

# Amino Acids and their Biosynthesis are Flowing in Ecosystem

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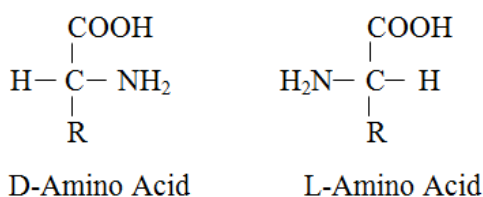
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**Abstract** - Amino acid is a nitrogenous compound having both an acidic carboxyl (-COOH) and a basic amino (-NH<sub>2</sub>) group. Proteins are the polymers, i.e., chain - like molecules produced by joining a number of small units of amino acids called monomers; every living cell must have a supply of amino acids constantly available for diverse synthetic processes, especially protein synthesis. These amino acids may be derived by synthesis from simple substances, i.e., from glucose as a carbon source and ammonium ion as a nitrogen source, or by their absorption from the surrounding environment. Amino acids are flowing continuously in all steps of ecosystem with flowing of energy. It is also metabolised with flowing in ecosystem.

**Keywords:** Amino acids, Biosynthesis, Ecosystem, Food chain.

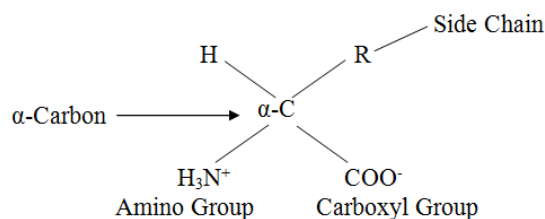
## I. Introduction

Amino acid is a nitrogenous compound having both an acidic carboxyl (-COOH) and basic amino (-NH<sub>2</sub>) group. R stands for the side chains that are different for each amino acid. R can be as simple as a hydrogen atom (H) as in glycine or a methyl group (-CH<sub>3</sub>) as in alanine or a more complex structure. The first carbon is the part of the carboxyl group. The second carbon, to which is attached the amino group is called the  $\alpha$ -carbon. The  $\alpha$ -carbon of most amino acids is joined by covalent bonds to 4 different groups. Thus, the  $\alpha$ -Carbon in all the amino acids is asymmetric except in glycine where the  $\alpha$ -Carbon is symmetric. Because of this asymmetry, the amino acids exist in the optically forms: those having -NH<sub>2</sub> group to the left as L-forms. However, the two amino acids threonine and isoleucine have two asymmetric carbon atoms each and thus have  $2^n = 2^2 = 4$  optical isomers. At pH 7.0 both the carboxyl and amino groups are ionized.



Two optical isomers of amino acid

Amino acids allow them to polymerize to form peptides and proteins are the existence of their two identifying chemical groups: the amino (-NH<sub>3</sub><sup>+</sup>) and carboxyl (-COO) groups. The amino and carboxyl groups of amino acids can react in a head - to - tail fashion, eliminating a water molecule and forming a covalent amide linkage, which, in the case of peptides and proteins, is typically referred to as a peptide bond. The equilibrium for this reaction in aqueous solution favours peptide bond hydrolysis.



The complex system, in which interactions between the different components of environment occur, is referred to as an ecosystem. To be more precise, any spatial or organizational unit which includes the living and the non living constituents interacting with and producing an exchange of materials between the two is termed as an ecosystem.

The non living as abiotic constituents of an ecosystem include mineral nutrients, temperature light, water, air etc., which surround, influence and shape the living or biotic components. A large number of individuals belonging to different species which adjust, adopt, interact with each other and share the same general environment and resources from a biotic community or the biosphere. Based on the function and the general manner in which organisms obtain their food material, individual within a biotic community can be grouped into: (a) Producers, (b) Consumers and (c) Decomposers.

- (a) **Producers** - The community of green plants, called primary producers, absorbs carbon dioxide, mineral nutrients, water and built up organic matter with the help of solar energy, releasing oxygen in the process.
- (b) **Consumers** - Producers are consumed by herbivorous animals, the primary consumers, which are in turn

consumed by carnivorous animals, the secondary consumers and so on.

- (c) **Decomposers** - Faecal matter, exudates and excreta of plants animals and their dead bodies are decomposed by the activity of bacteria, fungi and other small organisms which live on dead and decaying organic matter. These constitute the community of decomposers which bring the constituent elements of the plant and animal bodies back to the surrounding medium or to the soil.

## II. Steps of Bio-Synthesis of Amino Acids

All the 20 protein amino acids are derived from intermediates in glycolysis, citric acid cycle or the pentose phosphate pathways Nitrogen enters these pathways by way of glutamate and glutamine. The pathways for in amino acids are simple and are only or a few enzymatic steps removed from their precursors, whereas the pathways for others (such as aromatic amino acid) are more complex. Different organisms have varied capacity to synthesize these 20 amino acids. Whereas most bacteria and plants can synthesise all the 20 amino acids, mammals including man can synthesize only about half of them. These are termed as non essential amino acids and the remaining ones, which must be obtained from food, as the essential amino acid.

Most Pathways are essential irreversible and as such a continuous supply of all the amino acids is ensured. This is accomplished in general, by reactions in which ATP is utilized and in effect hydrolyzed to ADP+Pi. The cases, where ATP splits into AMP + P<sub>Pi</sub>, are more effective because the pyrophosphate is irreversibly hydrolyzed (P<sub>Pi</sub> → 2P<sub>i</sub>). In other instances, Synthesis is ensured by a reductive amination usually employing a pyridine nucleotide, in which equilibrium strongly favours such reduction. Most of the pathways for amino acid syntheses have been established mainly for bacteria, yeast and other moulds. It is believed that the pathways in higher plants and animals are similar, but comparatively less is known of the enzymes involved.

All amino acids can be synthesized from intermediates in glycolysis, the pentose phosphate pathways, or the citric acid cycle.

## III. Synthesis of Glutamate, Aspartate, Alanine, Glutamine, and Asparagine

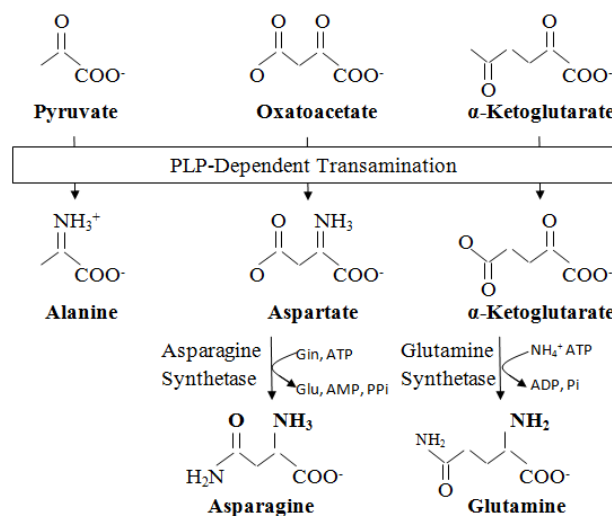
PLP - dependent transamination provides the major route for the synthesis of glutamate, aspartate, and alanine.

Reactions catalysed by glutamate dehydrogenase and glutamate synthase, present additional routes for glutamate synthesis from α-keto-glutarate.

Asparagine is synthesised from aspartate in a reaction catalysed by aspergine synthetase, a glutamine dependent amidotransferase.

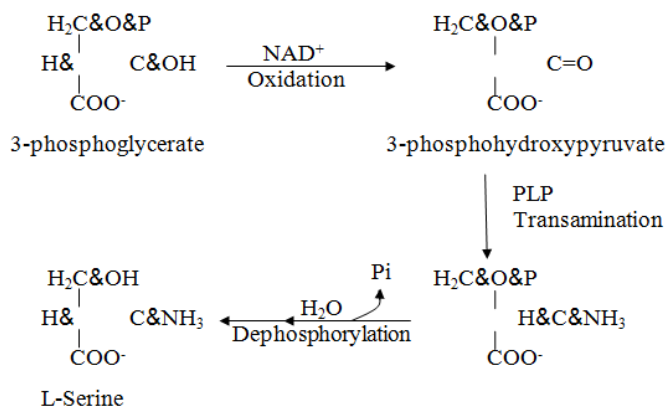
Glutamine is synthesised from glutamate by a similar amidation reaction, except that ammonia provides the amide N. The γ-glutamyl phosphate intermediate in this glutamine synthetase reaction.

In animals, a major metabolic function of alanine cycle as a carrier of carbon for gluconeogenesis from muscle to liver.



## IV. Synthesis of Serine and Glycine from 3-Phosphoglycerate

Serine and glycine are closely interconnected via the serine hydroxymethyl transferase reaction; it precedes more often in the reverse direction, as the principal biosynthetic route to glycine and to 5, 10-methylenetetrahydrofolate.

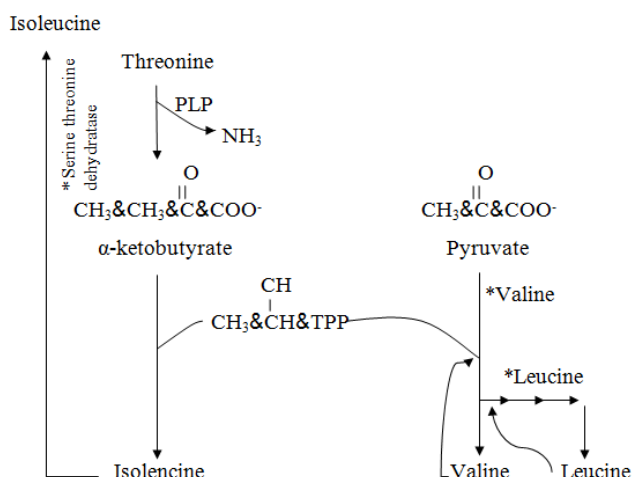


## V. Synthesis of Valine, Leucine and isoleucine from Pyruvate

The branched-chain amino acids valine, leucine, and isoleucine are essential for mammals, and they are synthesized primarily in plant, and bacterial cells.

Valine, leucine and isoleucine are structurally related, and they share certain reactions and enzymes in their biosynthetic pathways. The last four reactions in valine and isoleucine biosynthesis are catalyzed by the same four enzymes. Valine biosynthesis begins with transfer of a two carbon fragment from hydroxyethyl thiamine pyrophosphate (TPP) to pyruvate. The two carbon fragment derives from a second molecule to pyruvate in a TPP-dependent reaction similar to that catalyzed by pyruvate decarboxylase. A similar TPP-dependent transfer of a two-carbon unit to  $\alpha$ -ketobutyrate begins the pathway to isoleucine. The ketoacid analogue of valine is the input for a four step pathway to leucine.

In bacteria, each of these three amino acids controls its own synthesis by feedback inhibition of a different enzyme. In fact, the concept of allosteric control was developed largely in studies on the inhibition of threonine dehydratase by isoleucine.



### VI. Animals Differ in the form of Nitrogen That They Excrete

Animals often enjoy a dietary surplus of Nitrogen. Excess nitrogen liberated upon metabolic degradation of amino acids is excreted by animals in three different ways, in accord with the availability of water. Aquatic animals simply release free ammonia to the surrounding water, such animals are termed ammonotelic. On the other hand, terrestrial and aerial species employ mechanisms that convert ammonium to less toxic compounds that require little water ( $\text{H}_2\text{O}$ ) for excretion. Many terrestrial vertebrates, including humans, are ureotelic, meaning that they excrete excess nitrogen as urea, a highly water soluble non-ionic substance. Urea is formed by ureotelic animals via the urea cycle. The ureotelic organisms are those animals using the third means of Nitrogen excretion, conversion to uric acid, a rather

insoluble purine analog. Birds and reptiles are uricotelic. Some animals can switch from ammonotelic to ureotelic to uricotelic metabolism, depending on water availability.

Amino acids are required for many vital functions of an organism. Those amino acids that mammals can synthesize from common  $\alpha$ -keto acid carbon skeletons and preformed  $\alpha$ -amino nitrogen such as that of glutamate are known as non essential amino acids and those that mammals must obtain from their diets are called essential amino acids. The biosynthesis of non essential amino acids involves relatively simple pathways, whereas those forming the essential amino acids are generally more complex.

### VII. Food Chains

The transfer of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with respect eating and being eaten, is known as food chain. Producers utilize the radiant energy of sun which is transformed to chemical form, ATP during photosynthesis. Thus, in any food chain, green plants occupy the first trophic (nutritional) level – the producer levels and are called the primary producers. The energy, as stored in food matter not manufactured by green plants, is then eaten by the herbivores which constitute the second trophic level and are called the primary consumers (herbivores). Herbivores in turn are eaten by the carnivores, which constitute the third trophic level – the secondary consumers level, and are called the Secondary consumers (Carnivores). These in turn may still be eaten by other carnivores at tertiary consumer level i.e. by the tertiary consumers (Carnivores). Some organisms are omnivorous eating the producers as well as the carnivorous at their lower food chain. Such organisms may occupy more than one trophic level in the food chain.

### VIII. Conclusion and Recommendations

Amino acids are required for many vital functions of an organism. Those amino acids that mammals can synthesize from common  $\alpha$ -keto acid carbon skeletons and preformed  $\alpha$ -amino nitrogen such as that of glutamate are known as non essential amino acids, those that mammals must obtain from their diets are called essential amino acids. The biosynthesis of non essential amino acids involves relatively simple pathways, whereas those forming the essential amino acids are generally more complex.

The 20 common amino acids are degraded by 20 different pathways that converge to just 7 metabolic intermediates: Pyruvate, acetyl - coA, acetoacetate, oxaloacetate,  $\alpha$ -

ketoglutarate, succinyl-CoA, and fumarate. All seven of these compounds are intermediates in or readily feed into the pathways of energy production (citric acid cycle and phosphorylation).

In food chain, the amino acids and biosynthesis/metabolism etc. are also flowing with energy from producers to primary consumers, from primary consumers to secondary consumers and from secondary consumers to tertiary consumers.

The rapid advances and technology have put the scientists and technologists on their heels to cope up with the simultaneous changes that have occurred during the past decades. Various types of revisions, rectifications as well as modifications and sometimes even together innovated ideas that developed in numerous fields of specializations have required to be incorporated with the advanced to the field concerning of the study. The innovative techniques have put the researches on consistent 'think and rethink' level on the entertain high concepts related to the life science. The study of such concept as amino acid is to be considered with biosynthesis/metabolism of amino acid and its flow in ecosystem of land, aquatic, mountains, desert and air etc. and interrelationship in between plants, animals and biosphere.

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