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THE MINERAL ELEMENTS OF NUTRITION

Of all the nutritional materials necessary to health, the minerals have received the least attention by the investigators of science. It has required the study of vitamins to bring this fact into prominence. Vitamins as a class probably should be considered as factors of mineral metabolism and promoters of mineral assimilation, as each of the vitamins are now known to be involved in the normal control of the metabolism of the most important of the nutritional mineral elements - calcium.

We have to admit in the beginning that there is no background of any kind of systematic research to look to for information on this subject. Our information today is wholly dependent upon occasional discoveries here and there, and mainly in the study of animal nutrition. These results of animal tests may be, we believe, applied to the human with considerably more parallelism than in the case of animal tests with vitamin concentrates, for we are dealing with less highly organized and complex chemical entities, in which the variations in the physiological chemistry of the different species may be of less moment. (In the case of the vitamins, such differences in physiological chemistry may result in complete ineffectiveness of a vitamin when used for a different species. The chicken, for instance, requires a fat-soluble Vitamin C that is quite different chemically from the water-soluble C required by the human, and Vitamin D as developed for the rat is useless for the hen.)

The form in which mineral elements are required may be one or more of four general classifications - organic or inorganic, colloidal or crystalloidal.

An organic mineral may be defined from a nutritional viewpoint as a mineral element in some chemical combination that is peculiar to the reactions of a living cell. Such a combined mineral may be either crystalloidal or colloidal. Example: phytin of bran or the lecithin of wheat germ, both carrying organic phosphorus, and the phytin - magnesium, too.

An inorganic mineral is a mineral substance in the form in which it occurs before it has been acted upon by living cells. Plants absorb minerals in this form, and they are changed after absorption into organic forms, but that is not to say that the original inorganic forms are not also essential parts of the economy of living cells, both plant and animal.

A colloidal mineral is one that has been so altered that it will no longer pass through cell walls or other organic membranes. This colloidal mineral may still be either organic or inorganic in certain cases, although as a general rule it is necessary for the mineral to become changed into the organic form in order to get it into a colloidal form.

The crystalloidal form of a mineral or salt is the form in which it will form crystals. As a general rule, colloids will not form crystals. (Outstanding exception is blood hemoglobin.)

The crystalloidal form is the pure mineral substance. To form the colloidal form some greater or less amount of other materials must be present. (This is true only of minerals; there are many pure colloids, gelatine, for instance, of non-mineral nature.) Pure sodium silicate, for instance, is crystalloid, but the presence of small amounts of sodium chloride changes it to a colloid. The difference is simply in its molecular makeup, the colloid molecule being composed of a group of about 50,000 of the crystalloid molecules. That is why it will not pass through a cell wall. A snowflake is a water crystal, but built up of a vast number of water molecules. It will not go through an opening that would pass a smaller crystal, but under certain conditions the water in the air takes the form of flakes of relatively similar type. That is just what occurs when a crystalloid, through some apparently slight influence, changes spontaneously to a colloid. In adding the salt to the sodium silicate solution, the electrostatic balances are altered by reason of the water becoming conductive (pure water is not, and salt is one of the best ionizers to make it conductive), and possibly the sodium silicate molecules become attracted together in groups electrostatically.

It is obvious that a cell must be able to convert crystalloids to colloids to prevent the loss of its essential elements by diffusion out again. Glucose is a crystalloid; glycogen a colloid. Insulin is believed to make the conversion. Blood sugar as glucose passes into the muscle cell, and without insulin it cannot be retained.

The great class of colloids in living cells are the proteins. In the plant, the retention of minerals is accomplished by attaching the mineral molecules to proteins. These proteins are probably the simplest of all proteins, and may have been evolved for the special purpose.

Plant juices, therefore, contain both mineral forms, as absorbed as well as in the colloidal form. Milk contains a colloidal form of a calcium compound that is of a protein nature. Proteins are destroyed by heat, and that explains the loss of assimilable calcium in milk when it is pasteurized.

Cooking also destroys the plant minerals that are in the colloidal form. An attempt was made to preserve fruit juices without cooking by filtering through porcelain to remove the organisms, but the product was found to have lost nutritional values. The reason is here apparent - the colloids also were held back.

Potassium is probably the most important of the mineral elements that must be supplied in the organic form. Plant juices are high in potassium, but our intake of raw juices is never very high. Potassium is an antagonist of phosphorus; too much causes a sensitization of the nervous system (particularly the parasympathetic), which may be excessive if phosphorus deficiency is present. Horses on a high green grass diet become jittery and nervous; bran with its phosphorus content prevents and cures the condition. Phosphoric acid has been used, added to the drinking water, with the same effect. The phosphorus then need not be in the organic form. In fact, it has been shown that the phytin of bran is split by an intestinal enzyme into phosphoric acid and its other components. Few of us escape some of the effects of phosphorus deficiency, for our use of refined cereals greatly limits our intake of this element.

Calcium is put to work in the body in numerous forms, and it is a reflection upon our modern institutions of research that so little is known about just what forms are required, how they are made, and what their functions are. We do know that the form of organic calcium in raw milk is of exceptional value to the child in supplying the material for tooth and bone development, and that in the adult as well as in the child a calcium deficiency results in susceptibility to infectious disease. From a viewpoint of nutritional therapy the best form of calcium is still a matter of argument. Dicalcium phosphate has been much promoted commercially, but its assimilation is admittedly difficult by reason of the low solubility. Calcium gluconate has high solubility, but its effects are not outstanding even where acute deficiency exists. The lactate does often produce spectacular results in some symptoms of calcium deficiency such as fever blisters, canker sores in the mouth, cold sores, etc., but again may fail in another apparently identical case. Probably the differences are due to differences in vitamin reserves, as Vitamins A, C, D and F in particular regulate the calcium balances between the blood, lymph and intracellular fluids.

The blood contains calcium in, at least, half a dozen forms, the main divisions being a distinction between the diffusible and non-diffusible, and between serum, plasma and corpuscle calcium. Passing an electric current through blood serum drives a form of both diffusible and non-diffusible to each electrode, distinguishing four kinds of serum calcium besides the plasma and corpuscle calcium.

Vitamin D and the parathyroid hormone both act to increase the diffusible calcium of blood serum. The presence of Vitamin A is necessary to prevent the serum calcium from precipitating in such forms as kidney stones, and a deficiency of phosphates aids this precipitation (1). In Paget's disease it has been shown that the liver has lost its ability to convert carotene into Vitamin A (2), and the bone degeneration characteristic of this disease is the consequence. We see that the maintenance of bone, therefore, depends upon Vitamins A, C and D, at least. (In Vitamin C deficiency the bones become decalcified, the outstanding reaction in scurvy.)

Calcium metabolism also depends upon the presence of minute amounts of other more rare elements, of which manganese and fluorine have recently come to the front. These will be discussed under these respective headings.

It is a common experience for the physician to prescribe remedies for obvious deficiencies, observe a certain degree of encouraging improvement, and then have the patient come to a standstill before complete recovery. This is clearly a case where the replacement therapy has been incomplete. Suppose Vitamin C is supplied for a case of incipient scurvy, characterized by decalcification of the supporting tissues of the teeth, with resultant looseness of these important organs. A certain degree of improvement occurs, then the case drags along without complete recovery. Calcium deficiency obviously could be the reason. and Vitamin D, too, is necessary and may not be present (the Vitamin D puts the calcium into the blood stream; the Vitamin C unloads it where it is required), and all these activities may possibly be hindered by fluorine and manganese deficiency. The complexity of the problem is discouraging, but the remarkable results usually produced give us the stimulus to keep on the trail of an explanation of the failures, for such is the price of progress.

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