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WHY ARE THERE ESSENTIAL AMINO ACIDS AND OTHER NUTRIENTS?

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Virtually all introductory biology or animal-physiology texts give several basic "facts" of animal nutrition: Various ions and compounds called vitamins must be obtained via the diet. Likewise, just under half of the 20 or so amino acids found in animal flesh cannot be synthesized by the animal and must likewise be gotten from the diet. These "diet-demanded" amino acids are called essential amino acids. This paper addresses the question of why there are essential amino acids. My answer is not that the animal is unable to synthesize the compound, but if the compound is easily available from the diet, it is simply cheaper to get it that way.

Animals get food-derived compounds in only two ways. First, they can make the more complex molecule from smaller pieces, the pieces gotten from outside the animal. Or, second, they can get the compound whole from the diet and arrange to transport it to the sites of use. Given that these are the only two options, an economic analysis of the two pathways begins a proscriptive and predictive theory for the existence of nutrients.

Applied to essential versus non-essential amino acids, essential amino acids are predicted to have combinations of the following traits. They require specialized synthesis machinery with many steps and several enzymes. They are easy to get from the diet; ease means available and ease of transport to site of use (e.g., not destroyed by digestion). On the other hand, non-essential amino acids should require generalized synthesis machinery (e.g., pathways the cell uses for several functions), require few enzymes, and be more difficult to get out of the diet (i.e., by more easily destroyed during digestion).

While most higher animals lack the essential AA synthesis machinery, green plants, yeasts, fungi, and so forth have it... and thus allow a comparative test of the above hypotheses.

Finally, the paper will further ask if selection might not sometimes favor the substitution of an easily available nutrient in place of a harder-to-get one. Much recent discussion of amino-acid substitutions (in evolution) stresses the perhaps neutral or non-adaptive aspects of the function of the resulting new molecule. But function of an enzyme is only half the natural selection question; the cost of producing it may be equally important and these substitutions may be related to cost, not benefit.

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