

Basic concepts of human nutrition*

PART I

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ANIMALS eat to live. The collected varieties of those foods which under normal conditions in the wild an animal chooses to eat can be regarded as its natural diet. It is reasonable to assume that the natural diet will be a satisfactory one and enable the animal to grow healthily, benefit its general body economy and maintain a good state of health. By direct observation of an animal in the wild it is possible to list those foods which form its natural diet. If however we cannot make such observation, in which other ways could we determine what the natural diet is likely to be?

There are two such ways. First, we could study its body structure and determine how an animal is equipped to secure food, to ingest it, and further, we could perform physiological studies on its digestive processes to ascertain if such foods could be assimilated. Given an elephant for example, we would soon realize that its trunk is the only structure it has with which to obtain food and that its teeth are specifically designed to grind. This knowledge immediately gives some idea of its possible diet.

Secondly, we could compare the animal in question to its nearest biological relatives. For example, we could obtain some knowledge of a lion's food by comparing it with the known diets of other large cats, or again, by effecting a comparison with zebras the diet of a horse may reasonably be inferred.

In applying such an approach to Man, we would do well to remember that, in the 500 million years of life on earth, *Homo sapiens* has existed only in the last one million, that his ancestors were arboreal primates which descended to the ground to become plantigrade, and that, though we know him today to be an intelligent being, he has been civilized only for a few thousand years. Food technology is a twentieth century accomplishment.

Anatomical considerations

1. *Methods of obtaining food*

Animals eat whatever they can find of those foods to which they have become adapted. A gazelle will not live on a meat diet, neither can a cheetah exist by grazing. Their anatomical developments preclude these possibilities. The adaptation of an animal to its diet is entirely anatomical, the digestive processes being of no importance in this respect.

In all animals, including fish, reptiles, birds and mammals, it is the mouth that is the food-obtaining organ. To this almost universal rule there are a few exceptions, and the one relevant to this paper is that, in the highest primates it is the hand which is the food-obtaining organ. It follows then that those foods which are obtainable by grasp or by picking with the fingers are likely to be most appropriate to Man.

In other animals which obtain their food by the mouth, the eyes are recessed behind the foreteeth and snout (sense organ) otherwise a view of what was being secured would

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be very difficult. In Man, the eyes, nose and mouth are approximately in the same vertical plane.

2. *The ingestion of food*

“It may be said on broad lines that throughout the whole of the animal kingdom, the mouth parts show a development depending on the nature of the animal’s food and the method of obtaining it” (Wood Jones 1916). The mouth parts of Man show many interesting features—the jaws do not open very wide, the teeth are so closely fitted that there are no spaces between them, and they are all arranged approximately on the same horizontal level—even the canines hardly project beyond the incisors and molars. And because they are denied the ability to pierce and tear we may conclude that “in modern man the canines have no special function to perform” (Le Gros Clark 1962). Human teeth are designed to chisel or bite at the front and to crush at the rear. The molar teeth do not grind food as, say, an elephant grinds its food. Food is held in the human mouth between the upper and lower molars by the balanced pressures of the cheek on one side and the tongue on the other, and there it is pressed or crushed. There is no side-to-side movement of the lower jaw and foods which need grinding in the true sense are inappropriate to human beings. Such foods would result in excessive and very severe wearing of the teeth.

In this consideration, those functions which the teeth are unable to perform may be more important than those which they can do. Thus, if we consider the diet of a gorilla which is a herbivore, the existence of huge canine teeth might lead one to suppose that it is a meat eater. But because it has the ability to tear flesh, it does not follow that it uses its teeth for this purpose; if gorillas tear anything at all it is probably the bark of trees. On the other hand, if teeth are totally unable to tear anything, one can reasonably say that foods which require tearing do not form part of the animal’s normal diet.

In the human mouth, the inability to tear and to grind are important negatives.

“The mandible of primitive man can best be explained as a modified heritage from a primitive frugivorous anthropoid type, with deep jaws, high ascending ramus and condyles set far back above the plain of the cheeks” (Gregory 1934). A study of the mandible of modern man shows that we still exhibit the adaptive changes of our fruit-eating ancestors.

Since the hand is the food-obtaining organ, it is not surprising that the tongue has no need of the same function, and it will not protrude very far or curl as do the tongues of some other animals (e.g., cows) when they eat. The human tongue functions only after food has been taken into the mouth.

So far then, from anatomical considerations, we may conclude that, for food to be appropriate to Man, it must be obtainable by the hand, biteable and crushable.

The digestion of food

Food that has already been secured, ingested and well chewed, is swallowed and digested in the stomach and bowels.

A study of the comparative anatomy of the alimentary tracts of mammals is most unrewarding from the point of view of trying to obtain information as to what type of food the different viscera are designed to cope with. And a study of the comparative biochemistry of digestion is even less rewarding.

Most mammalian stomachs are just simple sacs, and though some animals have more complex stomachs (the cow appears to have four separate parts to its stomach), no generalizations can be made. The gut also, though shorter in carnivores than in herbivores, is of intermediate length in humans and variations among animals are great. Chalmers Mitchell (1905, 1916) has shown that the structure of the alimentary tract

depends more on inherited characteristics than on dietary adaptation, and in animals which have similar diets, e.g. herbivorous marsupials and placental mammals, there can be marked differences in the pattern of the gut. Conversely, animals having similar patterns in the gastro-intestinal tract may live on very different diets.

A study of the comparative biochemistry of the enzymes of digestion does not help us at all in a search to be specific in determining which foods are likely to be appropriate to Man, because "the basic pattern of digestion is the same throughout the whole of the animal kingdom" (Florkin and Mason 1964). Indeed, the digestive processes of carnivorous plants are similar to those of animals. Thus, "with the exception of pepsin, the same system of enzymes is necessary in all animals, and . . . plants for the cleavage of protein to amino-acids" (Florkin and Mason 1964). For the digestion of starch and glycogen, all animals have chiefly alpha-amylases activated by salts, in contrast to plants which have alpha- and beta-amylases not activated by salts. "Lipases everywhere digest fats and esters" (Florkin and Mason 1964).

From a study of the comparative anatomy and physiology of digestion, I am unable to conclude to what foods Man has become adapted.

In all those ways considered so far, the ability to draw conclusions about an animal's adaptation to its diet is most rewarding in the initial study of its habits of obtaining its food, less exact in the method of ingestion and mastication, and quite unspecific in relation to the processes of digestion.

Comparison with near biological relatives

Man belongs to the Order of Primates which is characterized on the one hand by the maintenance of many primitive features such as pentadactyly, the clavicle, the molar teeth and the underdeveloped olfactory sense, and is distinguished on the other hand by certain highly specialized functions such as vision and cerebral cortical development. The dental formula of Man, anthropoid apes and old world monkeys is the same for all, $\frac{2123}{2123}$, and for comparison of diet, I have chosen the gorilla and the chimpanzee as being the nearest to Man.

Gorilla

Paul du Chaillu (1861), Barnes (1923) and Bradley (1922) all conclude (the first two from their personal observations of the examinations of the stomach contents of animals which they killed) that gorillas are strict vegetarians. Yerkes and Yerkes (1929) in their comprehensive review, conclude that "the gorilla is primarily a ground-feeding herbivore which eats enormous quantities of plants and their fruits", but that, in captivity, it may take foods of animal origin. Schaller (1963) made a field study of the mountain gorilla and lists by name those foods which he observed them feed on—the stems, shoots, bark, pith, fruit and bases of the leaves of grass sedges, ferns, herbs, vines, trees and shrubs. The gorillas were very selective with the different parts of each plant, and on tasting their foods himself, Schaller found that mostly they were bitter and astringent but some were sweet and pleasant. He also observed gorillas eating soil but concluded that it was not an important part of their diet. He failed to see the animals eating honey but admits the possibility that they might. In his intensive studies he "found no evidence that gorillas in the wild eat animal matter", and quotes several occasions when the animals had the opportunity of eating flesh but ignored it.

If we accept these authorities, we may conclude that the gorilla in the wild is strictly a plant-eating animal, but that in captivity may take foods of animal origin.

Chimpanzee

Many authorities (Savage and Wyman 1843–44, Reichenow 1920, Oertzen 1913) are convinced that the chimpanzee is entirely vegetarian, whereas others (Koppenfels

1877, Faulkenstein 1879) believe that, though primarily plant eating, chimpanzees do eat animal food in the wild. Yerkes and Yerkes (1929) in reviewing all the evidence, conclude that the chimpanzee "is a vegetarian, and only under exceptional circumstances adds to its dietary animal products". Nissen (1931) conducted a field study in French Guinea and carefully observed the feeding habits of chimpanzees. He listed 34 foods which they chose to eat, and of them, 28 were fruits, six were the stalks, stems, leaves and blossoms of plants. Six were sour, nine were bitter, 15 sweet and 20 astringent. Twelve were agreeable and three disagreeable. The preponderance of bitter and astringent substances is similar to Schaller's observations on gorillas. Yerkes (1945) concludes that "whereas in freedom the chimpanzee is naturally and primarily a vegetarian, in captivity an occasional specimen may become omnivorous or carnivorous".

Conclusions

From a study of the structure of Man we may conclude that he is an animal designed to obtain food by the hand and that such food should be biteable and crushable. From comparisons with our nearest biological relatives it may be inferred that, like them, Man is primarily a plant eater, but in captivity (in Man's case, self-captivity or civilization) he may eat food of animal origin.

As a result of all these studies, it would not seem unreasonable to conclude that, rather than being omnivorous, Man is really a herbivore, and that his natural diet probably consists of those nuts, fruits, berries, leaves, shoots and flowers which please his palate.

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(To be concluded)
