

FOOD AND NUTRITION

THE PHYSIOLOGICAL BASES OF
HUMAN NUTRITION

BY

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PREFACE

IN presenting a brief survey of our present knowledge of the physiology of Food and Nutrition and of the means whereby this country met the problems of feeding the nation during six years of war, I have had in mind medical practitioners, medical students and those of the general public who are particularly interested in the part food plays in promoting and maintaining the welfare of the individual as well as that of the nation. The recent ideas of the General Medical Council concerning the training of candidates for the Diploma in Public Health have also been borne in mind. The suggestion that they should be given courses in the Physiology and Biochemistry of Food and Nutrition means that they must have a knowledge of the physiological bases of nutrition, dietary planning and the social and economic aspects of food.

A strong belief in the value of historical knowledge in understanding the development and significance of modern scientific investigation has led me to introductions of certain parts of the subject which may be considered all too brief. For those who feel disposed to criticise such brevity references are given. An equally strong belief in experimental evidence may, in the eyes of the general reader, appear to have led me into unnecessary by-paths, but the evidence of experiment is all important and so great is the bulk of it in nutrition to-day, that selection presents an ever growing difficulty. During six years of war the experimental field of nutrition has been extended in many interesting directions. To some of the work reference has been made, but much still remains to be published. The body of evidence concerning nutrients, food processing, and nutrition in relation to human well-being continues to grow so rapidly that the time is ripe for a British Journal of Nutrition.

War has emphasised with harshness and urgency what political reform has envisaged for many years, namely, the need of a greater production and better distribution of food in the interests of the nutritional status of our people. The hope of peace demands that, in the international sphere, this principle be not lost sight of. To this end, and with commendable vision, the United Nations Conference on Food and Agriculture convened at Hot Springs, U.S.A., in May 1943, resolved upon the formation of a World Food and Agriculture Organization. This Organisation was established on October 16, 1945, with Sir John B. Orr, F.R.S., as its Director-General, and with its creation the first plank to bridge the gulf between War and Peace had been fashioned. Naturally it is not the only plank required to bridge this great gulf, but it is, at present, the only one apparently sufficiently well prepared to bear the weight of responsibility it is destined to carry. It may not be too much to say that the hope of World Peace depends upon it.

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In gathering together scientific and medical data one soon becomes aware of one's indebtedness to others. I should like to express my thanks to those who by reprints or personal letters have kept me informed as to the latest developments in their respective spheres of research and to those who, in this country and abroad, have so willingly granted me permission to use their illustrations.

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CONTENTS

CHAPTER	PAGE
I INTRODUCTORY: THE EVOLUTION OF HUMAN DIETARIES	1
II THE PROBLEM OF WORLD MALNUTRITION . . .	11
III THE PROBLEM OF NUTRITION IN GREAT BRITAIN . . .	22
IV THE PROBLEM OF NUTRITION IN GREAT BRITAIN 1939-45	31
V THE ENERGY REQUIREMENTS OF THE BODY . . .	48
VI PROTEIN REQUIREMENTS OF THE BODY . . .	66
VII FOODSTUFFS AND THEIR FUEL VALUES . . .	77
VIII MINERAL SALTS IN NUTRITION	88
IX VITAMINS AND DIETARY DEFICIENCY DISEASES. VITA- MIN A AND THE VITAMIN B COMPLEX . . .	106
X VITAMINS AND DIETARY DEFICIENCY DISEASES (<i>Cont.</i>) VITAMINS C, D, E AND K	126
XI BREAD	150
XII MILK	172
XIII PROTEIN RICH FOODS	193
XIV VEGETARIANISM	204
XV DIETARY STANDARDS AND DIETARY PLANNING . . .	215
XVI DEHYDRATION AND PRESERVATION OF FOODS . . .	241
XVII DIET AND DENTAL CARIES	273
XVIII THE APPRAISAL OF THE NUTRITIONAL STATE IN IN- DIVIDUALS AND COMMUNITIES	286
XIX THE FOOD AND AGRICULTURE WORLD ORGANIZATION	306
INDEX	319

CHAPTER I

INTRODUCTORY

THE EVOLUTION OF HUMAN DIETARIES

THE evolution of the dietaries of man has had a distinct and characteristic influence upon the development of man himself. In the Simian Period, the Primates, because of their prehensile powers, fed chiefly on fruit, beans, roots and to some extent on birds and small mammals. When, in the course of time, man began to employ special devices in hunting and fishing, he became less dependent upon vegetable food and more and more dependent upon animal food. In doing so, he lost, to a great extent, his power of digesting what would now be regarded as most indigestible and unpalatable forms of vegetable food. In those early prehistoric days, a good nutrition must have waited upon good mastication, for in prehistoric man an excellent masseteric musculature and salivary mechanism were associated with a dental array which may have been as alarming as it undoubtedly was efficient. Certainly in those days much of salivary digestion was carried on in the mouth and not, as to-day, relegated almost entirely to the small intestine. A marked step forward in the evolution of dietary habits was taken when man learned to cook. In so doing he increased his food supply, lessened the time required for mastication, increased the amount of vegetable food taken, but lost to a large extent his power of digesting raw foods. There still exist in the world to-day peoples who are representative of this period in the evolutionary history of man. They are the Bushmen of South Africa, the Veddahs of Ceylon, certain American Indians and the Esquimaux. While geographically and ethnologically separated, their mode of eating is proof of their common origin. Before the advent of the use of boiling water in cooking, man used surface fires and underground ovens. In certain parts of the world, for example, in New Zealand, boiling pools afford an excellent means of cooking, but it was not until man created for himself receptacles which would both hold water and resist heat, that he was able to boil water in

order to cook his food. Not only by a remarkable resourcefulness and ingenuity did man select the food which he desired to cook, but he soon learned how to extract starch or sugar from foods rich in these substances. In the pre-agricultural period of man's existence, there appears to have been no knowledge of the art of making beverages, at least not of the art of making alcohol.

In the course of his long prehistoric existence, man had noted the quick passage of the sun, the slower motion of the moon and the long cycle of the great stars. The impression which these heavenly bodies must have made upon his mind, clouded and dominated by superstition and fear, must have been tremendous. In noting the equinoctial position of the sun, sensing the meaning of springtime in the regularly recurring outbursts of new life around him and ultimately realizing the significance of the cycle of the seasons, primitive man awoke to the meaning of springtime and harvest. The first experiments in agriculture had begun. No longer did he rely entirely upon the forests, the lakes, the rivers and the sea for his food, but he began now to assure himself of a regular and known supply of his material needs. Naturally at first, being still a migratory animal, his efforts in agriculture were doubtless spasmodic and limited, but as primitive digging implements of wood and bone gave way to the neolithic tools, the pick, the adze and the axe, a period of more stationary agriculture was introduced. In the migratory period, man had learned how to rear animals, to tend herds and to secure for himself a very valuable mammalian source of food supply. He had throughout the long process of the conquest of the seasons succeeded in securing for himself a mixed animal and vegetable dietary. His fortuitous existence as a primitive Primate had ended and he had entered upon that period of neolithic development which was to be the forerunner of the ancient civilizations of China and Egypt (*ca.* 4000 B.C.).

The Effect of Climate, Racial and Religious Differences upon Dietary Habits.—Throughout the agricultural period, as he continued to develop the cultivation of cereals, cane sugar and fruit, man came to rely less and less upon raw vegetables. As populations increased and tribes wandered further and further into the unknown seeking new areas for cultivation and developing new crafts, greater variations in dietary customs

became manifest. In the tropics a purely vegetarian mode of existence contrasted strongly with the carnivorous instincts of those who had elected to live their lives in the cold and less sunny regions of the arctic and sub-arctic climates. There were, of course, intermediary groups who did not rely entirely upon either fruits and vegetables or on cooked seal, walrus and whale. To climatic variations were added those of race and religion. The racial differences are more difficult to explain. Not only do we find primitive peoples who, like the aborigines of Australia, are very fond of putrid, fatty flesh, be it fish or fowl, or like the natives of Tierra del Fuego who, according to Darwin in his *Voyage of the Beagle*, regard the floating carcass of a putrid whale as a rich feast in store, but on the other hand, we find less primitive peoples, such as the Veddahs of Ceylon, who favour decayed meat with the added luxury of large masses of honey, and in India certain classes to whom putrefying fish is quite acceptable as an article of diet. In the Far East there are the Chinese, a people of ancient culture for whom milk and butter appear to have but little attraction.

In the religious sphere we find the Buddhist, to whom the taking of life is strictly forbidden, and for whom in China and Japan, and in India, the home of Buddhism, the eating of certain fish has become a quite orthodox custom. To-day the traditional attitude of avoidance of pork and alcohol by orthodox Mohammedans is well known. The Levitic Law stands pre-eminent as an example of priestly dictation in the interests of public or tribal health. What was once declared "unclean, an abomination", was strictly avoided, ultimately to become abhorred. Several animals, including the camel and the pig, many birds, fish without scales or fins, are to be found in this priestly category of things forbidden. It would appear that in the long history of the development of dietary habits, there has been a steady tendency in temperate climates to replace vegetable food by a greater dependence upon animal food. It has often been stated, with what truth we are free to surmise, that animal food has played a decisive part in human evolution. Perhaps too much stress has been laid upon this aspect of evolution, but nevertheless it is true that animal protein foods do exert a stimulating effect upon the complex of chemical processes within the body. To secure all the elements of the proteins necessary for body-building, much

more of vegetable than animal protein must be eaten. These animal foods, in conjunction with geographic position and climatic conditions, have a very important ethnological significance. That this is true of man is borne out by the appearance and disappearance of certain races, tribes and communities. Some races are tall, healthy and long-lived; others are puny, disease-ridden and prematurely senile. Heredity does, and always will, play an important part in determining human stature and health; but climate also plays a part, even if a small part, in determining physical and mental characteristics, and it must now be accepted that diet also plays its part, a fact which in the opinion of some outweighs both heredity and climate combined. One of the most interesting reports on the part played by diet in the development of races has been published by the Medical Research Council of Great Britain. It is a study of the physique and health of two African hill tribes in Kenya, by Sir John Orr and Dr. Gilks. One tribe, the Kikuyu, is vegetarian; the other, the Masai, is carnivorous. The Kikuyu tribe is agricultural, and, although the natives possess large herds of goats, they practically never eat meat. Meat is the diet of the old men of the tribe, the others live on cereals, tubers, plantains, legumes and green leaves. Sixty per cent of the diet of the males consists of maize and millet. The Masai, on the other hand, are a pastoral tribe; the staple diet of the young men consists of meat, milk and blood; the older people eat bananas, beans, maize and millet. It is interesting to note the physical characteristics of these two tribes, the one vegetarian, the other meat-eating. At every age the Masai tribes are taller and heavier than the Kikuyu; at the age of twenty-three years there is an average difference of five inches in height. At the same age the Masai women are three inches taller than their vegetarian neighbours. Measurements of physical strength show that the Masai present a marked superiority, the Masai women even being as strong as the Kikuyu men. Interesting are the diseases to which these tribes are prone. Dental caries is not common in either, but it is more prevalent in the Kikuyu children. Anæmia, unknown amongst the Masai children, is prevalent among the Kikuyu children. Bone deformities, as one would expect, are absent from the Masai, but definitely present in the Kikuyu. The resistance to tropical diseases, tuberculosis and pneumonia is greater with the meat-eaters,

but the prevalence of rheumatic troubles, arthritis and constipation is very marked in the Masai, troubles which are not to be found amongst the vegetarian Kikuyu. Before the white man came, the Masai lorded it over their puny neighbours; they were a fearless tribe; to hunt lion with only a spear was a common task of this virile tribe. The moral to be drawn from this comparison is that meat in moderation is an excellent adjunct to milk, green vegetables and cereals.

Such results are not confined to Kenya, but can be obtained throughout India, where various races subsisting on different diets give great opportunity for investigation of the numerous problems associated with nutrition and national health. The diets of Bengalis, Sikhs and Pathans vary in certain respects and comparing their dietaries, relative to their build and mode of life, one can see how diet does play a part in the development of the physical and mental characteristics of people.

The Impact of Social Conditions in Britain on Food and Feeding.—Having looked at the broad lines of development which have led up to distinct racial and tribal differences, we may now consider the progress in dietary advance in this country in its relation to social conditions. In mediæval times a clean-cut distinction existed in almost all respects between the Lord of the Manor and the common people. The crops grown on the manor lands by the common people were wheat, barley, oats, rye and beans. In the south, wheat and rye were the principal crops and these were often from mixed sowing, and from this fact arose the word “maslin” (Latin, *miscere* = to mix) which denoted the finely ground and sieved flour obtained from these crops. In the fourteenth century there is evidence of the cultivation of vegetables and fruits in England. This was a late development compared with what obtained in France and Italy, where by that time gardens were plentiful. In all circumstances, livestock, supporting the animal protein requirements of the people, were kept by landowners.

In the fourteenth and fifteenth centuries the bondage of serfdom slowly disappeared and we find a steady increase in tenant farmers and yeomen. By the system of Tudor enclosures, resulting from the growth of the wool trade, arable land was sacrificed to an astonishing degree to increase grazing, and much economic distress was caused thereby. This was accompanied by a deterioration in the diet of the common people. The

lack of grazing lands led to a decrease in dairy cows, which were the source of the "white meats" as dairy produce was called. This period of depression was probably responsible for a remarkable increase in gardening in which the Dutch were particularly skilful. With the growing of fruits, vegetables and potatoes and the improvement in agriculture which accompanied the increasing stability of the realm under Elizabeth, the diet of the common people living on the land and in the small towns again improved. In the larger towns, however, and particularly amongst the urban populations of large cities like London and York, the quality of the food was very bad and the practice of food adulteration grew to a scandalous extent.

Tudor days saw the first attempt to bring fish from the coastal towns to the large cities. The results were, to say the least, unsavoury. Putrefaction, with its attendant odours, or the odour itself, was regarded as the cause of the frequent outbreaks of plague so notable a feature of the fifteenth and sixteenth centuries. The trade in herrings was considerable—they were cheap, 40 a penny—and herrings with, occasionally, salmon, formed a valuable addition to a diet, not good in the large cities but on the whole very good in coastal and rural areas.

Before the nineteenth century, bread was made from wholemeal flour prepared by stone grinding, the coarse particles of the bran being removed by "bolting" through linen or woollen cloth of various degrees of coarseness. The more finely this flour was sieved the lighter in colour it became until the finest quality was of a pale cream colour. In the Tudor period this flour was called "manchet" and it became the sign of a type of living associated with the Court and later with the families of the rich.

Reference is made not infrequently to the peasant's diet of the fifteenth and sixteenth centuries, emphasis being laid upon its wholesomeness. Wholemeal bread and fruits in season were eaten freely. Vegetables and potatoes did not then bulk largely in his diet and it is for this reason that scurvy was a prevalent disease. If the peasant could secure a goodly supply of "the white meats", milk, whey, cheese and eggs, then regarded as a low class diet, he had a diet which was far superior to that eaten by many of our working classes to-day.

The formation of the East India Company in 1600 may be regarded as the first official pronouncement that England was to prosecute oversea trade far beyond the limits hitherto covered by such chartered companies as the Turkey Company (1581) and the Russian Company (1566). Throughout the seventeenth century this trade grew apace and in the eighteenth century became the open sesame to the great developments of our commercial and colonial empire. Our navy virtually commanded the seven seas and our merchant ships traded to the four corners of the earth, opening up tremendous possibilities for wealth, and bringing ever new ideas which had their effect on the diet and social customs of the peoples of these islands.

In the realm of our national dietary two changes amongst many were noteworthy—the importation of tea and sugar. Three hundred years ago sugar was unknown as an article of diet. In the days of Marie Antoinette it was an expensive luxury sold at about 4s. or 5s. per lb. At the end of the Napoleonic wars, which had cut Europe off from her source of sugar supplies, France and Germany had established the manufacture of sugar from beet, but English people had insular prejudices concerning beet sugar and were apparently content to pay dearly for cane sugar which for them was rapidly becoming a necessity. The history of sugar is the history of a habit-forming foodstuff. As sugar consumers we run a very close second to the people of the North American continent. From 1836 to 1936 the consumption of sugar rose in this country from approximately 10 to 100 lb. per head per annum. The great increase in the use of sugar has not been without its effect upon our taste for other and better foods. The craving for sugar has led to the use of unbalanced diets, for sugar eaten in excess destroys the appetite for those foods which supply the all-essential proteins, vitamins and mineral salts. From being a rarity sold by the Pepperers, the predecessors of our grocers, sugar has become the cheapest available source of energy.

Another of the striking changes in English dietary habits was the adoption of tea-drinking. Coffee introduced from Turkey and chocolate from the West Indies had become established as beverages in the seventeenth century. Tea from China and the Dutch East Indies was first sold in England at £3 10s. per lb. So quickly did it gain in popularity that it soon became coupled with coffee and chocolate in the

numerous London coffee houses where men from every walk of life congregated. When the East India Company began to bring large consignments of tea from India and China, the price fell until at the end of the seventeenth century it cost approximately 2s. per lb.. It was then drunk as in China to-day, that is, as a weak infusion without milk or sugar, and the habit grew to such amazing proportions that by the end of the eighteenth century it was an established drink among all classes. It has been said that the enormous consumption of tea was a source of anxiety to the brewers. Well it may have been, but, if it caused a certain diminution in the abominable addiction to spirits, gin mixtures and beer, it did well, for the drinking habits of the people of England during the eighteenth century were causing untold misery, illness and such general squalor that the terrible picture of Hogarth's "Gin Lane" is a revelation as true as it is appalling. While some regarded the excessive drinking of tea as harmful, almost as iniquitous as gin drinking, others were of the opinion that by "tea drinking and regular" living, the Distemper of England (i.e. scurvy) may be cured". With these two developments in dietary habits both tea and sugar rapidly became the cheapest of foods, and the consumption of coffee, cocoa and chocolate was markedly reduced, with the result that the famous coffee houses slowly disappeared.

Throughout the Victorian era the nutritive value of British diets was good for those who could afford an adequate diet, bad for those who could not. It has been authoritatively stated that at the end of the nineteenth century the dietary "and the material state of our working people was probably worse than it had been since the great famines of Tudor times". Had the poorest classes in the second half of the century not been eating bread made from stone-ground flour, one can hardly imagine what their fate would have been. Amongst the middle classes the diet of porridge, bread, butter and tea for breakfast, meat and potatoes or a greasy vegetable stew for dinner, with a supper of cheese and beer, may appear, at a superficial glance to be sufficient, but when the calorific value, the mineral and vitamin contents of these diets are calculated, there is no doubt as to their insufficiency. They lacked, sometimes in terrible measure, those factors which go to the building up of strong, healthy bodies in children and adolescents.

In any discussion of the dietaries at this dark time in English industrial history, we must clearly differentiate between farm labourers in the south of England and those in the north of England, Scotland and Ireland, as also between the artisan classes and the poor labourers who dwelt in the slums of great cities and small towns. The farm labourers of the north of England, Scotland and Ireland stood literally head and shoulders above all other classes, for the simple reason that they lived principally on wholemeal, milk and vegetables.

That these facts are true and that food in relation to physical fitness is not only an individual matter but one affecting the state of health and efficiency of the nation, is revealed in the available statistics concerning the height and weight of men, women and children. Medical examinations of recruits in war-time indicate fairly accurately the state of physique of the nation. In 1870 the minimal height for infantry recruits was 5 ft. 6 in. In 1883 it was reduced to 5 ft. 3 in.; in 1900, at the time of the Boer War, it was 5 ft. 0 in. ! A Government Board of Inquiry instituted at this time by the Army Medical Authorities, on which the Royal College of Physicians and others were represented, came to the conclusion that since army rations contained a sufficiency of protein—125 grams per day—and of carbohydrates, and gave 3500 Calories per day, the fault could not be attributed to diet. A comparison of the nutritive values of a diet of white bread, butter, sugar, meat and tea or beer and that of a diet of bread and butter with milk and oatmeal in abundance will give the answer to the problem which went unsolved in 1904. It will show why London Military Authorities in 1900 favoured recruiting campaigns in the north of England, Scotland and Ireland. In the North, men of the countryside were bigger and stronger in those days because they had in their diets not only calories but an adequate supply of foods rich in vitamins and mineral salts. In this connection it may be observed that, according to Sir Thomas Middleton, "the peasantry of the Scottish Highlands, physically perhaps the finest of British races, until recent years consumed very little meat; their staple foods were oatmeal, milk and potatoes with herring and other fish in coastal parishes". Unfortunately for us as a nation the dietaries of the great mass of the people have become more refined and lack, to a considerable extent, the essential nutrients in which the coarser diets are so rich.

In 1900 Seebohm Rowntree published a book called *Poverty: A Study of Town Life*. The town was York. The book is a classic in the literature of social economy. Its birth was naturally heralded at the time: it required a decade for the facts in it to arouse attention to the conditions in the slums of our large cities, where infantile mortality approached the appalling figure of 250 per 1000.

From such publications it was slowly forced upon us that the evolution of dietary habits was progressing along two clearly demarcated lines; one good, the other bad. Repeated examination of the latter showed that a too large section of the people of this country was undoubtedly suffering from malnutrition.

The food habits of the people of the United Kingdom have changed to the benefit of many; they had, until the present emergency, remained unchanged to the detriment of not a few. During the past five years we have learned how the benefits of wholesome food can be made available to all. If the most vicious expression of war's aftermath—hatred, prejudice and unrest—is to be avoided, the people must be adequately fed, housed and clothed. All bodies responsible for Food, Agriculture and Education must continue to inform parents and others of the value of food and, above all, our schools must not fail in their duty to train children in the elements of nutrition.

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