

NUTRITION AND HEALTH

Lecture to London School Children May 1937
by Sir Robert McCarrison

In this Lecture I want, if I can, to make you understand what nutrition means and why it is that health depends upon it.

STRUCTURE OF THE BODY

If you were asked what your bodies are made of you would probably say : of flesh and blood and bones. Yes ! but of what are these, and other parts of them, made ? It may surprise some of you to be told that they are made up of countless millions of minute organisms, called cells, and of the fluid in which they live ; this fluid being composed of water and nutrient materials. The existence of the cells depends on this fluid ; for from it they obtain the materials needed for their nourishment and to it they transfer the waste products of their activities. It is derived mainly from the blood which, in a continually moving stream, carries food and oxygen to the cells and removes their wastes. Like as " a flowing stream brings to the simple organisms fixed to the rocks of the stream-bed the food and oxygen needed for existence and carries away the waste " so do " the same conditions prevail for the incalculable myriads of cells which constitute our bodies. . . ." (Cannon).

Picture to yourselves these multitudes of cells : cells of many kinds—blood-cells, bone-cells, teeth-cells, muscle-cells, gland-cells, nerve-cells, skin-cells—each one of them a living, actively working unit of the body ; each intent on its own job ; each with a structure peculiar to its kind ; each fixed in its own place in the body ; each dependent for its existence, for its structure, and for the efficiency of its function on food, oxygen and water being brought to it, and on the food so brought being of a kind suited to its use ; each dependent, too, on the fluid medium in which it lives being kept constantly purified so that it may not be poisoned by its own wastes and those of its neighbours. Picture these myriads busy as bees in a hive ; forming themselves into the different parts of the body ; growing, multiplying and thus increasing the size of their own parts of the body and of the body as a whole ; ceasing to grow when the limits of growth, set by heredity, have been reached. Their wisdom is amazing and their ways wonderful to see. Nowadays we can see them ; for we can culture them outside the body in suitable nutrient fluids and watch them under the microscope. I shall never forget the first time I thus saw them : I had made cultures of cells from a certain gland, and as I watched them, for hours at a time,

growing, multiplying, working, I seemed, in imagination, to hear a busy murmuring amongst them as though they were saying : " We must form ourselves into our gland ; we must, we must, we must ! " Carrel tells us that when he has cultured blood-cells, whose duty it is to carry oxygen to all parts of the body, they actually formed for themselves vessels in which to flow. They seemed to *know* that without the vessels in which to flow they could not get on with their job. So they set about making them from the materials provided in the nutrient fluid surrounding them. Think of the wonder, the beauty, the order, the wisdom and the purposefulness of it all. And think, too, that all this depends on the proper composition of the fluid medium in which the cells live : on its containing everything they need for their proper structure and the proper performance of their functions ; and, on its being constantly kept free of the waste products of their activities. It is to these ends that nutrition—the most important of all functions of the body—is directed.

" Nutrition " may, then, be defined as the sum of the acts or processes by which the myriads of cells that constitute our bodies are nourished. It consists in the taking-in and assimilation, through chemical changes, of substances with which they and the organs and tissues they form, are built-up and their wear and tear repaired ; by which their processes, and those of the body as a whole, are regulated ; and, from which energy is liberated for their work and that of the body they constitute. The purpose of nutrition is thus to ensure that the body shall be properly constructed in all its parts and function efficiently. Now " health " or rather good health—for, as you know, health may be good, bad or indifferent—is that condition of body in which all its parts are properly constructed and functionally efficient. It follows, therefore, that the purpose of nutrition is to ensure good health so far as it can do so. You will notice that I say " so far as it can " ; this is because there are other factors besides nutrition which influence health, though none are so important. But nutrition, like health, may be good, bad or indifferent, and according as it is one or other it influences health for good or for ill.

SUBSTANCES NEEDED FOR NUTRITION

The substances with which the function of nutrition is effected are : (1) oxygen, which is present in the air we breathe ; (2) water, of which the greater part of our bodies is composed ; (3) food, which plants, under the influence of sunlight, produce for us out of the

earth and air ; and (4), a substance formed in the skin of our bodies, by the action of sunlight. Air, water, sunlight and food : these are the instruments of nourishment ; nutrition is the act of using them.

PROCESSES OF NUTRITION

The acts or processes involved in nutrition are many. First and foremost there is *breathing* by which, during inhalation, air is taken into the lungs and oxygen absorbed from it by the red cells of the blood ; by which, also, waste gases are expelled from the body, during exhalation. Second, there is the *circulation* of the blood, which, driven by the pumping action of the heart, carries oxygen and nutriment to every cell in the body. Third, there is the *drinking of water* which forms nine-tenths of the blood and of the fluid medium in which the cells live. Fourth, there is the *chewing*, the *swallowing*, and the *digestion of food* by which it is split up into its component parts and made ready for use by the cells of the body. Fifth, there is the *absorption* into the blood-stream, from the digestive tract, of the products of digestion and the *evacuation* by the bowels of the food-residues and waste products of digestion. Sixth, there is the *control of vital processes* by substances derived from the food or manufactured by certain glands in the body. Seventh, there is the *assimilation* by the cells of the nutriment conveyed to them by the blood, that is, its conversion, by chemical changes, into substances identical with themselves. Eighth, there is the *discharge of the waste products*, resulting from these chemical changes, by the lungs and kidneys. And, finally, the burning-up of certain food-materials ("fuel foods") with the *production of energy* for the work of the body—work which includes all these acts or processes as well as growth of the body, and bodily movements such as we make in walking, playing or taking exercise. Nutrition depends on all these acts or processes. Disturbance of any one of them disturbs it and, if severe or long continued, leads to ill-health. For instance, if for any reason we do not get enough fresh air then we do not get enough of the oxygen needed for the chemical activities of the cells that constitute our bodies. The sum of these activities makes up, as it were, "the fire of life". And just as an ordinary fire will not burn properly without a proper draught of oxygen-containing air, neither will the fire of life. It, too, needs an abundant supply of oxygen to keep it burning briskly. Hence the great importance to nutrition of abundant fresh air and proper breathing. Many children do not breathe properly through the nostrils, as they are intended, and should be instructed, to do. They should have breathing exercises and "nose-drill" every morning : the former to inflate the lungs properly and remove from them stagnant air ; and the latter to keep the nasal passages clear. There are all sorts of nooks and

corners, passages and cavities in and around the nose which tend to get stopped up unless air is made to pass freely through them. If not kept clear by proper breathing through the nostrils, they are apt to become infected and to cause much discomfort or even suffering.

Now as the chemical activities of the body proceed or—to continue my simile—as the fire of life goes on burning, gaseous and other waste products are formed ; just as smoke and ashes are formed by an ordinary fire. These must be got rid of, otherwise the fire will become choked, and the cells of the body poisoned, by their accumulation. The waste gases are taken up by the red cells of the blood, after they have given up their load of oxygen to the tissues, and are carried to the lungs where they are discharged into the air. The other waste products, dissolved in water, are passed out of the body by the kidneys. This is one reason why it is so necessary to drink plenty of water. There are other reasons ; but here it is only necessary to say that water is the very fount of nutrition. For it is the vehicle which conveys essential nutrients to all cells of the body, the medium in which their chemical activities take place, and the solvent in which their wastes are discharged from the body. During these chemical activities a certain amount of water is formed as a by-product. But in addition to this, and in addition to the water contained in all foodstuffs (three-quarters, by weight of a potato, for instance, is water), more than a quart of water a day, as such, or in beverages, needs to be taken if nutrition is to be normal. Many people drink far too little water and, in consequence, nutrition is interfered with and health suffers sooner or later. It is a good plan to drink a glass of water first thing in the morning and last thing at night as well as between meals whether you are thirsty or not. Water keeps the inside of the body clean just as it does the outside.

THINGS THAT DISTURB NUTRITION

The next important thing in nutrition is food which must be of a kind that supplies all the other materials needed for the growth, repair and work of the body and for the regulation of its functions. Presently I shall tell you what the right kind of food is. But here I want to remind you that nutrition may be disturbed not only by the wrong food but by the imperfect chewing of food, by sloppy foods that are swallowed without chewing, by poor digestion and the imperfect action of the bowels or constipation. The proper chewing of food is important because it exercises the jaws and helps to keep the gums, the teeth and mouth healthy ; and, because it starts off the processes of digestion by which food is split up into its component parts and made ready for use by the body. Failure to chew the food properly disturbs digestion at its very outset. Even more important is the proper action of

the bowels. Constipation is often a sign that the food is at fault and that nutrition is, or soon will be, at fault. But it is sometimes a sign of carelessness. It is very easy to be careless and fall into bad habits about emptying the bowels regularly. You may be late for school or something distracts your attention and so you neglect this very important duty of ridding your body of the waste products of digestion. I want you to realise that the regular and healthy action of the bowels is essential for proper nutrition and health.

Nutrition may also be disturbed by insufficient rest and want of sleep. Rest, as you know, is necessary to recovery from fatigue. During sleep, there is a slowing down of all vital processes; the bodily engine, as it were, just "ticks over". Without this periodic reduction of its activities to a minimum it would tend to wear itself out. Sleep and plenty of it—a child of twelve years old should, for instance, sleep for about eleven hours out of the twenty-four—is particularly necessary during childhood when the body has so much work to do in growing and when children, during waking hours, are hardly ever still. In these days of rush, bustle, excitement and noise many children get far too little sleep, and, in consequence, their nutrition and health suffer, especially if they are improperly fed, as is often the case.

Worry and emotional excitement, infections of various kinds, want of sunlight and lack of exercise are other factors which disturb nutrition, for they impair the vitality and working capacity of the cells. Proper exercise of the body is particularly important; for not only does it induce muscular strength, agility and beauty of form, but it promotes the circulation and purification of the blood. It is nutrition's great assistant, but an assistant only. For without proper nutrition the full benefits of physical exercise cannot be obtained. When, as is soon to happen, physical training becomes part of your everyday lives, you must take care, so far as you can, that your nutrition is not faulty.

FOOD, PHYSIQUE AND HEALTH

Before telling you what is the right kind of food to eat I will tell you of some experiments I carried out in India; for I hope that their results may help you to realise how important food is for physical fitness. India, as you know, is a very large country, with a population of about 350 million people made up of many different races; each race having its own national diet. Now the most striking thing about these races is the way in which their physique differs. Some are of splendid physique, some are of poor physique and some are of middling physique. Why is there this difference between them? There are, of course, a number of possible causes: heredity, climate, peculiar religious and other customs and endemic diseases. But in studying the matter it became evident that these were not principal causes. The principal cause appeared to be food.

For instance, there were races of which different sections came under all these influences but whose food differed. Their physique differed and the only thing that could have caused it to differ appeared to be food. The question then was how to prove that the difference in physique of different Indian races was due to food. In order to answer it I carried out an experiment on white rats to see what effects the diets of these different races would have upon them when all other things necessary for their proper nutrition were provided. The reasons for using rats in experiments of this kind are that they eat anything a man eats, they are easy to keep clean, they can be used in large numbers, their cages can be put out in the sun, the round of chemical changes on which their nutrition depends is similar to that in man, and, a year in the life of a rat is equivalent to about twenty-five years in the life of a human being. So that by using rats one gets results in a few months which it would take years to get in man. What I found in this experiment was that when young, growing rats of healthy stock were fed on diets similar to those of people whose physique was good the physique and health of the rats were good; when they were fed on the diets similar to those of people whose physique was bad the physique and health of the rats were bad; and when they were fed on diets similar to those of people whose physique was middling the physique and health of the rats were middling. Good or bad physique as the case might be was, therefore, due to good or bad diet, all other things being equal. Further, the best diet was one used by certain hardy, agile, vigorous and healthy races of Northern India. It was composed of freshly ground whole wheat flour made into cakes of unleavened bread, milk, and the products of milk (butter, curds, buttermilk), pulses (peas, beans, lentils), fresh green leaf vegetables, root vegetables (potatoes, carrots), and fruit, with meat occasionally.

Now in my laboratory I kept a stock of several hundred rats for breeding purposes. They lived under perfect conditions; cleanliness, roomy cages, good bedding, abundant fresh water, fresh air and sunlight—all these things they had; and, they were fed on a diet similar to that of a race whose physique was very good. They were kept in stock from birth up to the age of two years—a period equivalent to the first fifty years in the life of human beings. During this period no case of illness occurred amongst them, no death from natural causes, no maternal mortality, no infantile mortality except for an occasional accidental death. In this sheltered stock good health was secured and disease prevented by the combination of six things: fresh air, pure water, cleanliness, sunlight, comfort and good food. Human beings cannot, of course, be so sheltered as these rats were, but the experiment shows how important these things are in maintaining health.

The next step was to find out how much of this remarkably good health, and freedom from disease, was due to the good food : food consisting of whole wheat flour cakes, butter, milk, fresh green vegetables, sprouted pulses, carrots and occasionally meat with bone to keep the teeth in order. So I cut out the milk and milk products from their diet or reduced them to a minimum, as well as reducing the consumption of fresh vegetable foods while leaving all other conditions the same. What was the result? Lung diseases, stomach diseases, bowel diseases, kidney and bladder diseases made their appearance. It was apparent, therefore, that the good health depended on the good diet more than on anything else and that the diet was only health-promoting so long as it was consumed in its entirety, so long, in fact, as it contained enough milk, butter, and fresh vegetables.

Many more experiments were done which showed that when rats or other animals were fed on improperly constituted diets, such as are habitually used by some human beings, they developed many of the diseases from which these human beings tend to suffer : Diseases of the bony framework of the body, of the skin covering it and of the membranes lining its cavities and passages ; diseases of the glands whose products control its growth, regulate its processes and enable it to reproduce itself ; diseases of those highly specialised mechanisms—the gastro-intestinal tract and lungs—designed for its nourishment ; diseases of the nerves. All these were produced in animals under experimental conditions by feeding them on faulty human diets. Here is an example of such an experiment : Two groups of young rats, of the same age, were confined in two large cages of the same size. Everything was the same for each group except food. One group was fed on a good diet, similar to that of a Northern Indian race whose physique and health were good, and of which the composition is given above. The other was fed on a diet in common use by many people in this country : a diet consisting of white bread and margarine, tinned meat, vegetables boiled with soda, cheap tinned jam, tea, sugar and a little milk : a diet which does not contain enough milk, milk products, green leaf vegetables and whole meal bread for proper nutrition. This is what happened. The rats fed on the good diet grew well (Fig. 1), there was little disease amongst them and they lived happily together. Those fed on the bad diet did not grow well (Fig. 2), many became ill and they lived unhappily together ; so much so that by the sixtieth day of the experiment the stronger ones amongst them began to kill and eat the weaker, so that I had to separate them. The diseases from which they suffered were of three chief kinds : diseases of the lungs, diseases of the stomach and intestines, and diseases of the nerves ; diseases from which one in every three

sick persons, among the insured classes, in England and Wales, suffer.

It may, therefore, be accepted as an axiom that *the greatest single factor in the production of good health is the right kind of food* and the greatest single factor in the production of ill-health is the wrong kind of food.

DIET FOR HEALTH

Now as to the right kind of diet. If you have followed me so far you will have realised that it is the kind of diet on which certain hardy, agile, vigorous and healthy races of India live ; the kind of diet on which my healthy rats lived. It is, too, the kind of diet which, within the last year or so, has been recommended by the Technical Commission appointed by the Health Committee of the League of Nations to formulate the nutritional needs of the human body. And it is the kind of diet recommended, within the last few weeks, by the Advisory Committee, appointed by the Minister of Health and the Secretary of State for Scotland, to inquire into the faults of our national diet and to suggest means to rectify them. There is, therefore, no longer any doubt as to what the right kind of diet is. It is one made up of the following eight classes of foodstuffs :

1. Whole or lightly milled cereal grains ; whole wheat flour and the bread made from it or standard bread or bread containing the germ of the wheat and a proportion of the outer skin of the wheat grains ; rye bread ; oatmeal ; semolina.
2. Milk and the products of milk : cheese, butter, skimmed milk, curds and buttermilk.
3. Pulses : peas, beans and lentils.
4. Fresh green leaf vegetables such as spinach, lettuce, watercress, cabbage, parsley, turnip tops, nettle tops, and young dandelion leaves.
5. Root vegetables, particularly potatoes, carrots and onions.
6. Fruit, both fresh and sun-dried ; and with fruit may be included the tomato.
7. Egg.
8. Meat, including glandular organs such as liver, fowl, and fish, particularly the herring.

It is on diets made up of the first six of these, with meat in moderation or only as a luxury, that the vigorous, hardy and healthy races of Northern India live. And it is on diets made up for the most part of these that you must live if you wish to be vigorous, hardy and healthy and to remain healthy. These foodstuffs do not differ in kind from those we use in this country. Where we go wrong is in the way we use them and in the things we do to them before using them. We make our wheat into white flour, instead of into

wholemeal or lightly milled flour, thus depriving it of important nutritive substances : substances needed, amongst other things, for efficient nervous and muscular action and for efficient blood-formation. We do not drink nearly enough milk, and we neglect to use such excellent foodstuffs as skimmed milk and buttermilk. Many of us eat far more meat or other animal food than we need. We do not eat nearly enough fresh green vegetable foods in the form of salads, nor enough fruit. We boil our vegetables in water and throw the water in which they are boiled down the sink instead of using it as food ; and often we add soda to it which destroys some of the nutritive substances in the vegetables. And, perhaps worst of all, we eat far, far too much sugar which has no body-building substances in it at all. It is this inordinate use of sugar, sweets and sweet cakes which is so bad for children. It ruins their teeth and spoils their appetite for more nutritious foods. If you have money to spend do not spend it on sweets ; spend it on fruit or a glass of milk or both. There is no harm in sugar taken in moderation at meals, especially when it is taken in the form of natural brown sugar, black treacle or honey : what does the harm is the munching of sweets between meals and the finishing up of meals with sweet things.

There is another difference between the hardy, vigorous races of Northern India and ourselves. They live in a country where sunshine is abundant the whole year round ; we do not. So it is necessary during the winter months when sunshine is scanty, to make up for the lack of it. Fortunately, this is easy to do by taking cod-liver-oil which contains the substance that sunshine produces by its action on the skin. One often hears complaints that people cannot take cod-liver-oil. This is usually because they take more than a teaspoonful. This dose, taken once a day, at the end of breakfast and followed by a piece of dry bread is enough and the advantages derived from taking it are great. Cod-liver-oil contains iodine which is necessary for the health of a gland in the neck called the thyroid. This gland, sometimes swells, because there is not enough iodine in the diet, causing " goitre ".

" PROTECTIVE FOODS "

By this time you may be asking yourselves : what is it that makes these eight classes of foodstuffs the right ones from which to construct our diets ? From what I have told you you will have realised that food has two great functions : the first to supply materials needed for the construction of the body, for the maintenance of its structure and for keeping the mechanism of the body in proper running order ; and, the second, to supply materials that provide energy for the work of the body. In accordance with these two functions, the foodstuffs available for our use are divisible into two great classes : those rich in materials that subserve the first function and those rich in materials that subserve

the second. The first class includes the " protective foods ", so-called because they are rich in substances—proteins, mineral salts and vitamins—which protect the body against disturbance of its structure or functions, that is against disease ; for disease is disturbance of structure or functions of organs or parts of the body. The principal foodstuffs of this class are milk and its products, green leaf vegetables, whole meal bread, potatoes and fruit, though the other three of the eight classes of foodstuffs above mentioned have protective qualities also. To the second class belong the " energy-yielding foods ", or fuel foods, so-called because they are rich in substances—starches, fats and sugar—which provide energy for the work of the body. Included in this class are the cereal foods—flour, bread, rice, barley, oatmeal, etc.—the fats, such as mutton fat, beef fat, bacon fat, butter, margarine and vegetable oils, and sugar, either as such or in honey, treacle and sweet things generally. Meat, too, is an energy-yielding foodstuff, though of an extravagant kind. Many of these, if rightly chosen, are protective as well as energy-yielding. It is because the eight classes of foodstuffs I have mentioned are both protective and energy-yielding that they are the right ones from which to make up our diets, and because they form complete diets when properly combined. The great secret of food and nutrition is to eat these foodstuffs as nature provides them, and the fresher the better. This is not to say that they should not be cooked, but that such as are cooked should be cooked in a way which does not destroy their health-promoting properties.

In this country everyone or nearly everyone gets enough energy-yielding foods—bread, sugar, fats—and, except the very poorest, enough meat. But many people do not get enough of " the protective foods ", particularly milk, fresh vegetables and wholemeal bread. Their diets are, therefore, incomplete and incomplete in a direction which results ultimately in disorder of structure or functions of organs or parts of the body, that is in disease. It is as though motor-cars were given enough petrol but not enough of the things—oil and grease, for instance—needed to keep their mechanisms in good running order. You can well imagine what is bound to happen in these circumstances : how soon the cars would begin to creak and rattle, to rust and wear out ; how soon, in short, they would become diseased. It is much the same with human beings who get enough " energy-yielding " but not enough " protective foods ".

SOIL AND HEALTH-GIVING FOODS

In this lecture I have said little or nothing of calories, mineral salts, proteins, vitamins or other chemical constituents of food about which you may have heard

or read. I have done so purposely. For this is an introduction to the subject of food, nutrition and health and those who want to learn more about the chemical constituents of food and the parts they play in nutrition can do so from the books I mention below.* What I want you to learn from this lecture is that it is the foodstuffs themselves that matter to you, rather than any chemical ingredient of them : the foodstuffs which I have mentioned in the list given above. These, when properly combined in the diet, supply all the food-essentials, known and unknown, discovered or undiscovered, needed for normal nutrition, provided they are produced on soils which are not impoverished. For if they be produced on impoverished soils their quality will be poor and the health of those who eat them—man and his domestic animals—will suffer accordingly. Man is literally created out of the earth, since it is the earth that supplies, through the agency of plants, materials out of which he is made. If, therefore, he is to derive all the benefits which the earth is so ready to yield to him, he must employ his intelligence, his knowledge and his labour in rendering it fit to yield them to him. In this country impoverishment of the soil goes on apace because we take out of it in the form of crops more than we put into it in the form of animal and other organic manures. This impoverishment leads to infertility of the soil and this, in its turn, to a whole train of evils ; pasture of poor quality ; poor quality of the stock raised upon it ; poor quality of the foods this stock provides for man—meat, eggs, milk ; poor quality of the vegetable foods he raises for himself ; and, faulty nutrition with resultant disease in plants, beasts and men. Out of the earth are we and

the plants and animals that feed us created and made, and to the earth we must return the things whereof we are made if it is to yield again foods of a quality suited to our needs. There is in this country, at the present time, no greater need than that by proper care and cultivation of our soil we may make ourselves self-supporting in the health-giving foods, particularly milk, garden vegetables and potatoes. Unfortunately it would seem that we cannot grow all the wheat we need for bread ; but we can at least turn the wheat we do import, as well as the wheat we grow in this country, into wholemeal or lightly milled flour, using the bread made from it instead of the denatured white bread now in almost universal use. There are few greater services that anyone can render to his country and his fellow-men than to devote his or her energies to the cultivation of the soil. The production of these foods in such abundance that they will be within the means of everyone is a task that lies before the younger generation ; and I hope that some amongst you, who have listened to me to-day, may devote yourselves to it, and adopt one of the greatest of all professions : that of agriculture. Those of you who have the opportunity should take up the cultivation of kitchen gardens or allotments in your spare time. It is a health-giving pastime : health-giving not only on account of the exercise of your bodies but because of the fresh foods you produce for yourselves and relatives. There can be no doubt that without the greater production, the cheapening and the more even distribution and use of the foodstuffs I have mentioned, our people cannot attain to that perfection of physique which is their birthright.

* 1. *Teaching of Nutrition to Boys and Girls*, by M. S. Rose ; 2. *Food*, by R. McCarrison ; 3. *The Foundations of Nutrition*, by M. S. Rose ; and, 4. *Food Values at a Glance*, by V. G. Plimmer.



Fig. 1. Rat fed, from an early age, on a good diet consisting of whole wheat bread, butter, milk, pulses, fresh green vegetables and carrots, with a ration of meat and bone once a week. Compare with Fig. 2.



Fig. 2. Rat, of the same age as that in Fig. 1, fed from the same early age on a bad diet consisting of white bread and margarine, tinned meat, vegetables boiled with soda, tinned jam, tea, sugar and a little milk.

See text : pages 17 and 18. Compare with Fig. 1.

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