PLANTS VERSUS ANIMALS IN THE DINING HALL

CHEM-643 Intermediary Metabolism
Case Study in Amino Acid Metabolism
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Page 2 -Essential vs. NonessentialAmino Acids

Maura's wondered, "How do we know which amino acids are essential?" Most every textbook she looked at had a definition of essential and nonessential amino acids and a nice table listing those in each group. A few books also included a "marginally essential" category as if nutritionists couldn't make up their mind. What surprised and frustrated her was the absence in most cases of any connection to reality. There were assertions and definitions but little that provided experimental evidence supporting what was said or where to find out more. She wanted evidence and it wasn't there. Maura gave up. But, after a week or so when finals were looming, the fear of going home returned. Somewhat desperate, she found a biochemistry professor who loaned her two articles and invited her to come back if she had more questions. More questions! She couldn't make any sense out of the tables of numbers, she couldn't figure out what was being done, and she felt she would look stupid if she went back to the professor. So she enlisted the help of Janis, one of her vegetarian friends who happened to be a chem major.

The first paper took advantage of radioisotopes, something Janis had to explain to Maura It described a mouse that was fed almost 0.5 mCi of ^{14}C-sugar for a short time and then "sacrificed" three days later. (Maura didn't like this experiment.) Its proteins were isolated and hydrolyzed into constituent amino acids. After separation by chromatography, the amino acids were quantified and their radioactivity measured. In the other paper, the amino acid requirements of mouse fibroblast cells in tissue culture were determined by comparing cell growth when one amino acid was missing to growth with all other amino acids present. When there was no cell growth, the ratio of cells at the beginning and the end of the experiment would be 1.0. Thus, if cells were dying, the values would be less than 1.0.

Table 1. Specific radioactivity of amino acids biosynthesized from ^{14}C sucrose in three days by a mouse (Steele, 1952).

Amino Acid	nCi/mgC	Amino Acid	nCi/mgC	Amino Acid	nCi/mgC	Amino Acid	nCi/mgC
Glutamate	19.0±1.9	Threonine	0.09±0.02	Valine	0.02±0.01	Lysine	0.0±0.02
Aspartate	15.8±0.9	Serine	8.4±0.1	Phenylalanine	0.02±0.07	Histidine	0.07±0.08
Alanine	26.5±3.3	Glycine	5.1±0.2	Tyrosine	0.0±0.07	Cystine	3.3±0.3
Proline	3.1±0.1	Isoleucine	0.06±0.05	Arginine	3.0±0.2	Methionine	1.03±0.06

Table 2. Growth of mouse L cells in media lacking the indicated amino acid (Eagle, 1955).

Amino Acid	Cell Growth	Amino Acid	Cell Growth	Amino Acid	Cell Growth	Amino Acid	Cell Growth
Glutamate	3.6 - 4.5	Threonine	0.2	Valine	0.06 - 0.2	Lysine	0.2 - 0.5
Aspartate	3.6 - 6.1	Serine	2.5 - 2.8	Phenylalanine	0.3 - 0.4	Histidine	0.3 - 0.4
Alanine	2.2 - 2.6	Glycine	3.6 - 3.7	Tyrosine	0.06 - 0.2	Cystine	0.1 - 0.3
Proline	2.4 - 6.8	Isoleucine	0.1 - 0.4	Arginine	0.4 - 0.9	Methionine	0.3 - 0.4
		Leucine	0.4 - 0.6	Tryptophan	0.3 - 0.4		

How well does the classification of essential and nonessential amino acids agree with the results of these experiments?

Identify any discrepancies between the two sets of data. Can they be explained by known pathways of amino acid metabolism in mammals?