

## Properties and Functions of Amino Acids

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### ABOUT THE STUDY

Amino acids are organic compounds that play a fundamental role in the structure and function of all living organisms. These molecules serve as the building blocks of proteins, which are essential for a wide range of biological processes. Amino acids are incredibly diverse in their functions and properties, and understanding their significance is crucial to unravelling the complexities of life itself.

### Chemical structure

Amino acids have a common chemical structure consisting of a central carbon atom (alpha carbon or  $\alpha$ -carbon) bonded to four groups: an amino group (-NH<sub>2</sub>), a carboxyl group (-COOH), a hydrogen atom, and a unique side chain (R group). It is the side chain that distinguishes one amino acid from another, giving each its specific properties and role in biological processes.

There are 20 standard amino acids that are commonly found in proteins, and they can be classified into two main categories based on the nature of their side chains: polar and nonpolar amino acids. Polar amino acids have hydrophilic (water-attracting) side chains, while nonpolar amino acids have hydrophobic (water-repelling) side chains. This distinction plays a crucial role in protein structure and function.

### Protein synthesis

Amino acids are the key players in protein synthesis, a complex and highly regulated process that occurs in all living cells. Transcription and translation are the two main steps in the production of proteins. The genetic material encoded in DNA is converted into messenger RNA (mRNA) during transcription. This mRNA then carries the genetic code to the ribosomes, where translation occurs.

In the process of translation, the mRNA code is read in groups of three nucleotides called codons. Each codon is associated with a certain amino acid. Transfer RNA (tRNA) molecules, each carrying a specific amino acid, match up with the mRNA codons through complementary base pairing. This is where the genetic code is translated into a sequence of amino acids, leading to the

formation of a polypeptide chain, which ultimately folds into a functional protein.

### Amino acid functions

Amino acids are not only the building blocks of proteins but also have diverse roles in various physiological processes:

**Enzymes:** Some amino acids act as enzymes, catalyzing biochemical reactions in the body. For example, the amino acid serine is a crucial component of many enzymes involved in metabolic pathways.

**Structural proteins:** Amino acids like glycine and proline are important for the formation of structural proteins, such as collagen, which provides strength and support to connective tissues.

**Hormones:** Amino acids are involved in the synthesis of hormones like insulin (composed of two polypeptide chains) and growth hormone (composed of a single chain).

**Neurotransmitters:** Certain amino acids, including glutamate and GABA (gamma-aminobutyric acid), function as neurotransmitters in the nervous system, transmitting signals between nerve cells.

**Antibodies:** Antibodies, vital components of the immune system, are made up of protein molecules composed of amino acids. They recognize and neutralize pathogens like bacteria and viruses.

**Transport:** Amino acids are involved in the transport of molecules across cell membranes. For instance, the amino acid lysine plays a role in the absorption of calcium and other essential nutrients.

**Energy source:** When needed, amino acids can be metabolized for energy production. This occurs when the body breaks down proteins into their constituent amino acids during periods of fasting or intense exercise.

**Ph regulation:** Some amino acids, such as histidine, act as buffers to help regulate the pH levels within cells and maintain proper acid-base balance.

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**Detoxification:** Cysteine, an amino acid, is crucial for the synthesis of glutathione, a powerful antioxidant involved in detoxifying harmful substances in the body.

Amino acids are the essential components of life, serving as the building blocks of proteins and participating in a myriad of biochemical processes in the body. Their diverse functions

extend beyond protein synthesis to include roles in metabolism, signaling, and maintaining overall health. Proper nutrition is essential to ensure an adequate supply of both essential and nonessential amino acids, and understanding their significance is crucial for advancing our knowledge of biology, biochemistry, and medicine.