

**Course -M.Sc. Botany Part-II, Paper-IX  
(Group-“B”)**

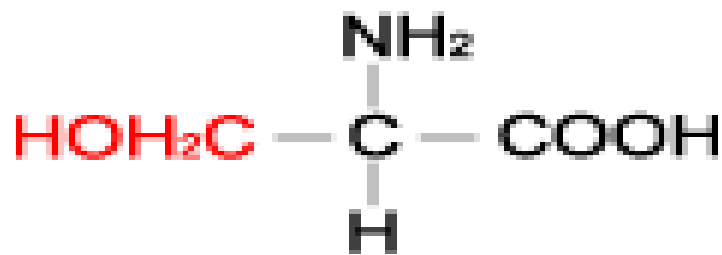
**Topic-Amino Acids (Bio-Chemistry)**

**Prepared by –Dr. Premlata Mehta**

**Co-ordinated by- Prof. (Dr.) Shyam Nandan Prasad**

## Amino Acids

Amino acids are often termed as building blocks or monomeric units of proteins. They are an organic molecule that is made up of a basic amino group ( $-\text{NH}_2$ ), an acidic carboxyl group ( $-\text{COOH}$ ), and an organic R group (or side chain) that is unique to each amino acid. They are involved in almost every body function, including growth and development, healing and repair, normal digestion, and providing energy for our body.



The term “amino acids” owes its name to its structure, showing the presence of both an amino group and a carboxyl group linked to  $\alpha$ - carbon (exception being proline). The 20 amino acids of protein differ from each other in the nature of R-group determined by the structure, size, electrical charge, and solubility in water. Although different classifications of amino acids are available in the literature, the most meaningful seems to be the one based on the polarity of R-groups. As polarity of R-groups is subjected change with change in the pH, the classification given in the following is based on the polarity of R-group at physiological range of pH 6.0 -7.0. At these pH range, the carboxyl group gets deprotonated (negatively charged) and the amino group gets protonated (positively charged).

Accordingly, standard amino acids have been classified into the following four classes:

1. Amino acids with nonpolar (hydrophobic) R-group
2. Amino acids with uncharged polar R-group.
3. Amino acids with positively charged polar R-group.
4. Amino acids with negatively charged polar R-group.

These standard amino acids have been assigned three-letter and one-letter symbols.

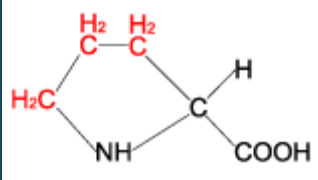
## Molecular and linear formulas

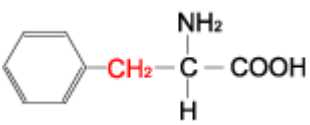
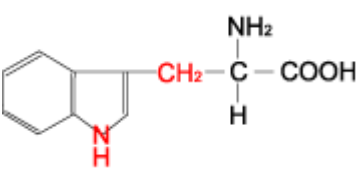
Amino acid	Abbreviations		Molecular formula	Linear formula
Alanine	Ala	A	$C_3H_7NO_2$	$CH_3-CH(NH_2)-COOH$
Arginine	Arg	R	$C_6H_{14}N_4O_2$	$HN=C(NH_2)-NH-(CH_2)_3-CH(NH_2)-COOH$
Asparagine	Asn	N	$C_4H_8N_2O_3$	$H_2N-CO-CH_2-CH(NH_2)-COOH$
Aspartic acid	Asp	D	$C_4H_7NO_4$	$HOOC-CH_2-CH(NH_2)-COOH$
Cysteine	Cys	C	$C_3H_7NO_2S$	$HS-CH_2-CH(NH_2)-COOH$
Glutamine	Gln	Q	$C_5H_{10}N_2O_3$	$H_2N-CO-(CH_2)_2-CH(NH_2)-COOH$
Glutamic acid	Glu	E	$C_5H_9NO_4$	$HOOC-(CH_2)_2-CH(NH_2)-COOH$
Glycine	Gly	G	$C_2H_5NO_2$	$NH_2-CH_2-COOH$
Histidine	His	H	$C_6H_9N_3O_2$	$NH-CH=N-CH=C-CH_2-CH(NH_2)-COOH$
Isoleucine	Ile	I	$C_6H_{13}NO_2$	$CH_3-CH_2-CH(CH_3)-CH(NH_2)-COOH$
Leucine	Leu	L	$C_6H_{13}NO_2$	$(CH_3)_2-CH-CH_2-CH(NH_2)-COOH$
Lysine	Lys	K	$C_6H_{14}N_2O_2$	$H_2N-(CH_2)_4-CH(NH_2)-COOH$
Methionine	Met	M	$C_5H_{11}NO_2S$	$CH_3-S-(CH_2)_2-CH(NH_2)-COOH$

Phenylalanine	Phe	F	$C_9H_{11}NO_2$	Ph-CH <sub>2</sub> -CH(NH <sub>2</sub> )-COOH
Proline	Pro	P	$C_5H_9NO_2$	NH-(CH <sub>2</sub> ) <sub>3</sub> -CH-COOH
Serine	Ser	S	$C_3H_7NO_3$	HO-CH <sub>2</sub> -CH(NH <sub>2</sub> )-COOH
Threonine	Thr	T	$C_4H_9NO_3$	CH <sub>3</sub> -CH(OH)-CH(NH <sub>2</sub> )-COOH
Tryptophan	Trp	W	$C_{11}H_{12}N_2O_2$	Ph-NH-CH=C-CH <sub>2</sub> -CH(NH <sub>2</sub> )-COOH
Tyrosine	Tyr	Y	$C_9H_{11}NO_3$	HO-Ph-CH <sub>2</sub> -CH(NH <sub>2</sub> )-COOH
Valine	Val	V	$C_5H_{11}NO_2$	(CH <sub>3</sub> ) <sub>2</sub> -CH-CH(NH <sub>2</sub> )-COOH

**Structures of different Amino Acids classified under four different classes based on polarity of R-groups.**

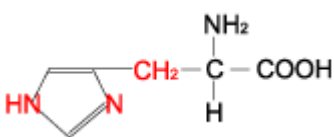
POLAR SIDE CHAINS		NON POLAR SIDE CHAINS	
SERINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{HOH}_2\text{C}-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$	GLYCINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$
THREONINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_3\text{C}-\text{CHOH}-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$	ALANINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_3\text{C}-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$

TYROSINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{HO}-\text{C}_6\text{H}_4-\text{CH}_2-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$	CYSTEINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{HS}-\text{CH}_2-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$
ASPARAGINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_2\text{N}-\text{CO}-\text{CH}_2-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$	VALINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_3\text{C} \quad \text{CH} \quad \text{C}-\text{COOH} \\ \quad \quad \quad   \\ \quad \quad \quad \text{H}_3\text{C} \quad \quad \quad \text{H} \end{array}$
GLUTAMINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_2\text{N}-\text{CO}-\text{CH}_2-\text{CH}_2-\text{C}-\text{COOH} \\   \\ \text{H} \end{array}$	LEUCINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_3\text{C} \quad \text{CH} \quad \text{CH}_2 \quad \text{C}-\text{COOH} \\ \quad \quad \quad   \\ \quad \quad \quad \text{H}_3\text{C} \quad \quad \quad \text{H} \end{array}$
		ISOLEUCINE	$\begin{array}{c} \text{NH}_2 \\   \\ \text{H}_3\text{C}-\text{CH}_2-\text{CH} \quad \text{C}-\text{COOH} \\ \quad \quad \quad   \\ \quad \quad \quad \text{CH}_3 \quad \quad \quad \text{H} \end{array}$
		PROLINE	

		METHIONINE	$\text{H}_3\text{C}-\text{S}-\text{CH}_2-\text{CH}_2-\overset{\text{NH}_2}{\underset{\text{H}}{\text{C}}}-\text{COOH}$
		PHENYLALANINE	
		TRYPTOPHAN	

Amino acids with negatively charged.

Amino acids with positively charged.

ACIDIC SIDE CHAINS		BASIC SIDE CHAINS	
ASPARTIC ACID	$\text{HOOC}-\text{CH}_2-\overset{\text{NH}_2}{\underset{\text{H}}{\text{C}}}-\text{COOH}$	LYSINE	$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{NH}_2}{\underset{\text{H}}{\text{C}}}-\text{COOH}$
GLUTAMIC ACID	$\text{HOOC}-\text{CH}_2-\text{CH}_2-\overset{\text{NH}_2}{\underset{\text{H}}{\text{C}}}-\text{COOH}$	ARGININE	$\text{H}_2\text{N}-\overset{\text{H}_2\text{N}}{\underset{\text{HN}}{\text{C}}}=\text{N}-\text{H}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{NH}_2}{\underset{\text{H}}{\text{C}}}-\text{COOH}$
		HISTIDINE	

(1) Paired cysteines allow **disulfide bonds** to form in proteins: **-CH<sub>2</sub>-S-S-CH<sub>2</sub>**.

Thanks and Regards

**Dr.Premlata Mehta**