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Chemical Properties Classification and Physiological Importance of Amino Acids

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ABSTRACT

Amino acids form a family of neutral products that are quite obviously separated, both chemically (primarily due to their ampholytic characteristics) and biochemically (primarily because of their protein component functions). This paper gives a detailed description of amino acids and their attributes in terms of polarity, charge, and side chain properties, physical and chemical properties. The paper also examines the functions of amino acids in protein synthesis, enzyme activity, cellular signaling and metabolic pathways. They are especially highlighted in the pathway they take in physiological processes including neurotransmission, hormone production, immune system and the metabolism of energy. Besides, the importance of both essential and non-essential amino acids in sustaining human health and homeostasis is also described. Knowledge of the versatile functions of amino acids is relevant to the progress of biochemistry, molecular biology, and medical research, and is useful in creating nutritional and therapeutic measures.

Keywords: *Amino acids, Protein, Enzymes, Aromatic, Alanine.*

I. INTRODUCTION

Each amino acid is a distinct chemical molecule with its own specific side chain (R group) in addition to the amine (-NH2) and carboxyl (-COOH) functional groups. Carbon, hydrogen, oxygen, and nitrogen are the four essential amino acid building blocks. The number of amino acids found in nature is around 500. According to polarity, pH level, and side chain group type (aliphatic, acyclic, aromatic, containing hydroxyl or sulphur, etc.), they can be categorised as alpha- (α-), beta- (β-), gamma- (γ-), or delta- (δ-) amino acids. Human muscles and other tissues are mostly water, with amino acid residues making up the second-largest component in protein form. The R group's molecular structure is one way in which amino acids vary from one another. Amino acids are involved in many different activities, including neuronal transmission and biosynthesis.

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In biochemistry, 2-, alpha-, or α-amino acids (general formula H2NCHRCOOH) are amino acids that have both the amine and carboxylic acid groups connected to the first (alpha-) carbon atom. Their 22 proteinogenic ("proteinbuilding") amino acids are crucial because they may be linked together to create peptide chains ("polypeptides"), which are the fundamental units of a wide variety of proteins.

The maintenance of biological processes relies heavily on proteins. The chemical processes that take place within a cell rely on proteins to speed them up. They aid in the binding of cells into tissues and supply a plethora of structural components for cells. As contractile elements, several proteins aid in movement. Important supplies are transported from outside the cell to within by others. Antibodies made by proteins shield animals from harmful pathogens. Hormones are often proteins. Proteins are also involved in regulating gene expression. Proteins come in a wide variety in the natural world. The size, structure, and charge of proteins vary. Proteins are constructed from amino acids. Glycine, meaning "sugar," is the name of the most basic amino acid. This amino acid was extracted from gelatin at an early stage.

Aside from glycine, all of the amino acids are chiral compounds. Both the active and inactive optical versions of these molecules are known as enantiomers, and they are essentially mirror copies of one another. D stands for one enantiomer and L for the other. Protein amino acids nearly usually have just the L-configuration as well. The evolution of the enzymes involved in protein synthesis to exclusively use the L-enantiomers is reflected in this. In instance, some antibiotics and bacterial cell walls include D-amino acids. The ribosome does not, however, produce these.

II. AMINO ACID AND ITS CLASSIFICATION

The hydrophilicity, charge, and aromaticity of amino acids allow them to be grouped into different categories. Each amino acid plays a specific function in proteins and possesses its own distinct chemical characteristics due to its distinctive side chains. Amino acid groups and individual amino acids will be examined in greater detail. You must be able to identify each amino acid by its structure, categorisation, and any distinctive features.

1. Nonpolar, Nonaromatic Amino Acids

The hydrophobic side chains of these amino acids keep them out of water and help to stabilise protein structures by bringing them closer to the protein's core. Here are a few examples:

Glycine (Gly, G): With only one hydrogen atom as a side chain, this amino acid is the most basic building block of proteins. Proteins can contain it either on the exterior or the inside.

Glycine

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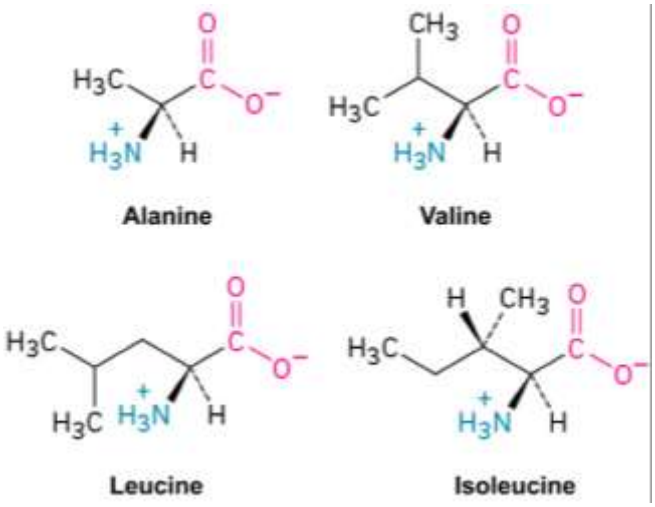
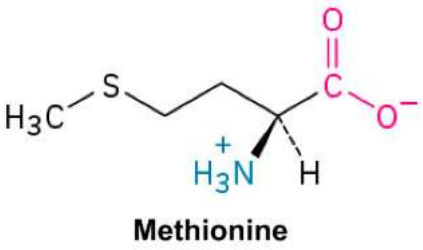
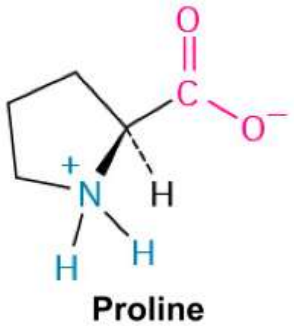
Alanine (Ala, A), Valine (Val, V), Leucine (Leu, L), and Isoleucine (Ile, I): Amino acids with different lengths of alkyl side chains make up proteins' hydrophobic core.



Methionine (Met, M): This amino acid contains a sulfur atom within a thioether group, and it's often involved in initiating protein synthesis.



Proline (Pro, P): This particular amino acid is typical of protein loops and turns because of its unusual cyclic shape, which limits its flexibility by incorporating the amino nitrogen.



2. Aromatic Amino Acids

These amino acids are great for spectroscopy-based protein concentration determination because the aromatic rings on their side chains absorb ultraviolet light. Here are a few examples:

Phenylalanine (Phe, F): This hydrophobic core amino acid is nonpolar and contains a benzyl side chain.

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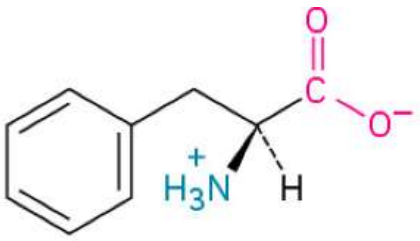
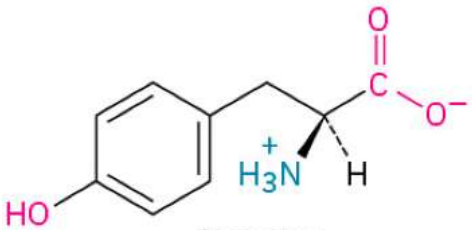


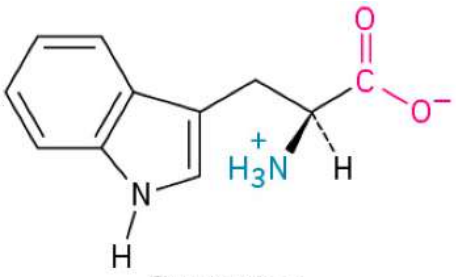
Phenylalanine

Tyrosine (Tyr, Y): The presence of a hydroxyl group on the benzyl ring gives this amino acid its polarity. Its structure is critical for tyrosine kinase receptor signalling pathways.



Tyrosine

Tryptophan (Trp, W): An essential component in protein-protein interactions, this amino acid is the biggest and has a nitrogen atom in its intricate double ring.

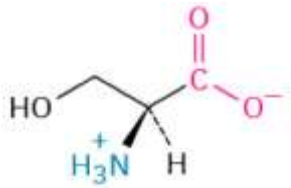


Tryptophan

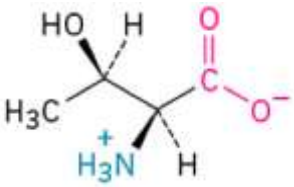
3. Polar, Uncharged Amino Acids

Amino acids having hydrogen bonding capabilities on their side chains are known as hydrophilic. Here are a few examples:

Serine (Ser, S) and Threonine (Thr, T): These both contain hydroxyl groups, which are often involved in phosphorylation.



Serine



Threonine

Cysteine (Cys, C): Because of its thiol group, this amino acid is reactive and may readily form disulphide bonds, which are essential for the stability of proteins.

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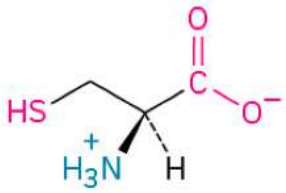
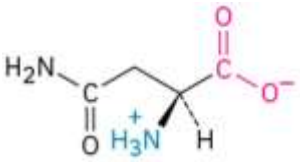
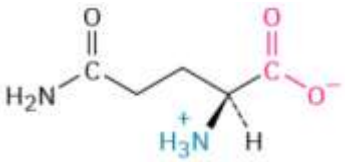


Cysteine

Asparagine (Asn, N) and Glutamine (Gln, Q): They engage in hydrogen bonding often and include amide groups, which do not acquire or lose protons and maintain a neutral charge.



Asparagine



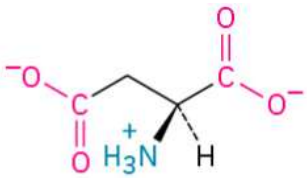
Glutamine

4. Charged Amino Acids

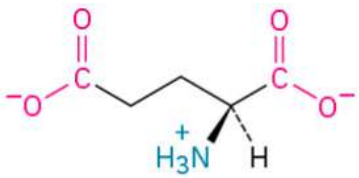
The charges on their side chains allow us to further categorise these amino acids as acidic or basic. They generate electrostatic interactions that aid in protein structural stabilisation and are frequently critical for enzyme function.

Acidic (Negatively Charged)

Aspartic Acid (Asp, D) and Glutamic Acid (Glu, E): The carboxyl groups on the side chains of these amino acids are negatively charged because they lose protons. They frequently participate in enzyme active sites.



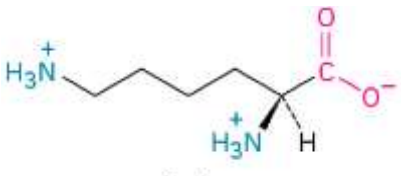
Aspartic acid



Glutamic acid

Basic (Positively Charged)

Lysine (Lys, K): This amino acid has a terminal primary amino group, often involved in binding to negatively charged molecules.



Lysine

Arginine (Arg, R): This amino acid contains a guanidinium group, making it highly basic and often involved in protein binding.

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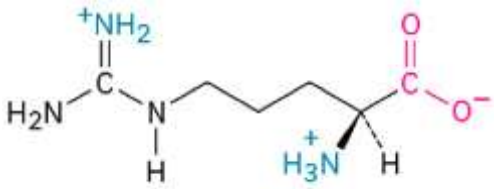
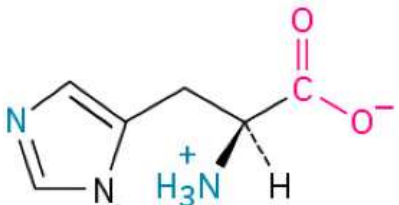


Arginine

Histidine (His, H): Enzyme active sites and buffering rely on this amino acid's imidazole ring, which may transport protons.



Histidine

III. AMINO ACID FUNCTIONS

In addition to their function as protein building blocks, amino acids play an important part in a wide range of physiological processes:

Enzymes

In the organism, some amino acids catalyse metabolic processes in the role of enzymes. The amino acid serine, for instance, is an essential building block of several enzymes that play a role in metabolic processes.

Structural Proteins

Collagen, a structural protein that gives connective tissues their strength and support, requires amino acids like proline and glycine to be formed.

Hormones

Hormones like insulin and growth hormone are made up of amino acids. Insulin is a polypeptide chain, whereas growth hormone is a single chain.

Neurotransmitters

Glutamate and gamma-aminobutyric acid (GABA) are two examples of the amino acids that play an important role in the neurological system as neurotransmitters.

Antibodies

Protein molecules containing amino acids are the building blocks of antibodies, which play an essential role in the immune system. When they detect harmful microbes like viruses and bacteria, they destroy them.

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Transport

The process of molecular transport across cellular membranes involves amino acids. The amino acid lysine, for example, is involved in nutrient absorption, including calcium.

Energy Source

Amino acids can be converted into energy through metabolic processes as and when required. This happens when your body undergoes protein hydrolysis, which can happen after fasting or extreme activity.

Ph Regulation

Histidine is one of the amino acids that works as a buffer to keep the acid-base balance in cells where it needs to be.

Detoxification

Glutathione is an effective antioxidant that aids in the detoxification of toxic chemicals in the body; cysteine, an amino acid, is essential for its formation.

Proteins and the many metabolic reactions they trigger rely on amino acids, which are fundamental to all forms of life. Beyond their involvement in protein synthesis, they play a wide variety of roles in metabolism, signalling, and general health maintenance. An appropriate quantity of essential and non-essential amino acids can only be achieved by a healthy diet, and our understanding of their importance is fundamental to progress in the fields of biology, biochemistry, and medicine.

IV. PROPERTIES OF AMINO ACIDS

The physical and chemical properties of amino acids differ, which in turn affect the protein's features.

Physical Properties

- **Solubility:** Most of them are water-soluble but insoluble in organic solvents.
- **Melting Points:** They generally have high melting points, often above 200°C.
- **Taste:** Glycine, alanine, and valine are examples of amino acids with sweet tastes; leucine and arginine are examples of amino acids without flavour; while isoleucine and glycine are examples of amino acids with bitter tastes. To improve the flavour, monosodium glutamate (MSG) is used.
- **Optical Properties:** All of them, except glycine, have optical isomers due to the presence of an asymmetric carbon atom. Some, like isoleucine and threonine, have a second asymmetric carbon.
- **Amino Acids as Ampholytes:** Due to the presence of both acidic (-COOH) and basic ($-NH_2$) groups, amino acids can act as ampholytes, donating or accepting protons.

Chemical Properties

The chemical reactions of amino acids primarily result from the carboxyl (-COOH) and amino ($-NH_2$) functional groups:

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- **Formation of Salts and Esters:** Amino acids form salts (-COONa) with bases and esters (-COOR') with alcohols.
- **Reaction with Ammonia:** The carboxyl group of dicarboxylic amino acids reacts with NH_3 to form amides.
- **Amino Group Behavior:** Amino groups act as bases and combine with acids (e.g., HCl) to form salts ($-NH_3^+Cl^-$).
- **Ninhydrin Reaction:** Alpha amino acids react with ninhydrin, producing a purple, blue, or pink complex known as Ruhemann's purple.
- **Oxidative Deamination:** They undergo oxidative deamination, releasing free ammonia.
- **Reaction with Acid Chloride/Anhydride:** In an alkaline medium, they react with acid chloride or acid anhydride, producing "phthaloyl amino acids."
- **Edman Degradation:** When they react with Edman's reagent, they form "phenyl thiohydantoin" and then cyclize into "phenyl thiohydantoin," an Edman's derivative.

V. CONCLUSION

Proteins are needed to ensure the existence and proper functioning of all living things. Proteins on their part are dependent on amino acids as their structural and functional backbone. They are engaged in a great number of biological and physiological processes due to their unusual chemical structure, including amino and carboxyl groups with different side chains. When we classify the amino acids on the basis of their polarity, charge and structural characteristics, we can learn more about the exact roles of the amino acids in protein synthesis and breakdown. Besides their key role in protein synthesis, the study demonstrates that amino acids also play a role in a number of other significant biological processes, including cellular signaling, hormone synthesis, immunological defense, and metabolic control. Their multidimensional involvement in the maintenance of homeostasis is further highlighted by their involvement in neurotransmission, detoxification, pH regulation, and energy production. The importance of some amino acids over others in health is a fact that emphasizes the necessity of a balanced diet in the acquisition of adequate quantities of these building blocks.

REFERENCES

1. R. Abdul-kader, "Amino Acids Metabolism Functions and Their Role in Health and Disease Management," *OBAT Jurnal Riset Ilmu Farmasi dan Kesehatan*, vol. 3, no. 4, pp. 35–57, 2025.
2. Balakrishnan, V. Vinoj, D. Muthusamy, and V. Vyshak, "Study of physico-chemical properties and amino acid profiling of buffalo paneer and acid whey," *Innovations in Agriculture*, vol. 7, no. 1, pp. 1–4, 2024.
3. M. Mustafa, M. Sorour, A.-H. Mehanni, and S. Hussien, "Amino acid profile physico-chemical properties and fatty acids composition of some fruit seed kernels after detoxification," *Chemical and Biological Technologies in Agriculture*, vol. 10, no. 1, pp. 1–11, 2023.
4. C. Kamble, R. Chavan, and V. Kamble, "A Review on Amino Acids," vol. 8, no. 3, pp. 19–27, 2022.

International Journal of Advanced Multidisciplinary Scientific Research (IJAMSR) ISSN:2581-4281

5. D. Alasady, A. Alabbasy, and H. Hassen, "Study of the chemistry of amino acids and their applications," *International Journal of Chemistry Studies*, vol. 5, no. 2, pp. 19–24, 2021.
6. H. Do, Y. Z. Chua, A. Kumar, D. Schick, M. Hallermann, D. Zaitsau, C. Schick, and C. Held, "Melting properties of amino acids and their solubility in water," *RSC Advances*, vol. 10, no. 72, pp. 44205–44215, 2020.
7. O. Horovitz and R. D. Pasca, "Classification of amino acids by multivariate data analysis based on thermodynamic and structural characteristics," *Studia Universitatis Babeș-Bolyai Chemia*, vol. 62, no. 2, pp. 19–31, 2017.
8. Kumar, A. Rani, and L. Hussain, "Investigations of amino acids profile fatty acids composition isoflavones content and antioxidative properties in soy okara," *Asian Journal of Chemistry*, vol. 28, no. 4, pp. 903–906, 2016.
9. J. Goudoever, H. Vlaardingerbroek, C. van den Akker, F. Groof, and S. van der Schoor, "Amino acids and proteins," *World Review of Nutrition and Dietetics*, vol. 110, no. 1, pp. 49–63, 2014.
10. R. Rezaei, W. Wang, Z. Wu, Z. Dai, J. Wang, and G. Wu, "Biochemical and physiological bases for utilization of dietary amino acids by young pigs," *Journal of Animal Science and Biotechnology*, vol. 4, no. 7, pp. 1–12, 2013.
11. F. Luckose, M. Pandey, and K. Radhakrishna, "Effects of amino acid derivatives on physical mental and physiological activities," *Critical Reviews in Food Science and Nutrition*, vol. 55, no. 13, pp. 1–8, 2013.
12. M. Akram, M. Asif, M. Uzair, A. Naveed, M. A. Madni, S. A. Shah, Z. Hasan, and A. Khan, "Amino acids A review article," *Journal of Medicinal Plants Research*, vol. 5, no. 17, pp. 3997–4000, 2011.