Biomedical Importance

Amino acid deficiency states include **kwashiorkor,** which results when a child is weaned onto a starchy diet poor in protein; and **marasmus,** in which both caloric intake and specific amino acids are deficient. Patients with short bowel syndrome unable to absorb sufficient quantities of calories and nutrients suffer from significant nutritional and metabolic abnormalities. Both the nutritional disorder **scurvy,** a dietary deficiency of vitamin C, and specific genetic disorders are associated with an impaired ability of connective tissue to form hydroxyproline and hydroxylysine. The resulting conformational instability of collagen results in bleeding gums, swelling joints, poor wound healing, and ultimately in death. **As well as** the deficiency of copper, which is an essential cofactor for lysyl oxidase, an enzyme that functions in formation of the covalent cross-links that strengthen collagen fibers**.**

Nutritionally essential & nutritionally nonessential amino acids

As applied to amino acids, the terms "essential" and "nonessential" are misleading since all 20 common amino acids are essential to ensure health. Of these 20 amino acids, 8 must be present in the human diet, and thus are best termed "nutritionally essential." The other 12 amino acids are "nutritionally nonessential" since they need not be present in the diet. The distinction between these two classes of amino acids was established in the 1930s by feeding human subjects purified amino acids in place of protein.

Table 27–1. Amino Acid Requirements of Humans

Nutritionally Essential	Nutritionally Nonessential
Arginine[1]	Alanine
Histidine	Asparagine
Isoleucine	Aspartate
Leucine	Cysteine
Lysine	Glutamate
Methionine	Glutamine
Phenylalanine	Glycine
Threonine	Hydroxyproline[2]
Tryptophan	Hydroxylysine[2]
Valine	Proline
	Serine
	Tyrosine

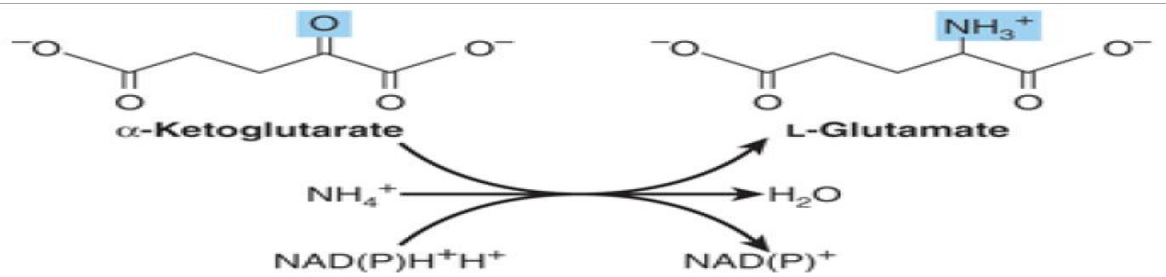
. The number of enzymes required by prokaryotic cells to synthesize the nutritionally essential amino acids is large relative to the number of enzymes required to synthesize the nutritionally nonessential amino acids. This suggests a survival advantage in retaining the ability to manufacture "easy" amino acids while losing the ability to make "difficult" amino acids. Arginine (Nutritionally essential amino acid) required 7 enzyme to synthesize but alanine (nutritionally nonessential) required just one enzyme for synthesized it.

Glutamate Dehydrogenase, Glutamine Synthetase, & Aminotransferases Play Central Roles in Amino Acid Biosynthesis

The combined action of the enzymes glutamate dehydrogenase, glutamine synthetase, and the aminotransferases converts ammonium ion into the -amino nitrogen of amino acids.

Glutamate

Reductive amidation of -ketoglutarate is catalyzed by glutamate dehydrogenase. This reaction constitutes the first step in biosynthesis of the "glutamate family" of amino acid



Glutamine

The amidation of glutamate to glutamine catalyzed by glutamine synthetase involves the intermediate formation of -glutamyl phosphate. Following the ordered binding of glutamate and ATP, glutamate attacks the -phosphorus of ATP, forming -glutamyl phosphate and ADP. NH4+ then binds, and as NH3, attacks -glutamyl phosphate to form a tetrahedral intermediate. Release of Pi and of a proton from the -amino group of the tetrahedral intermediate then facilitates release of the product, glutamine.