A FEW SIDE LIGHTS ON AMINO ACIDS

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Our studies to date have shown that unless we beware we shall individually find ourselves consuming vast unnecessary quantities of calories to get the other essential foodstuffs we need. The researches of recent years have shown that most of us get too much of the nonperishable and nonessential factors, too little organic minerals and vitamins. Now comes the question: Do we get enough amino acids from the proteins we eat?

Maybe we get enough protein, in all probability too much, but like our carbohydrates and fats, they are of such low grade, we still suffer from a lack of some rare ones. What are the major sources of protein? What is their biological value? Well, Hindhede in Denmark concluded the potato protein was the best of all for human nutrition. But the potato solids are only ten percent protein, we say we cannot tolerate the starch. But we forget potato starch has an alkaline ash, and is far better tolerated than the acid ash starch of the cereals. Even so, if we supplement potatoes with meat or beans we arrive at a pretty good diet.

But, most meat is just muscle. The rare amino acids needed to protect, repair or build the glandular organs must come from glandular organs, from the liver, kidney, pancreas or sweetbreads. There are also rare amino acids in the skin, so when we learn that liver sausage formulas call for about half pork skins and tripe, we can assume the amino acid balance is very good as a supplement for muscle meat.

When we eat protein, we must split it into amino acids to get it through the membrane walls of the alimentary tube, for proteins as such are not diffusible. If they do get in without being completely broken down they may cause allergic reactions, and one well-accepted theory of allergic disease is that it results from pancreatic weakness because the proteolytic enzymes from that organ are not fully effective in reducing the food proteins to amino acids, and in the presence of colitis or other irritated states of the intestinal tract, these half-split proteins can get into the circulation. This is probably the reason, too, for your aversion and reaction to certain foods you may have overeaten of, or have taken in a partly decomposed state, for it is a known fact, bacterial decomposition renders any protein more toxic and antigenic.

If your alimentary tract becomes filled with a half-digested mass of protein material in which protein poisons have been split off by some degree of decomposition which have the inherent powers to create

inflammation, it is evident some of the proteins will be forced through. After that your immune mechanism will violently react to a very small dose of the same protein. This is why a man once sick from eating lobster cannot tolerate any at all for a long time. He is actually and literally allergic to lobster.

The value of the vitamin G complex in correcting allergic states is no doubt by reason of its promotion of pancreas function, and improvement in the secretion of gastric juices, for the outstanding characteristic of pellagra is hypochlorhydria. And without hydrochloric acid in the stomach, the first stage of protein digestion cannot occur.

The vegetarian can supplement his potatoes with milk, cheese, butter, beans, or bean sprouts. And bean sprouts bring us to that old amino acid product, soy sauce, invented thousands of years ago by the Chinese, made by hydrolysing vegetable proteins with fungus enzymes and preserving the resulting liquid with salt. The flavor is that of amino acids, glutamic acid especially.

There are twenty-two known amino acids at the present time, not to consider glutamine and betaine which may be considered as first cousins to the amino acids and are probably dietary essentials. As to the amino acids, only eight are considered as indispensable factors in nutrition. These are: (Ref. 1)

Methionine
Threonine
Lysine
Tryptophane
Leucine
Isoleucine
Valine
Phenylalanine

It is possible at the present time to discuss the special function of most of these factors in some degree of detail, although the state of our knowledge is certainly very limited, and there is much to be done before even the general pattern of this field of biochemistry is established.

Let us dispose of glutamine and betaine first. Glutamine is glutamic acid amide, glutamic acid being one of the amino acids that is not indispensable, and the amide probably being capable of formation in the human system at least under some conditions, but quite probably also not formed under other adverse circumstances.

First, what is the function of glutamine? It is a buffer because it is split into ammonia and glutamic acid by the slightest drop in hydrogen

ion concentration below the blood levels. It immediately releases ammonia under the influence of free acid ions, to neutralize those acid ions. It probably is the buffer of the first line of defense against acids, and again it protects against ammonia too, because some of the tissues contain glutaminase which acts to synthesize glutamine whenever free ammonia is present. Glutamine is probably the medium of transport of ammonia from the kidney to the liver, where it is broken down into urea. Urea is a factor that denatures proteins; that is another way to say that it splits off a protein any attached mineral molecules.

Glutamine administration can cause calcium deficiency cramps, probably because it promotes this ionization of blood calcium, and its absorption by the tissues, particularly bone and teeth and thereby causing temporary shortage elsewhere. This shortage must be relieved by alimentary absorption, so the net effect will be to stimulate absorption and fixation in teeth and bone. All very well, you may say, why do we have so poor teeth and low bone calcium reserves? Well, probably because glutamine is so fragile, it is immediately destroyed by heat, so cooked foods are devoid of it. That is the reason of its price of five dollars a gram. But it can be made as cheaply as refined sugar if the production were as high, for it is one of the commonest substances in plant juices especially where the plants are grown on soils high in ammonia.

Meat contains a fair content of glutamine, but it is lost in cooking. Raw meat juices have always had a high rating as dietary adjuvants among clinical observers, but no one heretofore has found a reason. Hutchison and Mottram in "Food and Dietetics", 8th edition, page 584, report the results of feeding dogs raw meat juices and shows how experimentally produced tuberculosis is successfully controlled by a relatively small dosage. The benefits are shown to be in something in the juice as distinguished from the meat proteins.

Other investigators have found that dogs fed meat without the natural juices died quicker than other dogs fed nothing. The inference seems to be inescapable that meat without these juice elements therefore has a food value of less than nothing. Negative foods, they seem to be. Maybe some of our cold storage meats drained of their juices by being hung in cold rooms at just above freezing have degenerated into this class. At any rate, this explains the great value to the malnutrition case of beef extracts but the raw ones should be better than the cooked preparations.

The effect of glutamine to promote the fixation into bone of blood calcium can explain also the known fact that raw meats and raw fish foods insure a state of health to the tooth supporting structures, and prevent pyorrhea. There have been many clinical reports of late proving this statement. The effect of pasteurization of milk seems to put milk

too in the class of foods that invite pyorrhea, and any other disease which arrives as a consequence of lowered systemic calcium reserves. By the way, the best dietary source of glutamine is celery root, often used to flavor soups because cooking releases the glutamic acid and this affords a meaty flavor.

Betaine is another relatively neglected factor in foods. Chemically, it is trimethylglycine, another probably essential derivative of a non-essential amino acid, glycine. It combines with hydrochloric acid to form betaine-hydrochloride which releases the hydrochloric acid on solution in water, so it has been used for years as a means of administering hydrochloric acid in capsule form. The betaine was considered inert. Curiously, however, betaine has been found to destroy tetanus toxin on contact,(2) and its administration to a patient who is fighting any infective process seems to break down his resistance to temporarily aggravate the symptoms of the infective disease. It is probable this is the effect of betaine in destroying antibodies that were hindering the development of the infective process. The wiping out of antibodies, maybe, is a good thing in many cases, for a new production takes place probably more promptly after this than otherwise. But, the continuous use of betaine could be possibly an unwise procedure. In allergic patients there is a pathological sensitiveness to certain proteins and the effect of betaine in wiping out the antibodies here would be certainly of great benefit. Some believe pernicious anemia and other diseases such as myasthenia gravis are cases where a pathological antibody is destroying vital cells, and betaine here has a theoretical promise of benefit. It is now an established fact that the normal control or organ and tissue growth is maintained in part by the action of antibodies to our own cells and proteins.(3) So it is clear how atrophy can result from an excessive formation of any of these specific antibodies, whether muscle cell or red blood cell.

Methionine is one of the amino acids that has a vital importance just now becoming appreciated. It supplies the methyl radical for conversion of a poisonous substance in the blood into a useful substance. Namely, it converts guanidine into methylguanidine. The methylguanidine probably by reason of the influence of the parathyroid hormone becomes methylguanidine acetic acid, otherwise known as creatine, an important constituent of muscle.(4) The guanidine or methylguanidine act to promote ionization of calcium, but much more violently than urea, so the blood calcium is depleted by such agents to the danger point where tetany can occur. So methionine is a link in the chain of factors needed to prevent convulsions, and is particularly successful in preventing the convulsions of pregnancy. It is interesting to find that eclampsia is accompanied by a greatly increased output of urinary creatine.(5)

Since acetic acid is essential to the protective reaction, it is also interesting to recall that the pregnancy case often craves vinegar.

Also, it is probable fatigue toxins include guanidine. The use of small doses of methionine is often followed by immediate improvement in some cases of fatigability.

It is now known that a dosage of excess vitamin B is followed by liver degeneration and cirrhosis. These reactions are really methionine deficiency, aggravated by the increased demand made by the vitamin B. Methionine is one of the materials required by vitamin B to do its work, and its place can be taken by betaine which is normally a part of the natural vitamin B complex from wheat germ. Methionine, however, probably does not have the effect of inactivating antibodies. Again, one of the derivatives of betaine, glutathione, is more potent than betaine, apparently, in inactivating antibodies, for it is physiologically used for this purpose in the egg. The amount of glutathione in the egg of a hen determines how big the full grown chicken will be, for the number of cell divisions will be the greater before hatching if more glutathione is present to hold down antibody production for a longer time.(6)

Glutathione, chemically, is a tri-peptide, containing three of the non-essential amino acids: Glutamic acid, glycine and cysteine. Because of its growth promoting nature, cancer tissue has been investigated for its presence, but with no discovery of abnormal or increased quantity.(7)

The effect of threonine deficiency has not been as yet determined. It has only been known since 1935.

Lysine and tryptophane deficiency causes capillary breakdown and vascularization, obvious in the cornea, simulating riboflavin deficiency. (8) One per cent of the diet must be lysine, according to animal tests, the requirement for this amino acid being greater than for any other. Its lack causes human subjects to feel worn out and irritable. Lysine is not well distributed in vegetable proteins.

Casein contains six per cent, pea protein five, ten per cent or over in connective tissue, eight per cent in hemoglobin. Foods high in lysine are blood sausage or head cheese. Here are two formulas:

Blood Sausage:	205 pounds Shoulder Fat
	54 pounds Pig Skins
	47 pounds Beef Blood
Head Cheese:	44 pounds Pig Skins
	55 pounds Pig Snouts
	33 pounds Beef Hearts
	51 pounds Neck Fat

We may not think these sound appetizing, but if you want lysine to afford stamina and endurance, there it is.

Tryptophane is also hard to find outside of the connective tissue of pig skin or blood proteins. Milk is fair in its content of tryptophane and lysine, but not enough is present to compensate for deficiencies in other foods. Wheat protein is better than most vegetable sources, but still lower than milk.

Tryptophane is known to protect against dental caries by its effect of activating the salivary enzymes that digest starch particles that adhere to the teeth.(9)

Tryptophane is another heat labile food essential; it is destroyed by by heat and acid hydrolysis. This may be the reason the worst teeth are found in children who have no access to raw vegetables, and why raw potatoes are so good as a caries inhibitor.(10)

Leucine and isoleucine are essential to growth, needed in greater amounts in the diet for children. Again, they are highest in animal foods with some exceptions, hemp seed protein being twenty per cent. Otherwise, eggs and milk and wheat are fair sources, but the keratin of the pork skins and the hemoglobin of blood sausage is exceptionally high.

By the way, hemp seed protein is one of the few vegetable sources of amino acids that is well-balanced, and contains all of the indispensable amino acids in sufficient amounts to promote growth. It is apparently unique in this respect.

Valine is another factor essential to muscular stamina. In its deficiency the subject becomes extremely tired and sleepy. Milk is the best source; hemp seed a good second; wheat a poor third.

Phenylalanine is another growth requisite, and is highest in eggs; good supply in milk; better in peas.

It is important to remember that protein metabolism is dependent upon liver integrity, and factors that embarrass the liver interfere with protein metabolism and possible deficiency. The liver is very frequently abused by the use of vitamin B in excess, which can cause cirrhosis and degenerative changes if the rest of the B complex is not supplied too, in sufficient quantity. These protective factors are the fat metabolizers, including betaine, choline or lecithin. The amino acid methionine too, can protect the liver against damage from vitamin B_1 ingestion. This toxic action on the liver is a very common one, many patients spontaneously report vitamin B concentrates or synthetic B

creates unfavorable reactions which are usually corrected by treatment directed to the liver. One thing usually very helpful is sodium phosphate, which apparently is a nutritional factor if used in this connection.

Some years ago in Germany a group of coal miners were put on a ration that included one gram a day of sodium phosphate crystals and the effect was to increase the voluntary work output 20 per cent. I believe this was due to the improved metabolic activity of the liver, up to then inhibited by the deficiency of phosphates which are necessary for the transport of fat in the blood, formed in the liver from carbohydrates and proteins. The output of protein end products of toxic nature is increased by phosphate feeding, showing liver activity is delayed and inhibited by this deficiency.

Where high protein diets are being used to treat such diseases as tuberculosis, the intake of sodium phosphate should be a valuable aid to their proper assimilation. The bad effect of a loss of the meat juices previously discussed may in part be due to loss of phosphates. It is very probable that quality is more important than quantity in feeding such patients, but the state of our knowledge today is very incomplete as regards the details of what qualtiies we need and where they may be found. The splitting of the proteins in vital tissues like the liver, bone marrow, and brain by hydrolysis and their use clinically has been very encouraging. The amino acid patterns in these tissues are quite different from those found in the common foods, and appear to correct many of the common symptoms of deficiency such as poor endurance, slow rate of healing, and low vitality states in general, and to aid in correcting the nerve degenerations in the older patient. Ulcers of the gastrointestinal tract seem to respond well, probably by reason of the better rate of healing in which the growth vitamins of the B group otherwise known as the G complex, seem to be important synergists or catalysts.

Heart patients of later years are also good prospects for amino acid treatment, for overwork can only cause degeneration where repairs are delayed. The success of the growth vitamins for this type of patient merely shows the need for their partners, the amino acids. The main function of the G complex seems to supply the essential factors for the protein metabolizing enzymes, while the amino acids supply the structural material to be metabolized.

As the special amino acids become available, they undoubtedly will find special uses. But meanwhile, the natural amino acid complexes of the specialized organs are being used with considerable success, and we must await the accumulation of clinical experience for more detailed information as to their application in therapy and nutrition.

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