ABC of Nutrition

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SOME PRINCIPLES

There are two questions affecting health about any food.

- (1) Is it safe, or will it harm me (a) immediately or (b) later if I eat it repeatedly?
- (2) Is it good for me?

Is it "food"?

For a food one has not eaten before question 1a predominates. If it has not been contaminated or infected the answer depends ultimately on folklore. In every culture there are parts of plants and animals that the group recognises as food which other cultures do not. Only a minority of plants can be expected to be freely edible. For most plants it would be an evolutionary advantage to possess a toxin that discourages animals from eating it. Our folklore about which plants are edible comes down from unknown ancestors who took the risk of eating an unfamiliar plant, sometimes with unfortunate results.

Is this food good for me?

Simple trial and error by people with primitive technology cannot answer questions 1b or 2. One of the difficulties for professionals who give advice about healthy diets is that there is no immediate symptom of well being corresponding to the surge of amino acids or vitamins that blood samples can show. The feelings of satiety and of inner warmth after a meal are much the same after a good nutritious one as after a meal that contains only "empty calories." One rare exception is the gratifying faecal result that occurs within hours of eating wheat bran in people inclined to constipation. This is probably why the fibre hypothesis was accepted by lay people years before it was well supported by human experiments. The only reliable way to answer questions 1b and 2 is by the methods of nutritional science.

Origins of our scientific knowledge about human nutrition

Hunter-gatherers in general were lean, ate more plant than animal foods though they did eat meat or seafoods. They ate a variety of foods, had a high fibre intake, but took no salt or alcohol and concentrated sugar only rarely (as wild honey).

● *Comparative and evolutionary*—Homo sapiens and his predecessors have been on the earth one million years or more. Ninety nine per cent of this time our ancestors lived as hunter-gatherers. Agriculture started only 10 000 years ago. There has not been enough time for our species to evolve any new mechanisms required by the recent food supply but presumably our bodies have evolved well adapted for doing what hunter-gatherers did and eating what they ate. We have information from archaeological records and from studies of the few fast disappearing groups of contemporary hunter-gatherers.

● *Experiments of nature and travellers' tales*—From peoples who eat different foods from us, under stable conditions or during a disaster, we can form hypotheses about the physiological effects of different food patterns that we could not easily persuade our fellow countrymen to adopt. We have, for example, learnt about the physiological role of very long chain polyunsaturated fatty acids from the Eskimos, and about deficiency diseases from nutritional experiences of prisoners of war.

● *Epidemiological studies* range in the power of their design. Associations and correlations of disease characteristics and dietary variables do not prove cause and effect, but prospective studies, especially if repeated in different groups, give valuable information on the relation between usual diets and chronic diseases.

Some examples of human experiments and trials

- Intervention trial of low saturated fat diet in half of 850 middle aged male veterans in Los Angeles over five years
- Trials of vitamin C against placebo for preventing colds during winter
- Experimental depletion of a single nutrient in human volunteers
- Long term testing of the value of novel protein foods
- Experiments measuring energy expenditure
- Metabolic balance studies—for example, to assess the effect of diet on plasma cholesterol
- Absorption and uptake studies—for example, glycaemic index after different foods containing carbohydrates

● *Animal experiments* were the principal technique for working out the vitamins. The right animal model has to be used. Understanding of scurvy was static and controversial until Norwegian workers found (in 1910) that guinea pigs are susceptible like man because, unlike most animals, they cannot synthesise ascorbic acid from glucose.

● *Clinical records* have been informative about the role of diet in disease, including inborn errors of metabolism. Information about requirements for trace elements has come recently from experiences with total parenteral nutrition.

● *Food analysis*—The independent variables in nutritional epidemiology and in dietetic treatment of disease are food constituents. Food analysis is work that is never finished; foods keep changing and demand develops for constituents not measured before, such as different types of dietary fibre and fatty acids C20:5 and C22:6. To facilitate international sharing of what food composition data there is INFOODS (the International Network of Food Data Systems) was set up in 1983.

● *Human experiments and trials* last from hours to years and many different variables can be measured.

The three groups of substances in foods

(1) *Energy and nutrients*

Man needs oxygen and enough food energy (calories), water, 8 to 10 essential amino acids in proteins, essential fatty acids—for example, linoleic acid—a small amount of carbohydrate, 13 vitamins, and 18 elements scattered across the upper half of the periodic table (in addition to hydrogen, carbon, nitrogen, and oxygen).

Together they add up to over 40 nutrients, and many are normally taken for granted: the minor nutrients are present in sufficient amounts in a mixed diet of foods. But for long term total parenteral nutrition all the minor vitamins and trace elements must be included in the required postabsorptive amounts.

For some of the nutrients *you can have too much of a good thing*. Generous intakes of saturated fat raise the plasma cholesterol concentration and contribute to coronary heart disease. People with high salt intakes have more hypertension. Too much food energy leads to obesity.

Energy and nutrients

Water and packing

Other substances

Colour, flavouring, etc
Toxins

Size of adult requirements for different nutrients

Adult daily requirement in foods	Essential nutrients for man
2-10 µg	Vitamin D, Vitamin B-12, Cr, vitamin K
c 100 µg	Biotin, I, Se
200 µg	Folate, Mo
1-2 mg	Vitamin A, thiamin, riboflavin, vitamin B-6, F, Cu
5-10 mg	Mn, pantothenate
c 15 mg	Niacin, vitamin E, Zn, Fe
c 50 mg	Vitamin C
300 mg	Mg
c 1 g	Ca, P
1-5 g	Na, Cl, K, essential fatty acids
c 50 g	Protein (8-10 essential amino acids)
50-100 g	Available carbohydrate
1 kg (l)	Water

Figures are approximate and in places rounded. The range of requirements for different nutrients is about 10°.

(2) *Water and packing*

All foods contain water. In many it is more than half the weight. The percentage of water is higher in some fruits and vegetables than in milk. The more water a food contains the fewer calories. But this water has to be counted in the diet of patients with anuria. The "packing" of plant foods—that is, dietary fibre—is not all inert. Some fractions have physiological effects: arabinoxylans (hemicelluloses) of wheat increase faecal bulk and speed colonic transit; pectins slow absorption of lipids and carbohydrate.

(3) *All the rest and toxins*

All the many other substances in foods are non-nutritive. They produce most of the flavour, colour, and other sensory qualities. In most natural foods there are inherent substances that are potentially toxic but usually present in small amounts—for example, solanine in potatoes, nitrates and oxalates in spinach, thyroid antagonists in brassica vegetables, cyanogenetic glycosides in cassava and

- Possible modifications of four food groups to incorporate dietary guidelines**
- *Bread*—Yes but wholegrain and with lower salt. Prefer lower fat, low salt *cakes* and *biscuits*.
 - *Meat*—Lean cuts with the fat removed and not fried. Alternate with *fish* (grilled) and *legumes*.
 - *Vegetables* slightly cooked, not with salt.
 - *Fruit* fresh, not canned in syrup or dried.
 - *Milk* with half or all the cream removed.

subdivided into first preference and second preference subgroups, based on the amounts of fat, sugar, and fibre in individual foods.

Junk foods and nutritious foods

Whether a food is nutritionally bad or good depends on the rest of the diet. As Hippocrates taught, “All things in nutriment are good or bad relatively.” An extra portion of saturated fat is bad in Britain but would be good for starving children in north east Africa. An orange does nothing for someone who takes vitamin C tablets but is important for an elderly person who eats no vegetables. Value judgments about foods are being made all the time; they are nearly always subjective and usually wrong.

A good objective method is to work out for a typical serving of the food its provision of important nutrients as a percentage of their recommended dietary intakes compared with its content of energy (calories), also as a percentage of the recommended dietary intake. For each nutrient the index

of nutritional quality = $\frac{\text{nutrient as \% standard}}{\text{energy as \% standard}}$

The profile of indices for major nutrients can be put in an array and the other components, like saturated fatty acids and dietary fibre, treated in a similar way by using a dietary goal as the standard.

The example, modified from an American book, shows that egg contains a smaller proportion of fat per energy than butter; it is less saturated and also a good source of protein and some other nutrients. Egg and butter both contain some vitamin A but this is the only essential nutrient (other than a tiny amount of linoleic acid) in butter. However, an egg contains much more cholesterol than 1/2 oz butter.

Calculations of this type should be made before authorities advise whole communities to eat more or less of a food. Applying them to the recent DHSS recommendations about diet to prevent cardiovascular disease, the amount of butter eaten should be reduced more than the amount of egg, because reduced saturated fat is recommended but current cholesterol intake is not considered excessive.

Calories do count

The law of conservation of energy applies to human nutrition as in the rest of nature. Atwater established this around 1900. A little more heat may be produced after some foods or in some people but the more calories (or kilojoules) you eat the more you can expect to store as adipose tissue.

Indices of nutritional quality (INQ) for butter and egg						
	Butter (1/2 oz; 14 g)			Egg (50 g), hard boiled		
	Amount	% Of standard	INQ	Amount	% Of standard	INQ
Energy (kcal)	100	5	1.0	80	4	1.0
Vitamin A (mg)	0.129	11	2.2	0.078	7	1.6
Thiamin (mg)	0	0	0	0.04	4	1.0
Riboflavin (mg)	0	0	0	0.14	12	2.9
Niacin (mg)	0	0	0	0.03	0	0
Vitamin C (mg)	0	0	0	0	0	0
Iron (mg)	0	0	0	1.0	6	1.5
Calcium (mg)	3	0	0.07	28.0	3	0.8
Potassium (mg)	4	0	0.02	65	1	0.3
Protein (g)	0	0	0	6	12	3.0
Carbohydrate (g)	0	0	0	1	0	0.1
Fat (g)	12	15	3.1	6	8	1.9
Oleic acid (g)	2.9	12	2.4	2	8	2.0
Linoleic acid (g)	0.3	2	0.3	0.6	3	0.8
Saturated fatty acids (g)	7.2	25	5.1	1.7	6	1.5
Cholesterol (mg)	32	11	2.2	225	75	19

Based on Hansen RG, Wyse BW, Sorenson AW. *Nutritional Quality Index of Foods*. Westport, Connecticut: Avi Press, 1979. [The standards they used are energy 2000 kcal (8.4 MJ), vitamin A 1.2 mg, thiamin 1 mg, vitamin C 60 mg, riboflavin 1.2 mg, niacin 14 mg, iron 16 mg, calcium 900 mg, potassium 5000 mg, protein 50 g, carbohydrate 275 g, fat 78 g, oleic acid 24.5 g, linoleic acid 20 g, saturated fatty acids 28.5 g.] I have taken 300 mg as standard for cholesterol.

Energy values as metabolised in the body of the main energy-yielding groups of food components (Atwater factors)

	kcal/g	kJ/g
Fat	9	37
Alcohol	7	29
Protein	4	17
Carbohydrate	3.75	16

Foods differ in their calorie content from 7 kcal/100 g (29 kJ/100 g) for boiled French beans, cabbage, celery, and vegetable marrow up to 899 kcal/100 g (3.8 MJ/100 g) for vegetable oils—a 128-fold range. This great range depends on the different energy values of fat, alcohol, protein, and carbohydrate and how much these are diluted by water. It is useful for doctors to know the energy values of average servings of common foods (there is a short list in the article on obesity: causes and management).

No perfect diet

There are several diets that appear (in our present state of knowledge) to be good. We can advise on a better diet for Mr Smith or, as in a US report, make recommendations "Towards healthful diets," but there is no best diet. The reason is that man is an omnivore with enzyme systems that can adapt to ranges of intakes of many food components. There is, for example, an inducible enzyme sucrase in the small intestinal epithelium; if people eat sucrose this enzyme appears and digests it. There are several enzymes in the liver which oxidise proteins; their activity increases when protein intake is high and falls in people on low protein diets.

When the intake of one nutrient is varied and the rest of the diet is held constant there is a middle range, over which health does not improve or deteriorate as the intake is changed. For most nutrients this is quite a long range. There is therefore no single optimal intake figure. The recommended daily amount is intended to be at the top of the left hand slope in the diagram.

Replacement

For every food you remove from the diet another has to take its place. This principle is prominent in the design and interpretation of metabolic ward experiments. Does consumption of milk raise or lower the plasma cholesterol concentration? To test this an adequate but physiological amount of milk is to be given in a middle two week period and the plasma cholesterol value measured at the end of this period and at the end of equal length control periods before and after. What should be given to replace the calories of the milk in the control periods? If nothing is given the periods will not be isocaloric. To some extent the effect of milk on plasma cholesterol could be manipulated by the choice of the control food. We do not want to influence the experiment so might ask, "If people here stop drinking milk what would they drink (or eat) in its place: beer, water, fruit juice, fizzy drink, etc?" A similar situation applies in outpatients when the doctor or dietitian instructs a patient to cut out one food from his diet. Unless he is to lose weight he will sooner or later choose other food(s) as replacement, which may affect the outcome.

Some concluding proverbs

People have been thinking about the safety and goodness of food as well as its social roles and tastiness ever since the Garden of Eden or its evolutionary counterpart. So it is perhaps not surprising that a number of proverbs about food and eating are being confirmed by nutritional science.

Moderation in all things—The recommendation of many expert committees on nutrition. Don't eat too much or too little of anything and don't follow one of the extreme unorthodox regimens.

Variety is the spice of life—You should eat a mixed and varied choice of foods.

Enough is as good as a feast—More leads to obesity. People's energy requirements differ. "Enough" is an individual amount.

You can have too much of a good thing—For example, saturated fat, salt, dietary cholesterol, vitamins A, D, and B-6.

One man's meat is another man's poison—The subject of the article on food sensitivity. For each of us there are foods we dislike and may well be foods that can make us ill.

There's no accounting for taste—Taste has to be considered in planning therapeutic diets.

A little of what you fancy does you good—Dietary prescriptions are sometimes more rigid than they need be. This proverb also speaks of the placebo effect: if someone believes a food is doing him good he may feel better for a time after eating it.

Old habits die hard—Food habits must be respected. Prescribed dietary changes are likely to be followed better if they are fitted into the least strongly held of an individual's food habits.

There's many a slip twixt cup and lip—People don't necessarily eat what they intend or say they eat. That patient you just put on a diabetic diet may not have understood you.

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