grains or the whole flours made from them should be used in preference to their refined products ; *secondly*, that when possible more than one of them should be included in the diet ; and, *thirdly*, that when they are the staple articles of diet, adequate amounts of *the protective foods* should be eaten with them (Lesson XIV).

LESSON XX

Dhals. These belong to the same order of plants—the pulses—as **peas** and **beans** and have, in general, the same qualities. What is here said about dhals applies also to dried peas and beans. There are several different kinds of dhal : Arhar, Masur, Gram, Mung, Mattar, Kalai and Urid. Their chief value lies in the large amount of protein they contain, and it is for this reason that they are so much used in India and Pakistan as supplements to the staple cereals. They contain about twice as much protein as wheat and three times as much as polished rice. One ounce of dhal contains as much protein as one ounce of meat, nearly twice as much as one ounce of egg, and seven times as much as one ounce of whole milk. The proteins of dhals are of fairly good quality but it is well to combine them in the diet with some animal protein. Dhals contain a small amount of fat and are rich in carbohydrate. They are eaten in various ways, and the way in which they are cooked makes a difference to the good we get out of them. The best way to use them is to grind them into meal and make them into *chapattis* with *atta* or barley or other suitable cereal grain. Rice-eaters usually boil the dhal and make it into a kind of porridge, or they cook the rice and dhal together. If the water used for boiling the dhal is hard and contains much lime it makes the dhal very indigestible ; when cooked in this way the water used should be soft. Sometimes the dhal

or gram is fried or parched and eaten dry; when so cooked it must be thoroughly chewed, as in this form it is less digestible than when ground into meal.

A man cannot digest more than 4 or 5 ounces of dhal a day; anything over this amount is simply wasted and goes bad in the bowels. People who eat dhal and rice should remember this. If a great deal of rice is eaten with the dhal it prevents the dhal being properly digested; so if a man eats twenty ounces of rice a day he should not eat more than four ounces of dhal, and it will be better for him to take only two ounces with fourteen ounces of milk, or two ounces of fish or meat, instead of the four ounces of dhal.

The best dhals are Arhar and Mung. Whole dhal (*sabut*) is better than washed (*dhuli*) or spilt (*dali*) dhal. The boiling of dhal in water reduces its content of Vitamin **B₁**.

All the dhals contain iron and phosphorus in considerable amounts. They are rich in Vitamin **B₁** and are, therefore, good for preventing beri-beri. But if our food consists mainly of *polished rice* we can only be sure of preventing beri-beri if with every five ounces of this rice we take one ounce of dhal; if we take less, beri-beri may arise in places where this disease is prevalent.

The dhals are in general very poor sources of Vitamin A, and they contain no Vitamin C; but Vitamin C can easily be made in dhals and peas by sprouting them in the way described in

Lesson XIII. Sprouting improves their flavour and their nutritive value. Bengal gram, black gram, cow gram, green gram and dhal Arhar, are fairly good sources of Vitamin **B₂**. Green peas contain Vitamin C and are fairly good sources of Vitamin A.

Soya bean is the richest of all the pulses in protein. It is also rich in fat, B-vitamins, iron, calcium and phosphorus but is poor in starch. It is a favourite foodstuff amongst the Chinese and the Japanese, and should be more widely grown and used in India and Pakistan.

Nuts of all kinds, except coconut, are rich in proteins and most of them are very rich in fat. The proteins of some of them (*e.g.*, almonds, groundnuts) are of fairly good quality. An ounce of groundnuts contains twice as much protein as an ounce of egg and over three times as much fat. Nuts are good sources of the B-vitamins, but poor sources of Vitamin A ; they contain no Vitamin C. **Groundnuts** are especially valuable as supplements to Indian dietaries and help to make good their deficiencies.

Tuber and Root Vegetables. These include all vegetables such as potato, tapioca, sweet potato, yams, artichoke, parsnip, radish, turnip, beetroot, carrot, onion and other roots used as food by different races. Some of them, such as potatoes, yams and tapioca, are fairly rich in carbohydrates and are, therefore, useful as 'fuel foods' ; others, such as turnip and carrot, contain little carbohydrate. All have proteins of relatively poor quality ; and, compared

with leafy vegetables, they are poorer sources of mineral elements. In general they contain less B-vitamins than the cereal grains though parsnips are fairly rich in Vitamin **B₁**, and potatoes, sweet potatoes and yam are fairly good sources of Vitamin **B₂**. Excepting those of a yellow colour, such as carrot, they are poor sources of Vitamin A. A good rule to remember is that all yellow and yellowish-red vegetables, whether roots or other parts of the plant, are better sources of Vitamin A than white vegetables or white parts of vegetables. Thus, the white inside of a cabbage is a poorer source of Vitamin A than the green leaves surrounding it. All root vegetables contain some Vitamin C which is largely destroyed when the vegetables are boiled. Potato, when boiled in its skin, is an exception to this rule. Tapioca, which is rich in carbohydrate, is a staple article of diet in Travancore, where its too exclusive use gives rise to serious stomach and bowel complaints. It is poor in protein and mineral elements, notably potassium, and contains little or no vitamins.

Leafy Vegetables. We have learnt that these are one of the three classes of 'protective foods,' so-called because they are rich in the mineral elements and vitamins in which the cereal grains are poor. By providing those mineral salts which are deficient in the staple food grains, dhals and in flesh-meats, they also balance the acid-producing tendencies of these foodstuffs. They contain much water, little carbohydrate, less protein, and still less fat, and

have, therefore, little energy-yielding value (Lesson XV). But the amount of mineral salts they contain is relatively large, they are rich, or fairly rich, sources of Vitamins A, B₂ and C, and fair sources of Vitamin B₁. It is on these qualities that their high nutritive value depends. Their framework—which is composed mainly of *cellulose*—gives bulk to the diet and helps the action of the bowels. This is an important function ; for, if all the essential ingredients of our food were provided in a highly purified form there would be little residue on which the bowels could act, and so constipation would result. But the clean, smooth, non-irritating vegetable matter, left after the intestines have absorbed most of the nutritive materials the leaves contained, serves the further purpose of helping the bowels to act properly. Vegetables are apt to become contaminated by dust, dirty water and excreta containing disease-producing organisms ; they should be well washed in boiled water before they are eaten in the raw state.

Other Vegetables. These include such vegetables as the gourds, brinjal, cucumber, cauliflower, cluster beans, drumstick, knolkhol, ladies fingers, leeks and tomatoes. Little need be said about them except that they possess many of the nutritive qualities of the green leafy vegetables, but in lesser degree. They are good sources of mineral elements of the alkali-producing kind, and should form a considerable part of our diet (Lesson XV). *Tomatoes* are amongst the best of all vegetables and

should be more widely grown and used as food in India and Pakistan. They are fairly good sources of Vitamins A, B₁ and C and, when eaten in sufficient amount, are a protection against beri-beri and scurvy. Onions and garlic are especially valuable as additions to our food.

Fruits and **Berries** have much the same qualities as green leafy vegetables and are classed with them as protective foods. They contain little protein and less fat (except avocado pear which is rich in fat). In general, they are poor in carbohydrate, which is present in the form of sugar. Bananas and plantains are exceptions to this rule, being fairly rich in carbohydrate ; and *dried* fruits—bananas, dates, figs, prunes, raisins, tamarinds—are rich in carbohydrate. Fruits are, in general, poorer sources of Vitamin A than green leafy vegetables though some—papaya and ripe mangoes—are rich sources of it, and others—dates, jack fruit and oranges—are fairly good sources of it. They all contain Vitamin B₁, and Vitamin B₂ has been found in the few fruits that have so far been tested for it. The citrus fruits—oranges, lemons, limes and grapefruit—are among the richest sources of Vitamin C ; the great value of their juices, especially for pregnant and nursing women, infants and young children, has been emphasized throughout these Lessons. Other common fruits are also important sources of anti-scorbutic vitamins when eaten in sufficient quantities.

Fruits are stimulants of the appetite and of the flow of the digestive juices ; their odour, sweet-

ness and flavour add to their value as foods. They promote healthy action of the bowels and the removal of waste products from the body. Their liberal use is of great benefit to health. A good way to eat fruit is as a meal by itself or, in its raw state, at the end of a meal.

Coffee and **tea** are not foods but stimulants ; their stimulating action being due to the presence in them of a substance called *caffeine*. Tea contains appreciable amounts of Vitamin **B₂**. Owing to the presence in tea of large amounts of *tannic acid*, its excessive use, particularly in “ strong ” infusions, has a harmful effect on digestion.

Condiments such as chillies, tamarind, coriander, mustard, pepper, cloves, cardamoms, asafoetida, ginger, nutmeg and mace are valuable additions to the diet chiefly for their flavouring and appetizing qualities and as aids to digestion. In so far as the essential ingredients of food are concerned they add but little to the nutritive value of the diet.

LESSON XXI

Milk is the best of all foods for young children ; and, mother's milk is the best of all milks for infants. It is best because it contains, if the mother be properly fed, everything the baby needs for its proper growth and development, and in the right amounts and proportions for its rate of growth. The composition of the milk of different animals, including that of human milk, varies with the rate of growth of the young animal for which it is intended. Thus, a calf grows three times as fast as a baby ; so cows' milk contains three times as much building-materials (proteins and mineral salts) as human milk. Human milk contains more sugar than cows' or goats' milk (7 per cent as compared with 5 per cent). It is, as we have learned in previous Lessons, very necessary that the mother's food should be such as will provide everything the baby needs, otherwise the milk will be of poor quality, the baby will not grow properly and it will become ill. So her food should contain an adequate supply of *the protective foods*. If she is a purdah woman she should take a little cod-liver oil, or bask in the sun, each day (Lesson XIV).

Cows' milk. For older children and adults, cows' milk is a very valuable constituent of food. Its *proteins* (*casein* and *lactalbumen*) are of the highest quality. Its *fat* is present in the form of minute globules which run together, when milk is allowed to stand, and come to

the surface as *cream*. If cows are properly fed on green pastures and exposed to sunlight, their milk should contain a considerable amount of A, B₂, C and D Vitamins. It is a poor source of Vitamin B₁ ; if milk were the only source of this vitamin at least a quart a day would have to be taken to provide a child with enough of it. Milk is richer in the other B-vitamins than in Vitamin B₁ ; these are not, as we have already learned, destroyed by heat, whereas Vitamin B₁ is. It contains varying amounts of Vitamin C depending on the way the cows are fed. This vitamin is largely destroyed by boiling ; and since, in India and Pakistan, milk should always be boiled before use, it is best to regard cows' milk as containing little or no Vitamin C and very little Vitamin B₁. Although cows' milk contains Vitamin D it does not always contain enough for growing children.

Cows' milk contains about 5 per cent of carbohydrate in the form of milk-sugar (*lactose*). It is rich in calcium, phosphorus and potassium. These elements are present in the form of the mineral salts, *calcium phosphate* and *potassium phosphate* ; the former needed for the building of the bones and teeth, the latter (together with proteins) for making the tissues, particularly the muscles (Lesson VI). Cows' milk is poor in iron ; but this does not greatly matter to the calf, for the young animal is born with a large amount of iron stored up in its body, which it has obtained from the blood of its mother. It is important to remember that cows' milk is

deficient in iron ; for when people live largely on milk, as they sometimes have to do in certain illnesses, they are likely to become anæmic (Lesson VI) for want of iron. Milk, it will be remembered, is one of the protective foods.

Skimmed milk is milk from which the cream has been removed. It is a very valuable food, for it is cheaper than whole milk and contains most of the proteins, mineral salts and water-soluble vitamins (B and C) present in the whole milk. It does not, of course, contain the fat-soluble vitamins (A and D), which are present in the fat (cream), or only a very little of them.

Buttermilk is the fluid left after the fat has been removed from cream by churning. It resembles skim milk in its composition, and is a valuable food. It is more easily digested than whole milk. Its sourness is due to the presence of a small amount of *lactic acid*. A good way to use milk in hot countries, and one widely used in India and Pakistan, is in the form of **Curds**. The curdling of milk is due to the production of lactic acid by the lactic acid bacillus, which is always present in milk and grows in it under conditions of warmth.

Another good way to use milk in the Tropics is to turn it into **soured milk**. The sourness is due to lactic acid produced, as in the making of curds, by the action of lactic acid bacilli. These bacilli are harmless. If the milk is soured before harmful microbes have time to grow in it, the lactic acid prevents or retards their growth. Soured milk keeps longer than unsoured milk,

is more easily digested, more refreshing, and is good for people suffering from bowel complaints. People who habitually use soured milk, as a staple article of diet, are vigorous and long-lived.

Microbes grow quickly in milk, and not only do they spoil it but many of them are dangerous to human beings using such contaminated milk. Milk is often contaminated in India and Pakistan ; it is a common cause of inflammation of the bowels and diarrhoea in infants. Milk should, therefore, be boiled before use, in order to kill any harmful microbes it may contain.

Buffaloes', goats' and camels' milk have much the same properties as cows' milk. Buffaloes' milk is richer in protein, fat, calcium and phosphorus than cows' milk. It is largely used in India and Pakistan for making ghee. Goats' milk is of similar composition to cow's milk and has this advantage that it is not so likely to contain harmful germs, particularly those of tuberculosis from which cows often suffer. If the breed of goats and their milk-yielding capacity were improved throughout India, as has been done in some places, it would be of great benefit to the people. Camels' milk is not much used in India. It differs from other milks in being relatively rich in Vitamin C.

Cheese is hardened curds of milk. When made from whole milk it contains most of the milk-proteins and fat, some of its material salts, and is rich in Vitamins A and B₂. It is a useful supplement to the diet, but, being a very

rich food and not easily digested, too much of it should not be eaten at one time.

Milk-powder, if made from whole milk, contains all the ingredients of milk in a concentrated form. It is easy to digest and good for infant-feeding. Four-and-a-half ounces of milk-powder mixed with a quart of boiled water is equal to a quart of whole milk. If made from skim milk it contains all the ingredients of milk except fat and the fat-soluble Vitamins A and D.

Many brands of *tinned milk*, having some of the nutritive properties of the milks from which they are made, are nowadays available for those who have the means to buy them. They usually contain less vitamins than the fresh milk.

Butter contains all the fat in milk and most of its A and D Vitamins. Yellow butter usually contains more Vitamin A than white butter. It does not contain any vitamins of the B-class nor any Vitamin C. It is the most easily digested of all fats.

Ghee is butter that has been boiled. It keeps better than butter and does not go rancid so soon. If the butter is boiled in open vessels, exposed to the air, the Vitamin A it contains is likely to be partly destroyed. It should be boiled in covered vessels, from which air is, as far as possible, excluded. Ghee is often adulterated with vegetable oils, and, in consequence, it may contain little Vitamin A. Owing to lack of care in its preparation it is often very dirty and ill-smelling.

One of the greatest nutritional needs in

India and Pakistan at the present time is the production of more and purer milk; for there is no more important foodstuff than this, and none on which public health is more dependent. The conditions under which milk is produced and distributed are often insanitary in the extreme ; its adulteration with dirty water is a frequent practice ; the cream is commonly removed to make butter or ghee before the milk is sold, so that much of the milk available to the people is not only skimmed milk but dirty skimmed milk ; except in Government Farms no proper attention is paid to the feeding of cows nor to their hygiene and in consequence the milk, and the butter and ghee made from it, are often of poor quality and lacking in essential vitamins. Animals for milk-production are not selected with sufficient care and their yield of milk is almost invariably low. The rising generation must learn to realize the importance of pure milk to the well-being of the people and see to it that India and Pakistan shall become as enlightened, in regard to milk-production and milk-distribution, as other countries.

LESSON XXII

Eggs. Next to milk, eggs are the most valuable of the animal foods available for use by man ; for they contain all the materials necessary for the making of the chick. They are easily digested except when hard-boiled. Their proteins, in common with those of milk, are among the best of all proteins for conversion into human protein ; they are, therefore, useful additions to the food of children. They are good sources of all the vitamins except Vitamin C. White-of-egg, usually called *egg-albumen*, is a mixture of different proteins ; it is relatively rich in Vitamin B₂ but relatively poor in Vitamin B₁. Eggs are rich in fat, phosphorus and iron, which are present principally in the yolk. As a source of calcium, they rank below milk and green leafy vegetables, but above meat and cereals. They are a concentrated food and not more than one or two should be eaten in one day.

There is great need in India and Pakistan for the proper breeding of hens from good laying stock, and great opportunities for this industry. The increased production of eggs, by those who have the space in which to keep poultry, would bring an increase of health and strength to the people, provided they used the eggs as food and sold only those they did not need.

Liver. This is one of the best of the animal foods available for use by man. It is the chief store-house in the body of the Vitamins A and D.

It is a good source of Vitamin A ; the livers of fish and birds being particularly rich in it. Sheep and goats' liver also contain it in large quantity. Liver is also a rich source of the B-vitamins and is valuable in the prevention of pellagra. Its proteins rank in order of quality with those of milk and egg. It contains some fat and carbohydrate ; the latter in the form of *glycogen*. Liver is also rich in iron and in phosphorus, but is a poor source of calcium. Altogether, liver is an excellent food, and its use in moderate amounts—say, once a week—is very beneficial. Fresh liver extract or pounded liver is a cure for certain kinds of severe *anaemia*, and is very useful in the treatment of *pellagra* and of a disease of the intestines called *sprue*.

Meat. This includes the flesh of animals such as sheep, goats, game and birds. Meat is rich in proteins of high quality ; in order of nutritive value they rank with the proteins of milk, egg, liver and fish. For people whose religion permits its use, meat is a most useful means of making good the defects of the proteins in vegetable foodstuffs (cereal grains, dhals, etc.). Its protein is rapidly digested and absorbed into the body, and *as a fuel-food* is quickly utilised. Meat is a stimulating food, increasing bodily vigour. When eaten with the fatty parts of animals it is a source of animal fat and, therefore, of Vitamin A. It does not contain much Vitamin B₁, but is a rich source of the other B-vitamins. It contains some Vitamin C ; but to get enough of this vitamin from meat, red or raw

meat would have to be eaten. One of the risks of eating raw meat is that it may be infected with young tape-worms which grow to a large size in the bowels and cause anaemia and weakness. Meat contains little Vitamin D, but some Vitamin E. It is rich in phosphorus but poor in calcium. Red meat is also rich in iron.

Fish. Fish is a very valuable food ; it is a favourite one for those who live near the sea-coast or who can obtain it from rivers, streams or tanks. So valuable is it that fish-culture should be greatly extended. Dried fish, provided it be of good quality, is also a valuable food. The proteins of fish are of high quality. Fish is rich in phosphorus but relatively poor in calcium. It contains some of all the vitamins except C ; and fish-oils, especially those of sea-fish, such as cod and halibut, are rich sources of Vitamins A and D. Fat fish contain, on the average, about 12 per cent of fat ; white fish contain less than 2 per cent. Iodine is present in sea-fish.

Kidney, brain and other organs of edible animals are very good foods ; their proteins are of high quality, and they are rich sources of the B-vitamins. They also contain some Vitamin A. *Brain* is rich in phosphorus and in certain kinds of fats, which are very valuable as food.

Eggs, liver, meat, fish, kidney, brain and other organs, are all ' acid-forming ' foods. This acid-forming tendency should be counteracted by including plenty of vegetables and fruit in the diet (Lesson V).

LESSON XXIII

Faults of Indian Diet. The great majority of the people of India and Pakistan live on diet made up mostly, and sometimes almost entirely, of vegetable foodstuffs. Millions of them do not get enough of these ; or they get too much of some and too little of others. The consequences are that their diet have, very commonly, a number of serious faults : (1) The calorie-value is frequently too low. (2) The total amount of protein is often insufficient. (3) Animal protein is often scanty and sometimes entirely absent. (4) The total amount of fat is frequently too low and animal fat scanty or lacking. (5) Carbohydrate-rich staples—particularly rice—frequently form as much as 80 to 90 per cent of the whole diet, which therefore contains too much starch in proportion to other essentials. (6) Deficiency of one or more of the mineral elements, particularly calcium and iron, is frequent. (7) One or more of the vitamins is frequently deficient, particularly in diet of which the staple article is polished rice or tapioca or a mixture of both. (8) Besides all this the diet lacks variety, and monotony is added to their faults.

These faults are, of course, most often found in the diet of the poorer classes. But faulty diets are not peculiar to the poor ; they are met with also amongst the well-to-do ; for prejudice, ignorance and habit often prevent the proper choice and use of health-giving foods.

In previous Lessons we have learnt the nature

of the defects of the different cereal grains, tubers or roots which, singly or combined, form the staple articles of diet of the people of India and Pakistan. We have learnt, too, that other foodstuffs, called **the protective foods**, when combined with the staple articles of diet, make up for the defects of these staples. Now although it may not be possible, under existing conditions, for people in many parts of India and Pakistan to obtain enough of the foodstuffs needed to correct the defects of their diet yet it is necessary to learn how these defects may be remedied.

Let us consider first the staple cereal grains, and, taking wheat and rice as examples, let us see how we may correct their defects.

Supposing the staple article of diet is **wheat** and that it is eaten in the form of whole wheat flour (*atta*). The flour provides enough carbohydrate but not enough fat. The latter must, therefore, be added. The best way to do this is by taking some form of animal fat, such as butter or ghee, because it not only provides the fat required but vitamin A as well. Failing animal fat, red palm oil or 'vitaminized' margarine may be used instead.

The proteins of whole wheat flour, though better than those of most other grains, are not good enough nor are there enough of them. So we must take some other foodstuff which will not only provide sufficient proteins of good quality, but will bring the total protein up to *at least 65 grammes* a day (Lesson XV). For the first of these purposes we may use fresh milk or

sour milk or curds or cheese ; or, we may use meat or poultry or liver or fish or eggs. If a man eats one pound of *atta* a day, he will get all the good proteins he needs by taking with it a pint of milk, though he will be a stronger man if he takes a quart. To increase the total protein it is both economical and advantageous to add a certain amount of *dhal* to the wheat-eater's diet, for the proteins of milk, dhal and wheat supplement each other.

A third defect of whole wheat flour is its deficiency in vitamin A ; so some foodstuff must be used with it which makes good this defect. The best foodstuffs for this purpose are whole milk and its product—butter or ghee. By taking milk and butter or *pure* ghee we not only provide protein of good quality and fat but the Vitamin A in which wheat is deficient ; we thus make good three of its chief defects. We can get the Vitamin A from other sources besides milk, butter and ghee : such as from fish, egg, liver, red palm oil, carrots *and* green leafy vegetables. Some of the animal foods—egg, liver and fish—will also help to make good the deficiency of fat.

Whole wheat flour is rich in Vitamin B₁, but does not contain enough of the other B-vitamins. This defect can also be made good by including in the diet one or more of the animal foods mentioned above as well as fresh, young, green leafy vegetables, or if animal foods are not available, by including pulses, groundnuts and green leafy vegetables.

Another defect of whole wheat flour is its deficiency in Vitamin C. So we must select some foodstuff which is rich enough in this vitamin to make good the deficiency. The best foodstuffs for this purpose are green leafy vegetables, fresh fruit and sprouted grains. Thus by taking milk, milk-products *and* green leafy vegetables (*the protective foods*) we make good five of the defects of the wheat: fat, protein of high quality, Vitamin A, Vitamin B₂ and Vitamin C.

A further defect of whole wheat flour is its deficiency in Vitamin D. A foodstuff has, therefore, to be selected to rectify this. We can choose for this purpose either milk and its product—butter or ghee—or egg or fish-oil. Any one of these, or the action of sunlight on the body, with an occasional oil bath, will provide all the Vitamin D we need.

Another defect of the wheat-eater's diet is its deficiency in certain mineral elements, particularly calcium, sodium and chlorine. So we must add to it foodstuffs which will provide these minerals. The best for this purpose are green leafy vegetables, fruit and milk, with a little common salt. The wheat-eater's diet should contain plenty of vegetables and fruit so that the non-irritating vegetable matter may help the action of the bowels, and the acid-producing tendency of the wheat may be counteracted by the alkali-producing tendency of the vegetables and fruit.

We see, therefore, that if whole wheat flour

be the staple article of diet and we take with it enough milk and milk-products, dhal, green leafy, root and other vegetables and fruit, with flesh meat occasionally, we get everything the body needs for health, strength and vigour. Now this is precisely the kind of food which the wheat-eating races do eat, if they can get it ; and for this reason no races of mankind are better developed physically nor more capable of endurance and hard work. But it is only when they actually do eat this kind of food and make good each and every one of the defects of the wheat that they remain in good health and vigorous even unto old age.

Now let us take, as a further example, a **rice-eater's** diet ; but this time working out its food-value and calorie-value according to the principles we have learnt in Lesson XV. The diet is that of a man of the poorer classes in South India and is made up daily of the following ingredients :

Polished rice	..	..	15 ounces
Milk	..	..	1 ounce
Pulse (dhal)	..	..	1 ounce
Gingelly oil	..	..	1 ounce
Green leafy vegetables	..	..	$\frac{1}{4}$ ounce
Other vegetables	..	..	$1\frac{1}{2}$ ounces

From the Table of Food-values at the end of the book we find, on making some simple calculations, that the protein, fat and carbohydrate

contents of this diet and its calorie-value are approximately as follows :—

Protein	..	..	36 grammes
Fat	..	..	32 grammes
Carbohydrate	..	..	398 grammes
Calories	..	..	2024
Less 100 calories for waste			100
			—
Calorie-value		..	1924
			—

From these results it will be seen that the calorie-value is too low: the diet does not provide enough to eat (Lesson XV). Its proteins and fats are insufficient in quantity ; and they are poor in quality because they are derived mainly from vegetable sources ; its carbohydrate is also too low ; it is deficient in protective foods and, therefore, in minerals and vitamins. It is an *ill-balanced diet* because the essential ingredients of food—protein, fat, carbohydrate, minerals and vitamins—are not present in proper amounts and proportions one to another.

There are a number of ways in which this diet can be adjusted so as to remedy these faults. One way is shown in the Table on the next page.

By using unpolished rice instead of polished rice and substituting 5 ounces of ragi for an equivalent amount of rice we increase the quantities of vegetable protein, of minerals and of Vitamin B₁. By increasing the milk from 1 to 6 ounces and by adding 1·5 ounces of dried fish,

Foodstuffs.	Amount in ounces.	IN GRAMMES.			Calories.
		Protein.	Fat.	Carbo- hydrate.	
Unpolished rice ..	10·0	23·0	3·0	210·0	960
Ragi ..	5·0	10·0	2·0	110·0	500
Milk ..	6·0	5·4	6·6	7·8	112
Fish (dried) ..	1·5	14·0	2·1	0·0	75
Pulse (dhal) ..	2·0	12·0	0·4	34·0	188
Butter or ghee ..	0·5	0·0	12·1	0·0	109
Gingelly oil ..	1·0	0·0	28·0	0·0	252
Root vegetables (average).	6·0	2·2	0·0	31·0	133
Green leafy vegetables (average).	4·0	2·2	0·0	5·2	30
Coconut, dried ..	1·0	1·2	11·6	12·6	160
Fruit, dried ..	2·0	2·0	0·0	48·0	200
Jaggery ..	1·0	0·0	0·0	27·0	108
Total ..	40·0	72·0	65·8	485·6	2827
Say ..	40·0	72·0	66·0	486·0	2826

Allowing 100 calories for waste, this diet provides 2726 calories.

we increase the amounts of animal protein, animal fat, calcium, phosphorus, Vitamins A, B₂ and D, and calories. If it is not possible to get milk, another half ounce of dried fish or an ounce of fresh fish may be used instead. The addition of half-an-ounce of butter or ghee provides animal fat and Vitamins A and D. If butter or ghee is not procurable red palm oil will do instead. The extra ounce of dhal, the additional vegetables, dried fruit, coconut and crude sugar increase the Vitamins (A, B₁, B₂ and C) and minerals, and bring the calories up to the required amount. The diet is now a **balanced**

diet ; adequate in quantity and quality for the average man doing ordinary work (Lesson XV). In this example the staple article of diet is rice but the same principles of adjustment and balance apply whatever the staple may be.

Throughout these Lessons we have learned that many kinds of disease are caused, directly or indirectly, by eating the wrong kind of food, or by combining the foodstuffs we eat in wrong ways. We may end these Lessons, and sum up their teaching, thus :—

(1) **The greatest single factor in the production of good health is the right kind of food.**

(2) **The right kind of food is one made up of adequate amounts of the following simple things : (a) any whole cereal grain or mixture of whole cereal grains ; (b) milk and the products of milk—curds, buttermilk, butter, cheese ; (c) pulses—peas, beans, dhals ; (d) egg ; (e) tuber and root vegetables ; (f) fresh, green leafy vegetables ; (g) fruit and, (h) flesh-meat and fish, if religion permits their use. These are the things with which the appetite should be satisfied ; the things that should be eaten for health's sake. What else is eaten does not greatly matter so long as it is simple, clean, easily digestible, well prepared and not in excess of the body's needs ; and, so long as the proper balance of the food in proteins, fats, carbohydrates, mineral salts and vitamins is maintained.**

TABLE OF FOOD-VALUES

Protein, Fat and Carbohydrate in grammes per ounce, calorie-value and approximate vitamin-value, of common foodstuffs.

Foodstuff	Protein	Fat	Carbo- hydrate	Calories	Vitamin-Value				
					A	B ₁	B ₂	C	D
Milk and Milk-products									
Milk, whole, cows' ..	0.9	1.1	1.3	19	++	+	++	+	++
Milk, whole, buffaloes' ..	1.3	2.2	1.3	30	++	+	++	+	++
Milk, whole, goats' ..	1.0	1.1	1.5	20	++	+	++	+	+
Milk, whole, camels' ..	1.1	0.8	1.7	18	+	∴	∴	++	∴
Cream ..	0.5	11.9	0.7	112	++	V.L.	+	V.L.	++
Butter ..	0.1	24.2	V.L.	218	++	0	0	0	++
Butter-milk ..	0.8	0.1	0.4	5	V.L.	+	++	V.L.	0
Skim milk ..	0.9	0.1	1.2	9	V.L.	+	++	V.L.	0
Curds ..	0.8	0.8	1.5	16	V.L.	∴	++	∴	++
Cheese ..	7.1	9.8	V.L.	116	++	+	++	0	++
Milk-powder, whole ..	7.5	8.4	10.4	147	++	++	++	0	++
Milk-powder, skim ..	10.7	V.L.	14.4	100	V.L.	++	++	0	0
Meat, Fish, Eggs									
Muscle meat, fresh, lean : bullock, sheep, goat, deer ..	5.3	3.8	0	55	V.L.	+	++	V.L.	V.L.
Poultry : chicken, game ..	7.6	1.4	0	52	+	+	+	∴	V.L.
Shellfish : crab, prawns ..	4.0	0.4	V.L.	20	V.L.	+	∴	∴	∴

Fish, average	..	5.2	2.0	0	39	+	+	..	V.L.
Fish, dried	..	9.3	1.4	0	50	V.L.	+	0	V.L.
Egg, whole	..	3.4	3.5	0	45	+	+	+	+
Egg-yolk	..	4.6	8.7	0	97	+	+	+	0
Egg, white-of	..	2.6	0	0	10	0	+	+	+
Liver	..	4.7	2.3	V.L.	39	+	+	+	+
Kidney	..	4.8	0.9	0	23	+	+	+	..
Animal and Vegetable Fats and Oils									
Beef, mutton, goat and deer fat	..	0.3	26.4	0	239	+	+	0	+
Butter	..	0.1	24.2	V.L.	218	+	+	0	+
Ghee	..	0	26.0	0	234	+	+	0	+
Cod-liver oil	..	0	28.0	0	252	+	+	0	+
Halibut oil	..	0	28.0	0	252	+	+	0	+
Other fish-liver oils	..	0	28.0	0	252	+	+	0	+
Red palm oil	..	0	28.0	0	252	+	+	0	..
Palm kernel oil	..	0	28.0	0	252	0	0	0	0
Other vegetable oils	..	0	23.8	0	214	0	0	0	0
Margarine	..	0							
Margarine, with vitamins added	vita- ..	0	23.8	0	214	+	+	0	+

TABLE OF FOOD-VALUES

Protein, Fat and Carbohydrate in grammes per ounce, calorie-value and approximate vitamin-value, of common foodstuffs.

Foodstuff	Protein	Fat	Carbo- hydrate	Calories	Vitamin-Value			
					A	B ₁	B ₂	C
Sugars and Starches								
White sugar	V.L.	0	28.4	114	0	0	0	0
Brown sugar	0.1	0	28.2	113	V.L.	..	0	..
Jaggery (palm sugar)	V.L.	V.L.	27.0	108	V.L.	..	..	..
Honey	0.1	V.L.	21.7	87	..	..	..	..
Tapioca	0.1	V.L.	27.0	108	0	0	0	0
Arrowroot	0.1	V.L.	25.7	103	0	0	0	0
Sago	0.1	V.L.	26.7	107	0	0	0	0
Cereal Grains and Bread								
Whole wheat flour	3.5	0.6	19.0	95	+	++	+	0
White flour	3.0	0.3	23.0	107	0	V.L.	V.L.	0
White bread made with yeast	2.2	0.2	15.2	71	0	+	+	0
Unpolished rice	2.3	0.3	21.0	96	V.L.	++	V.L.	0
Polished rice	1.9	0.2	24.6	108	0	V.L.	0	0
Parboiled rice	2.0	0.1	22.3	98	0	+	V.L.	0
Millet, ragi (average)	2.0	0.4	22.0	100	..	++	V.L.	0
Cholam	3.0	0.5	21.0	100	+	++	V.L.	0
Cambu or bajra	3.3	1.4	19.0	101	+	++	V.L.	0

Barley ..	3.4	0.4	20.0	97	V.L.	++	V.L.	0
Oatmeal ..	3.8	2.5	20.6	120	V.L.	++	+	0
Maize meal, yellow	2.1	0.5	20.8	96	++	+	V.L.	0
Maize, tender, cob	1.1	0.1	4.2	22	+	..	V.L.	0
Semolina	3.3	0.5	22.0	106	V.L.	++	..	0
Rice polishings	..	..	..	..	..	..	..	..
Pulses (Dhals and Grams)								
Bengal gram	5.0	1.5	17.5	103	+	++	++	0
Chick-pea (black gram)	6.8	0.4	17.3	100	+	++	++	0
Field bean, dry	7.0	0.2	17.0	98	V.L.	++	0	0
Horse gram	6.2	0.2	17.0	95	+	++	..	0
Green gram	7.0	0.5	16.0	96	++	+	++	0
Cow gram..	7.0	0.2	16.0	94	+	..	++	0
Red dhal (lentil)	6.0	0.2	17.0	94	+	++	+	0
Dhal, Arhar	6.3	0.5	16.4	95	+	++	++	0
Dried peas	6.6	0.3	16.0	91	V.L.	++	+	0
Kidney bean, dry	7.0	0.6	12.0	81	V.L.	++	V.L.	++
Peas, fresh, green	2.0	0.1	4.0	25	++	++	++	+
Soya bean	12.0	5.6	6.0	122	++	++	++	0
Nuts and Seeds								
Almond	6.0	16.8	3.0	187	V.L.	++	..	0
Coconut, fresh	1.6	14.3	8.0	167	V.L.	+	+	0
Coconut, dried	1.2	11.6	12.6	160	..	+	++	0
Groundnut	8.0	11.4	5.8	158	+	++	+	0
Walnut ..	4.4	18.4	3.1	196	+	++	..	0
Other nuts (average)	6.1	13.4	6.3	170	..	++	..	0
Linseed ..	5.8	10.6	8.2	151	V.L.	..	..	0

TABLE OF FOOD-VALUES

**Protein, Fat and Carbohydrate in grammes per ounce, calorie-value
and approximate vitamin-value, of common foodstuffs.**

Foodstuff	Protein	Fat	Carbo- hydrate	Calories	Vitamin-Value			
					A	B ₁	B ₂	C
Nuts and Seeds (Contd.)								
Gingelly seed ..	5.1	12.0	7.0	156	V.L.	++	..	0
Pumpkin seed ..	7.5	6.8	5.0	111	V.L.	++	+	0
Mustard seed ..	6.3	11.3	6.8	154	+	++	..	0
Tubers and Roots								
Artichoke ..	1.0	V.L.	4.5	22	+	++	..	+
Beetroot ..	0.5	V.L.	5.0	22	+	+	+	+
Carrot ..	0.3	V.L.	3.0	13	++	+	+	+
Leeks ..	0.7	V.L.	2.6	13	V.L.	+	0	+
Onion ..	0.3	V.L.	3.0	13	V.L.	+	+	+
Parsnip ..	0.5	V.L.	6.0	26	+	++	+	+
Potato ..	0.5	V.L.	6.5	28	V.L.	+	++	+
Radish ..	0.3	V.L.	1.0	5	V.L.	+	..	+
Sweet potato (white)	0.3	V.L.	8.6	35	V.L.	+	+	+
Sweet potato (yellow)	0.3	V.L.	8.0	33	V.L.	++	++	+
Turnip ..	0.3	V.L.	1.3	6	V.L.	++	++	+
Yam (elephant) ..	0.6	V.L.	8.0	34	++	++	++	V.L.
Other yams (average)	0.4	V.L.	6.5	28	V.L.	+	..	V.L.

TABLE OF FOOD-VALUES

Protein, Fat and Carbohydrate in grammes per ounce, calorie-value and approximate vitamin-value, of common foodstuffs.

Foodstuff	Protein	Fat	Carbo- hydrate	Calories	Vitamin-Value			
					A	B ₁	B ₂	C
Gourds and Pumpkins								
Ash gourd ..	0·1	V.L.	0·1	1	V.L.	+	V.L.	V.L.
Bitter gourd ..	0·4	V.L.	1·1	6	++	+	V.L.	+
Bitter gourd (small) ..	0·8	0·3	2·8	17	++	+	V.L.	+
Pumpkin (yellow) ..	0·3	V.L.	1·5	7	++	..	..	V.L.
Ridge gourd ..	0·1	V.L.	1·1	5	+	+	..	V.L.
Snake gourd ..	0·1	V.L.	1·2	5	++	V.L.	..	V.L.
Vegetable marrow ..	0·1	V.L.	1·1	5	V.L.	..	..	+
Fruit								
Apple ..	0·1	V.L.	3·7	15	V.L.	+	..	++
Apricot ..	0·2	V.L.	2·0	9	++	+	++	++
Avocado pear ..	0·3	6·5	0·5	62	+	+	++	+
Banana ..	0·3	V.L.	10·5	42	+	+	++	+
Cape gooseberry ..	0·5	V.L.	3·4	16	+	+	+	+
Figs, fresh ..	0·4	V.L.	2·7	12	+	+	+	+
Grapes ..	0·2	V.L.	4·6	19	+	+	+	+
Grapefruit ..	0·2	V.L.	1·5	7	V.L.	+	..	+
Guava (country) ..	0·3	V.L.	3·0	13	++	+	++	++
Jack fruit ..	0·4	V.L.	5·0	22	++	+	++	V.L.

TABLE OF FOOD-VALUES

Protein, Fat and Carbohydrate in grammes per ounce, calorie-value and approximate vitamin-value, of common foodstuffs.

Foodstuff	Protein	Fat	Carbo- hydrate	Calories	Vitamin-Value		
					A	B ₁	B ₂ C
Miscellaneous							
Betel leaves	0.8	V.L.	1.7	10	++	..	..
Chillies, green	0.8	V.L.	1.5	9	++	..	..
Chillies, dry	4.0	1.7	8.8	66	++	..	..
Coriander	0.7	0.2	9.0	41	++	..	..
Cumin ..	5.3	V.L.	14.5	79	++	..	V.L.
Fenugreek seeds	7.3	1.6	12.5	93	+	..	V.L.
Marmite (yeast extract)	—	—	—	—	V.L.	..	0
Toddy, fermented	..	V.L.	4.0	16	++	++	..
Toddy, sweet	..	—	—	—	++	++	..
Yeast, dried	—	—	—	—	V.L.	++	0

Three crosses (+ + +) mean 'rich in',
Two crosses (+ +) mean 'moderately rich in',
One cross (+) means 'some' or 'poor in',
V.L. means 'very little'.

Two dots (..) mean 'not estimated'.
Calories are given in round numbers.
One ounce equals 28.4 grammes.

The chemical composition of foodstuffs varies in different localities. The figures given are therefore to be taken as averages.