

B.Sc Part III Paper ORGANIC

TOPIC: - AMINO ACID

COLLEGE: - PATNA SCIENCE COLLEGE, PATNA
DEPARTMENT OF CHEMISTRY

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Amino Acid

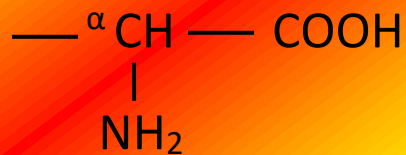
All proteins are macromolecules because of their very high molecular weight. They are the polymers i.e chain like molecules produced by joining a number of small units of amino acid looks of proteins. The general formula of AA



Each AA is a nitrogenous compound having both an acidic carboxyl (- COOH) and basic amino (NH₂) group. R stands for the side having that are different for each AA. R can be as simple as a H – atoms or a methyl group (-CH₃) or a more complex structure. The first carbon is the part of the carboxyl group. The second carbon attached to which is attached to the amino group is called the α carbon . Thus, the α - carbon in all the amino acids is asymmetric except in glycine where α carbon is symmetric.

Classification :- 3 system of classifying AMINO ACID.

A. On the basis of the composition of the side chain or R group. There are 20 different AA which regularly appears in proteins.



Common component of an Amino Acid. There posses a side chain which is the only variable feature present in their molecules. The other feature such as α – carbon, carboxyl group and amino group are common to all the Amino Acids.

Based, on the composition of the side chain, the twenty Amino Acids may be group in to following 8 categories.

- i.) Simple Amino Acid :- They have no functional group in the side chain e.g – glycine, alanine, valine and isoleucine.
- ii.) Hydroxy Amino Acid :- These contains a hydroxyl group in the side chain e.g glycine, serine, threonine.

- iii.) Sulfur – containing Amino Acid :- These possess a sulfur atom in the side chain e.g. cysteine and methionine.
- iv.) Acidic Amino Acid :- These have a carboxyl group in the side chain e.g. – Aspartic Acid and glutamic acid.
- v.) Amino Acid Amides :- These are derivatives of acidic Amino Acids on which one of the carboxyl groups has been transformed into an amide ($-\text{CONH}_2$) e.g. Asparagine and glutamine.
- vi.) Basic Amino Acid :- These possess an amino group in the side chain e.g. Lysine and Arginine.
- vii.) Heterocyclic Amino Acids :- These Amino Acids have in their side chain a ring which possesses at least one atom other than carbon e.g. – Tryptophan, Histidine and Proline.
- viii.) Aromatic Amino Acids :- These have a benzene ring in the side chain e.g. – Phenylalanine and Tyrosine.

B.) On the basis of number of Amino and Carboxylic Acid groups.

I. Mono- amino and mono carboxylic Amino Acid.

1. Unsubstitued – Glycine, Alanine, Valine, Leucine, Isoleucine
2. Heterocyclic – Proline
3. Aromatic – Phenylalanine, Tyrosine, Tryptophan
4. Thiether – Methionine
5. Hydroxy – Serine, Threonine
6. Mercapto – Cysteine
7. Carboxamide – Asparagine, Glutamine

II. Mono amino - Dicarboxylic Amino Acids :- Aspartic acid and Glutamine acid.

III. Diamino – Monocarboxylic Acid :- Lysine, Arginine, Histidine.

C.) On the basis of polarity of the side chain or R group.

A more meaningful classification of Amino Acids is however based on the polarity of the R groups present in the molecule i.e their tendency to interact with water at a given pH.

- I. Amimmo Acids with non – polar R group :- The R group in this category of Amino Acids are hydrocarbon in nature and thus hydrophobic . This group includes five amino acids with aliphatic R group (Alanine, Valine, Leucine, Isoleucine, Proline) two with aromatic ring (Phenylalanine, Tryptophan) and one containing sulfur (Methionine) .

1. Alanine (α – aminopropionate)
2. Valine (α – aminoisovalerate)
3. Leucine (α – aminoisocaproate)
4. Isoleucine (α – amino- β methyl valerate)
5. Proline (δ pyrrolidine carboxylate)
6. Phenylalanine (α – amino – β phenylpropionate)

7. Tryptophan (α - amino - β 3 indolapropionate or β - indolylalanine)

8. Methionine (α - amino - β - methylcaprobutyrate)

II. Amino Acids with polar but uncharged R group .

9. Glycine (α - aminoacetate)

10. Serine (α - amino - β - hydroxypropionate)

11. Threonine (α - amino - β - hydroxybutyrate)

12. Tyrosine (α - amino - β - (P - hydroxyphenyl) propionate)

13. Cysteine (α - amino - β - mercaptopropionate)

14. Asparagine (β - amide of α - aminosuccinate)

15. Glutamine (γ - amide of α - aminoglutarate)

16. Aspartic acid (α - aminosuccinate)

17. Glutamic Acid (α - aminoglutarate)

III. Amino Acids with + vely charged (= basic) R groups.

18. Lysine

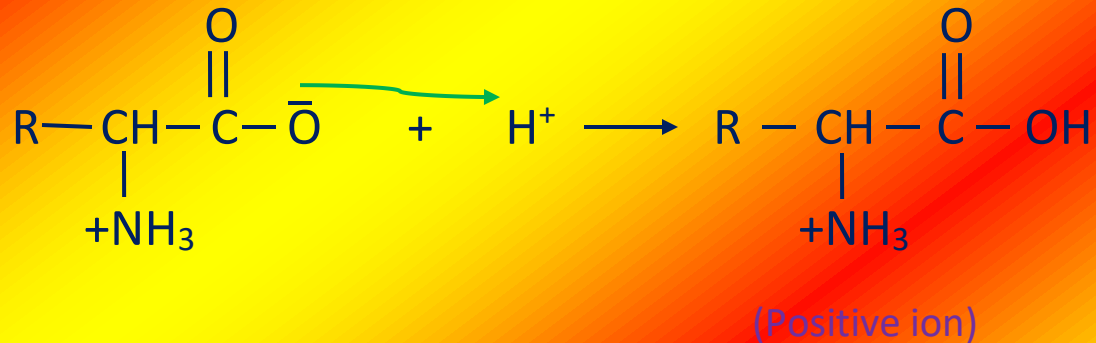
19. Arginine

20. Histidine

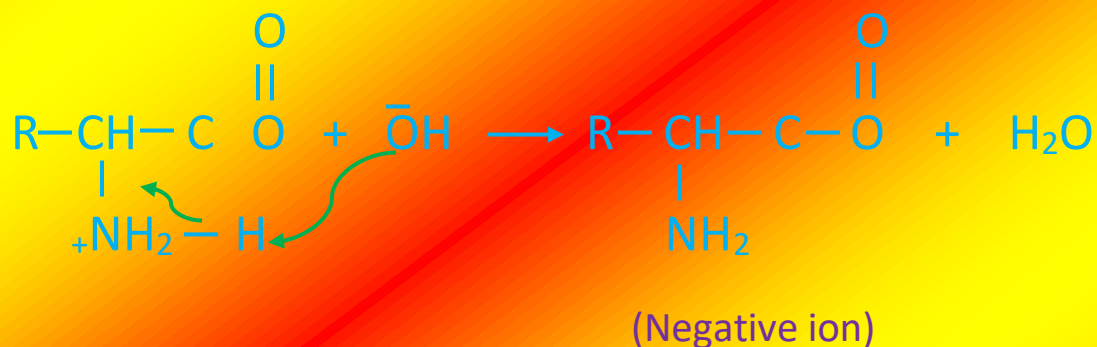
ISOELECTRIC POINT

Amino acids in the zwitterions form are amphoteric. That is, react readily with acids on bases. The reaction with bases converts the ammonium group $-(NH_3^+)$ into an amino group $(-NH_2)$. The reaction with acids converts the carboxylate group $-COO^-$ into a carboxyl group $(-COOH)$.

Amino acid in Acidic solution :-



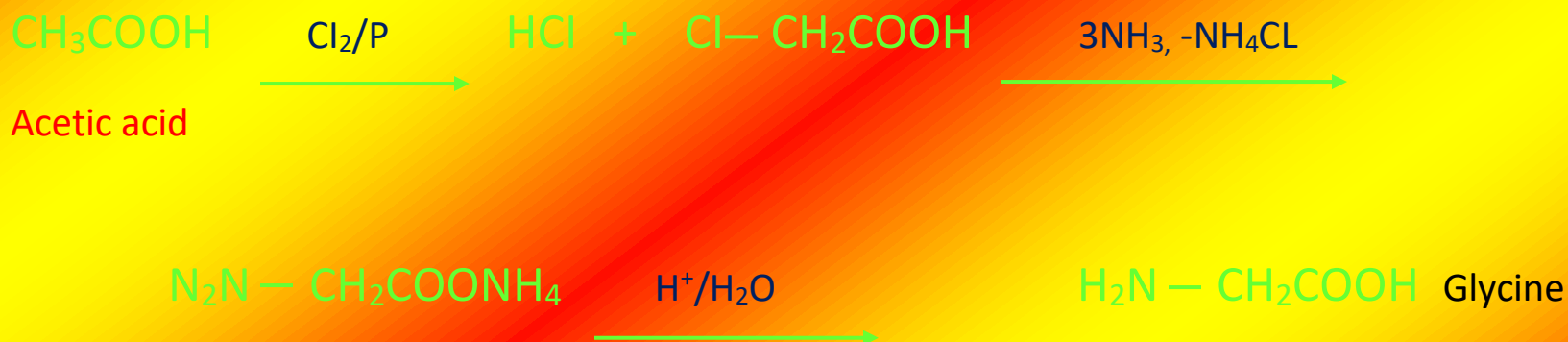
Amino acids in Basic solution :-



METHODS OF PREPARATION

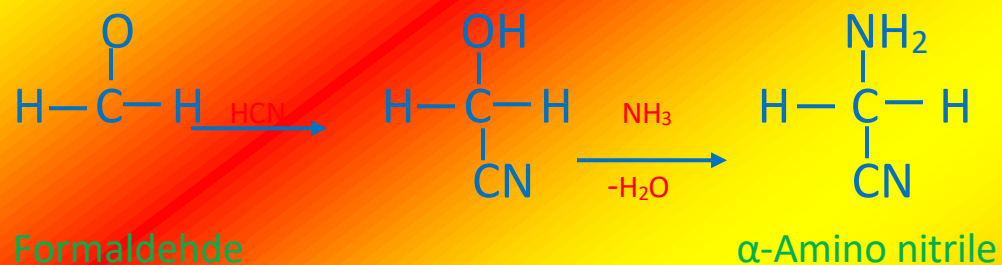
α -Amino acids are prepared by the following methods :

- (1) **Form Acids.** This involves three steps : (i) Acid converted into α -halo acid by Hello-Volhard-Zelinsky (HVZ) reaction ; (ii) α -Halo acid is treated with ammonia ; (iii) Ammonium salt is hydrolysed.



(2) **By Strecker synthesis.** This involves step :

Step 1. An aldehyde is treated with a mixture of HCN and ammonia.



Step 2. α -Amino nitrile is hydrolysed.



CHEMICAL PROPERTIES

Amino acids give reactions characteristic of both carboxylic acids and amines. α -Amino acids give the following reactions :

REACTIONS OF THE CARBOXYL GROUP

- (1) Salt Formation with NaOH
- (2) Reduction with LiAlH_4
- (3) Esterification
- (4) Salt Formation with Mineral Acids
- (5) Acylation
- (6) Reaction with Nitrous Acid ($\text{NaNO}_2 + \text{HCl}$)
- (7) Reaction with Formaldehyde
- (8) Reaction with 2,4-Dinitrofluorobenzene (DNFB).
- (9) Effect of Heat

Thank you