Chapter#13

Carboxylic Acids

1. How carboxylic acids are classified?

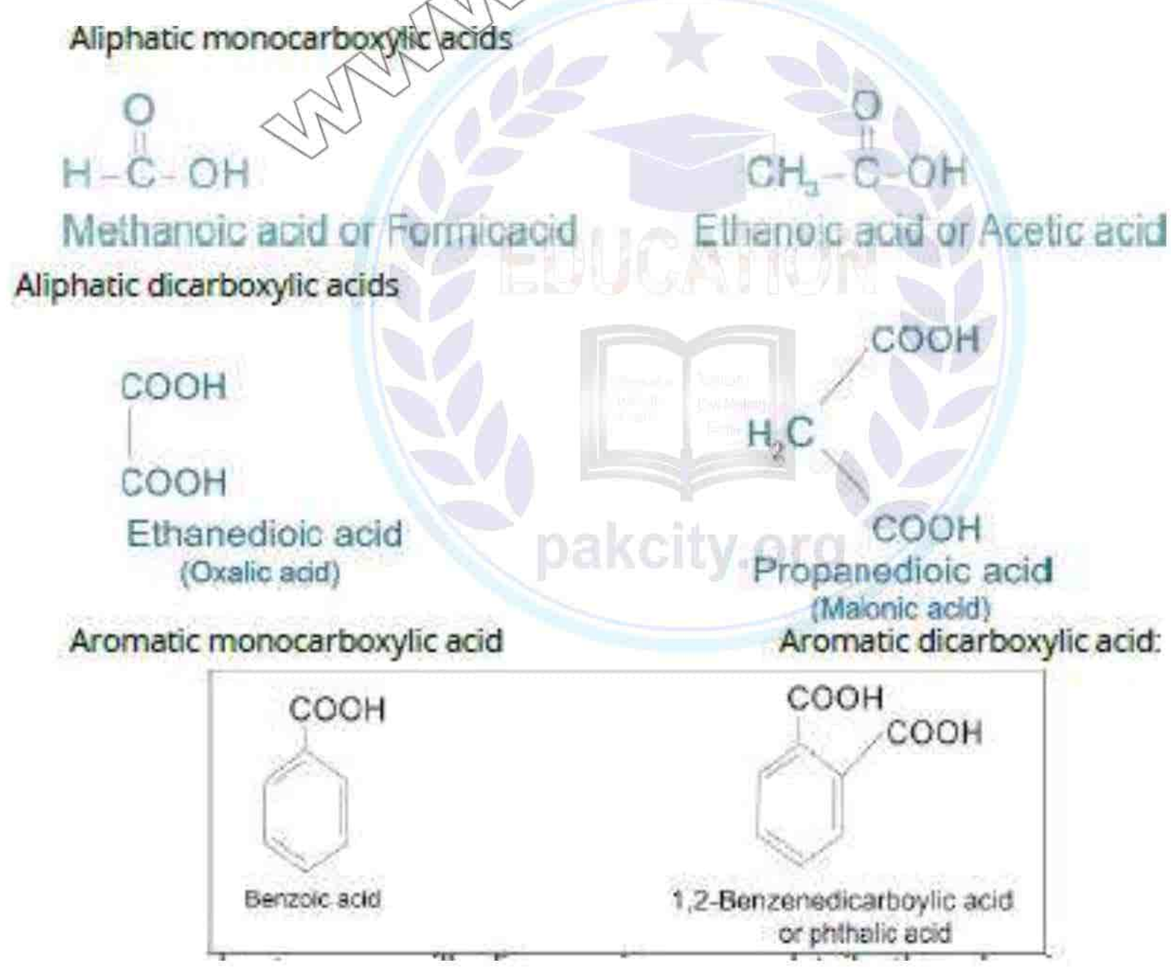
Ans: Carboxylic acid may be aliphatic or aromatic depending upon whether the –COOH group is attached to an alkyl group (or a hydrogen atom) or an aryl group.

Aliphatic carboxylic acid

RCOOH where R=H or an alkyl group

ArCOOH where Ar is a phenyl or an aryl group

Carboxylic acids are further classified as mono, di, tri or poly carboxylic acids as they contain one, two, three or many carboxyl groups respectively in their molecules.

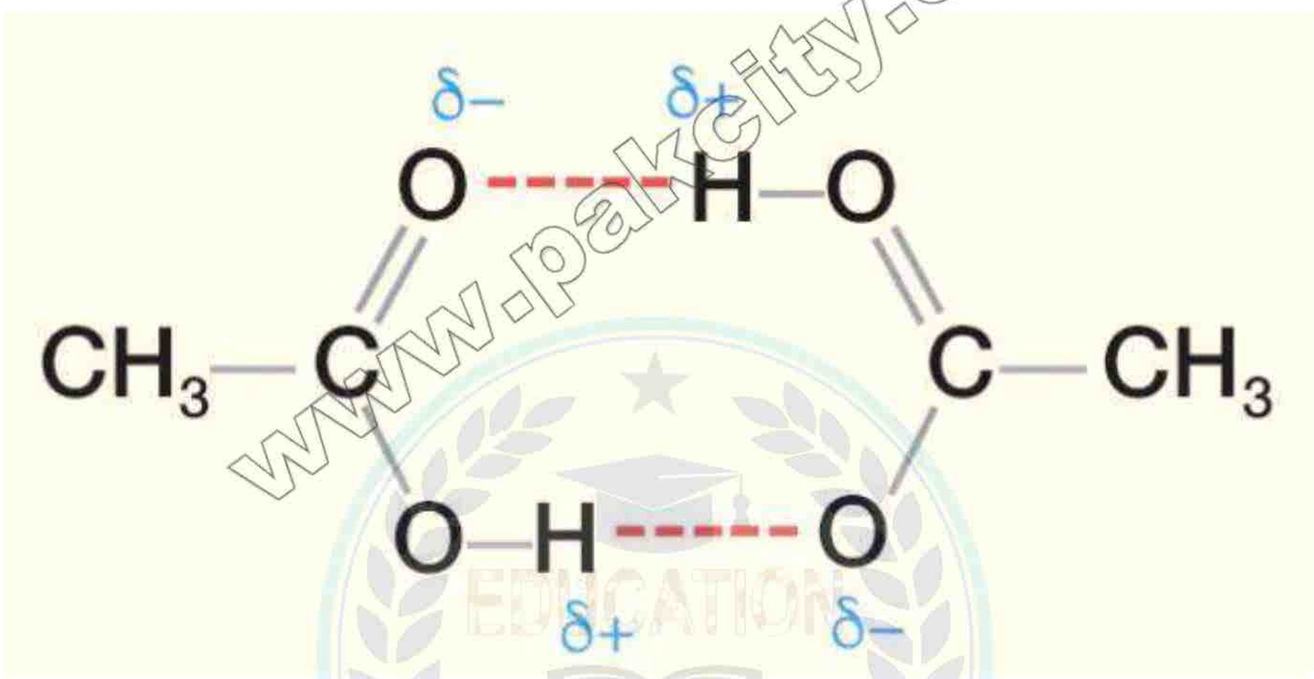


2. Why are lower carboxylic acids soluble in water?

Ans: Among the aliphatic acids, the first four members are very soluble in water due to hydrogen bonding.

3. The boiling points of carboxylic acids are relatively higher. Why?

Ans: The boiling points of carboxylic acids are relatively high due to intermolecular hydrogen bonding. The molecular mass determination in non-polar solvent like benzene shows that carboxylic acids exist as cyclic dimers.



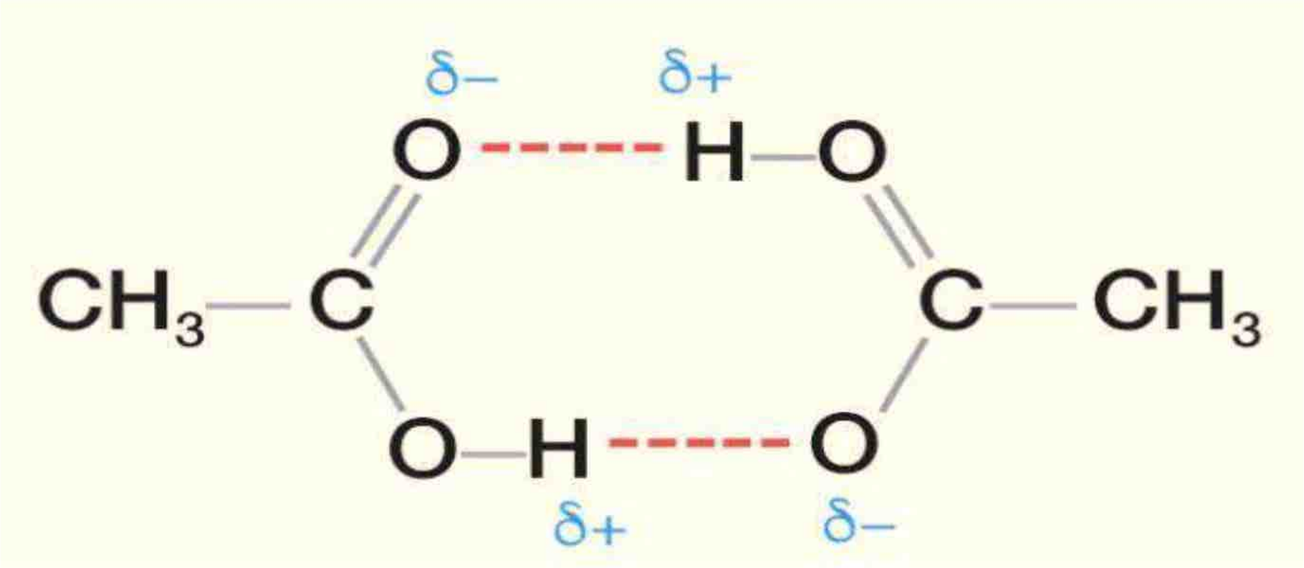
Boiling Points

HCOOH	CH_3COOH	C_2H_5COOH
373K(100°C)	391K(118°C)	424K(141°C)

4. Why do mostly carboxylic acids exist as dimers?

Ans: In pure carboxylic acids Hydrogen bonding can occur between two molecules of acid to produce a dimer. This immediately doubles the size of the molecule and so increases Vander Waals dispersion forces between one of these dimmers and its neighbours, resulting in a high

boiling point.



5. Tell about the trend of melting point of carboxylic acids.

Ans: The melting points of carboxylic acids increase irregularly with the increase in molecular mass. It has been observed that the melting points of carboxylic acids containing even number of carbon atoms are higher than the next lower and higher members containing odd number of carbon atoms e.g.,

	CH_3CH_2COOH (3 carbon)	$CH_3CH_2CH_2COOH$ (4 carbon)	$CH_3CH_2CH_2CH_2COOH$ (5 carbon)
Melting points	251K(-22°C)	267 K (-6°C)	237 K (-36°C)

6. Discuss reactivity of carboxylic acids.

Ans: The carboxyl group displays the chemistry of both the carbonyl and the hydroxyl groups. In most reactions of carboxylic acids the carboxyl group is retained, however, the reactivity of these molecules is a consequence of the presence of the carbonyl group. Carboxylic acids undergo the following type of reactions.

a) The reactions in which hydrogen atom of the carboxyl group is involved (salt formation).

b) The reactions in which OH group is replaced by another group.

c) The reactions involving carboxyl group as a whole.

7. What type of reactions do carboxylic acids give?

Ans: Carboxylic acids undergo the following type of reactions.

a) The reactions in which hydrogen atom of the carboxyl group is involved (salt formation).

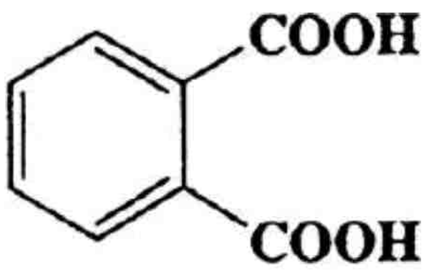
b) The reactions in which OH group is replaced by another group.

c) The reactions involving carboxyl group as a whole.

8. Write structural formula of Phthalic and Malonic acid.

Ans:

Phthalic acid



Malonic acid

9. What is glacial acetic acid?

Ans: The pure, anhydrous acetic acid, forming ice-like crystals at temperatures below 16.7°C, is called glacialacetic acid. (CH_3COOH).

10. Give uses of acetic acid (Mention any four as answer to short question)

Ans: Acetic acid is used:

i) As a coagulant for latex in rubber industry.

ii) In the manufacture of plastics (polyvinyl acetate) rayon (cellulose acetate) and silk.

iii) In medicine as a local irritant.

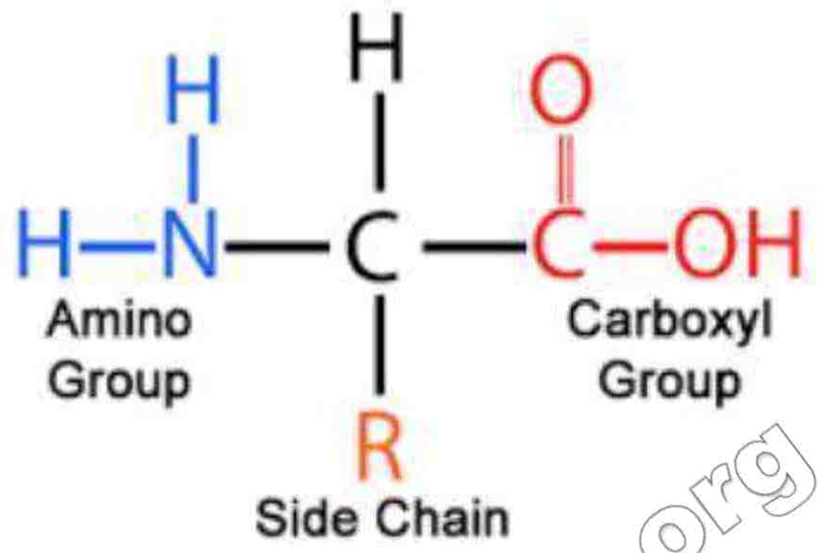
iv) As a solvent in the laboratory for carrying out reactions.

v) In the manufacture of pickles.

vi) In the manufacture of many organic compounds like acetone, acetates and esters.

11. Define amino acids? Give examples.

Ans: Amino acids are organic compounds containing both amino and carboxyl groups. They are represented by the general formula:



Examples are glycine and alanine.

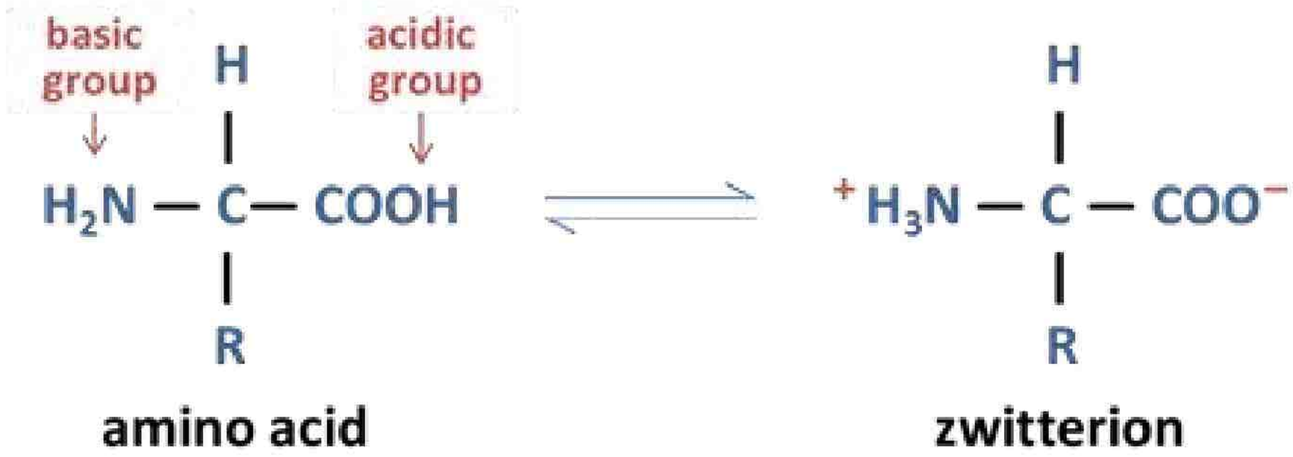
12. What is the difference between essential and non-essential amino acids?

Ans:

Essential amino acid	**Non-essential amino acids**
1. The amino acids which our body can't prepare are called essential amino acids.	1. The amino acids which our body can prepare are called non-essential amino acids.
2. These we have to take in to our diet for proper health and growth.	2. These are not required in diet.

13. Discuss structure of amino acids OR What is a zwitter ion Or What is internal salt?

Ans: The amino acids exist as dipolar ion called Zwitter ion. It has positive as well as negative ends within the same molecule. In the formation of Zwitter ion, the proton goes from the carboxyl group to amino group. The Zwitter ionic structure of an amino acid may be written as:

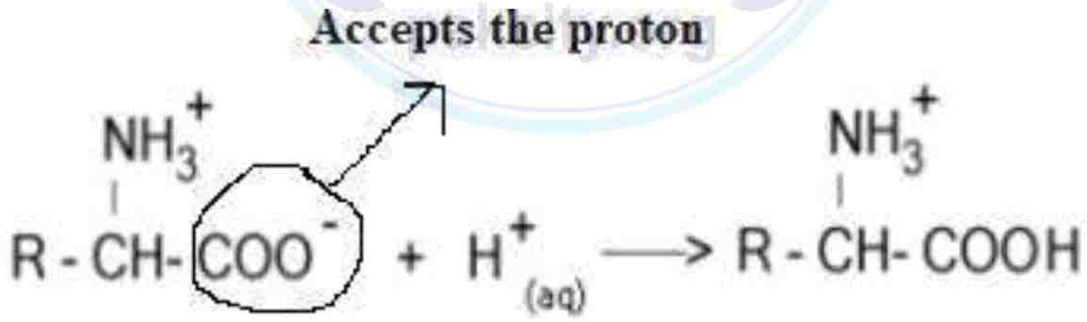


The dipolar structure is also called internal salt. All α - amino acids exist largely in dipolar ionic forms.

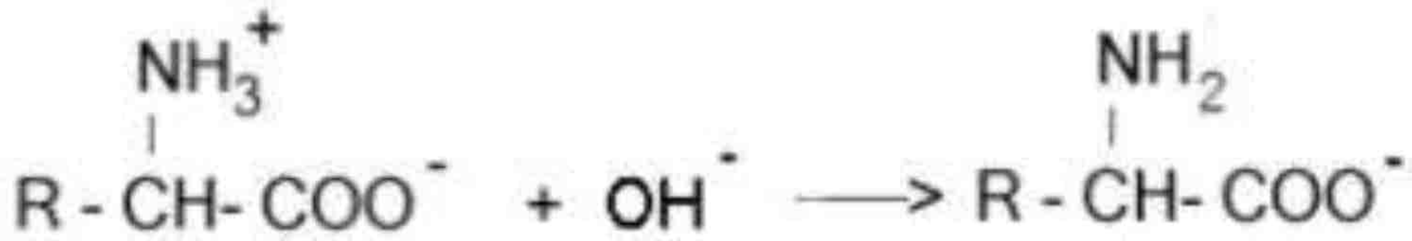
14. Discuss acidic and basic character of amino acids.

Ans: On the basis of dipolar ion structure, the acidic and basic reactions of amino acids may be represented as:

1. When an acid is added to an amino acid the carboxylate ion accepts the proton and, therefore, the basic character is due to this group.



2. When an alkali is added to an amino acid, NH_3 group releases the proton and therefore the acidic character is due to this group.



15. Differentiate between acidic and basic amino acids.

Ans:

Acidic amino acid	Basic amino acid
1. The amino acids which contain two carboxyl groups are called acidic amino acids.	1. The amino acids which contain two amino groups are called basic amino acids.
2. For example, Glutamic acid and Aspartic acid.	2. For example, Lysine and Histidine.

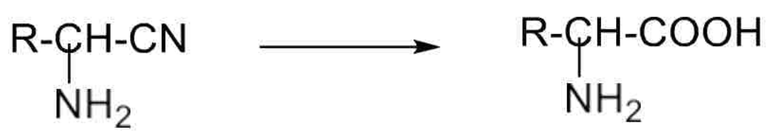
16. Define neutral amino acid with example.

Ans: Since an amino acid has both an amine and acid group which have been neutralized in the zwitter ion,the amino acid is neutral unless there is an extra acid or base on the side chain. If neither is present then the whole amino acid is neutral. eg. glycine, alanine, valine etc.

17. How amino acid is prepared by Strecker's synthesis?

Ans: When hydrogen cyanide is added to an aldehyde in the presence of ammonia α-amino acid is obtained:

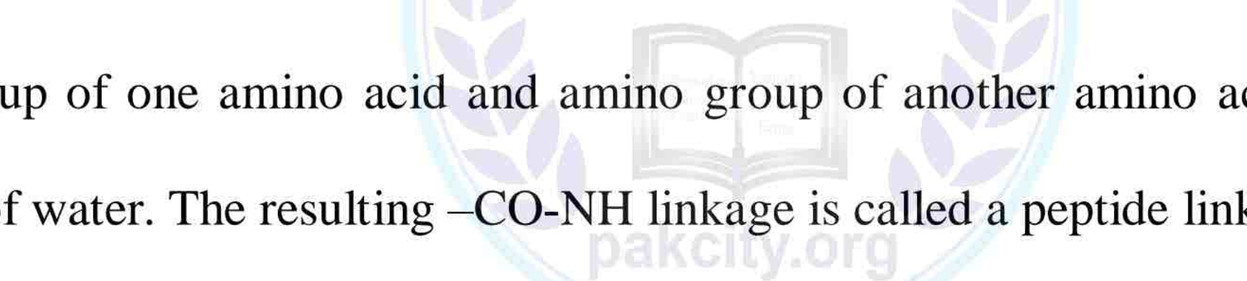
α-amino nitrile on acid hydrolysis yields an α-amino acid.



18. How carboxylic acids can be converted in to α-amino acid?

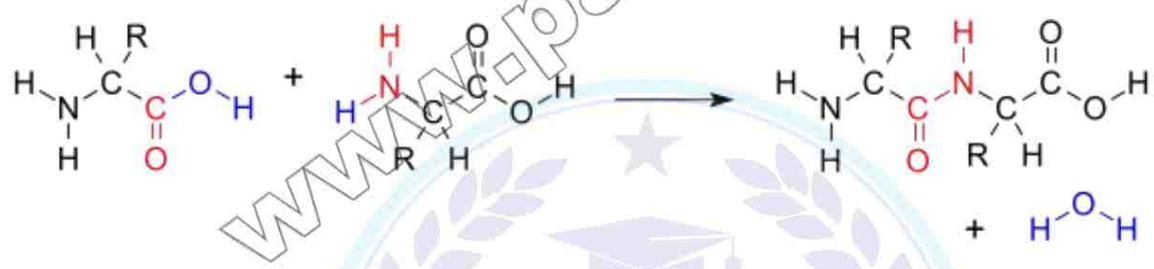
Ans: Amino acids can be synthesized by the reaction of α-bromo acid with ammonia.

Synthesis of Amino Acids
From α-Halo Carboxylic Acids



19. Define peptides.

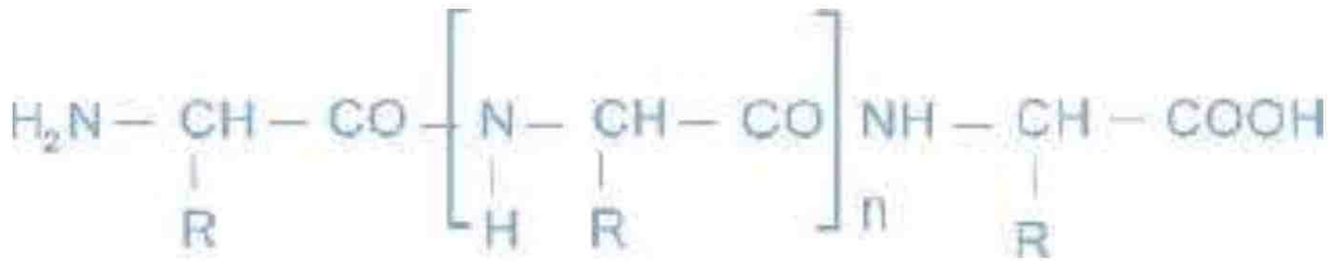
Ans: Peptides are the compounds formed by the condensation of two or more same or different α-amino acids.



The condensation occurs between amino acids with the elimination of water. In this case, the carboxyl group of one amino acid and amino group of another amino acid gets condensed with elimination of water. The resulting –CO-NH linkage is called a peptide linkage.

20. Define polypeptide.

Ans: If a large number of amino acids (hundreds to thousands) are joined by peptide bonds, the resulting polyamide is called a polypeptide.



21. Define protein.

Ans: The formation of peptide bonds can continue until a molecule containing several hundred thousand amino acids is formed. Such a molecule is called polypeptide or protein.

22. What is the difference between a protein and a polypeptide?

Ans: A peptide having molecular mass up to 10,000 is called a polypeptide while a peptide having a molecular mass more than 10,000 is called a protein.

23. What are α-amino acids, proteins and peptides? How are they related?

Ans:

α-Amino Acids

The acids in which amino groups are attached to α-carbon are called α-amino acids. Example

Proteins

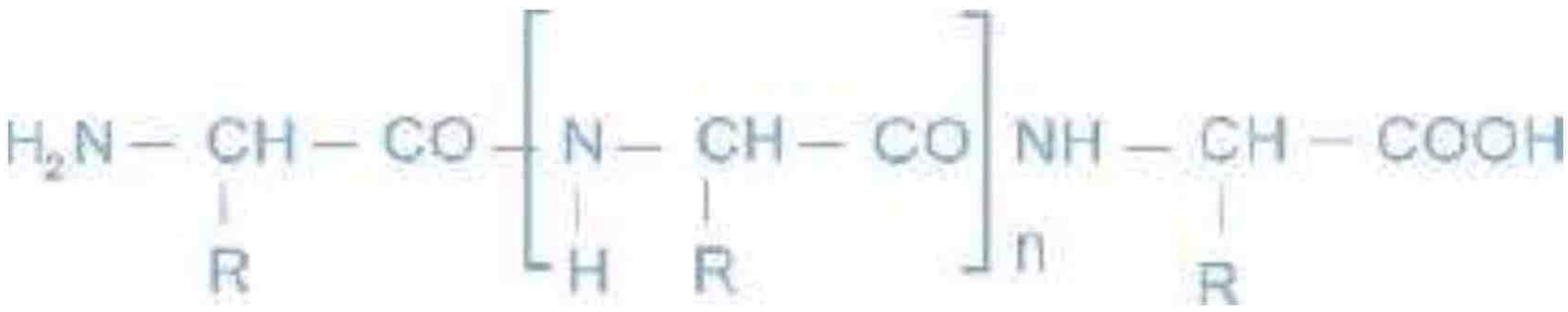
If the molecular mass of a polypeptide chain is more than 10000 then it is called proteins

Peptide

If the molecular mass of a polypeptide chain is up to 10000 then it is called peptide.

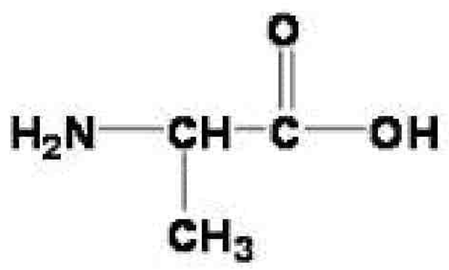
Relation

When amino acids link with each other through a peptide bond a long chain of polypeptide is formed.

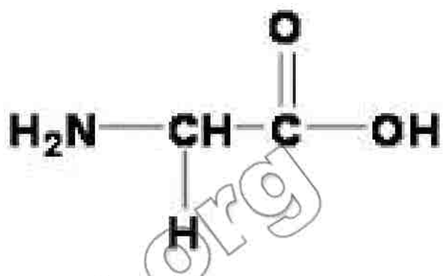


24. Write formulae of glycine and alanine.

Ans:



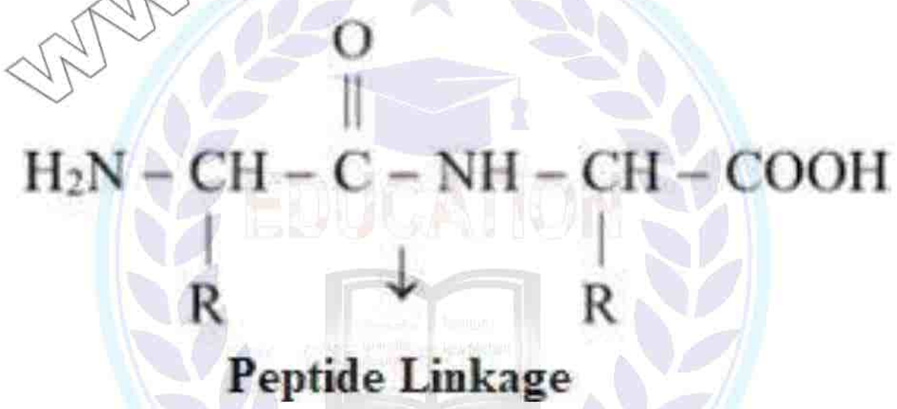
alanine



glycine

25. Write down the formula of a dipeptide.

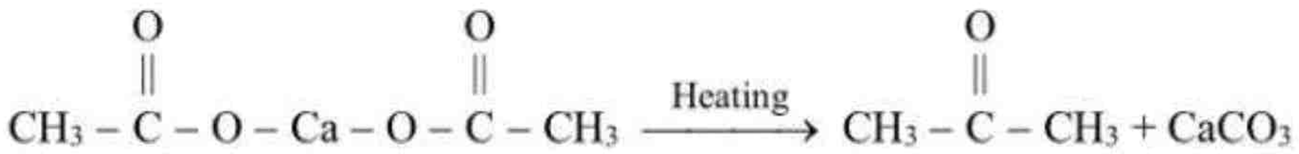
Ans: Following is the formula of a dipeptide:



Peptide Linkage

26. What happens when calcium acetate is heated?

Ans: Calcium acetate on heating produce acetone.



27. What happens when sodium formate and soda lime are heated?

Ans: Sodium formate on heating with soda lime produces sodium carbonate and hydrogen.

$$HCOONa + NaOH \xrightarrow[CaO]{Heat} Na_2CO_3 + H_2$$

28. What happens when ammonium acetate is heated?

Ans: Ammonium acetate on heating produces acetamide.

$$CH_3-\overset{\overset{O}{\|}}{C}-ONH_4 \xrightarrow{Heat} CH_3-\overset{\overset{O}{\|}}{C}-NH_2 + H_2O$$

29. How will you convert acetic acid in to acetamide?

Ans: Acetic acid react with ammonia to form ammonium salts which on heating produce acetamide

$$CH_3COOH + NH_3 \longrightarrow CH_3COONH_4$$

$$CH_3COONH_4 \xrightarrow{\Delta} CH_3CONH_2 + H_2O$$

30. How will you convert acetic acid to acetone?

Ans: This conversion involves two steps:

$$2CH_3COOH + Ca(OH)_2 \longrightarrow CH_3COOCaOOCCH_3 + 2H_2O$$

$$CH_3COOCaOOCCH_3 \xrightarrow{\text{Dry distillation}} CH_3COCH_3 + CaCO_3$$

31. What are Fatty acids? How acid chlorides are made by them?

Ans: The aliphatic mono carboxylic acids are commonly called fatty acids, because higher membersof this series such as palmitic acid, stearic acid etc. are obtained by the hydrolysis of fats and oils.

Formation of acid chlorides:

Acid chlorides can be made by reacting mono carboxylic acids with phosphorous penta chloride or with thionyl chloride as follows.

$CH_3COOH + PCl_5 \longrightarrow CH_3COCl + POCl_3 + HCl$

$CH_3COOH + SOCl_2 \longrightarrow CH_3COCl + SO_2 + HCl$

32. Write reactions of acetic acid with HI/red P and NH_3/heat.

Ans:

HI/red phosphorus:

Acetic acid on reduction with HI and red phosphorus give ethane.

$CH_3COOH + 6HI \longrightarrow CH_3—CH_3 + 2H_2O + 3I_2$

NH_3/ heat :

Acetic acid react with ammonia to form ammonium salts which on heating produce acid amides

$CH_3COOH + NH_3 \longrightarrow CH_3COONH_4$

$CH_3COONH_4 \xrightarrow{\Delta} CH_3CONH_2 + H_2O$

33. How will you convert acetic acid in to methane and acetic anhydride?

Ans:

Acetic acid to Methane:

Acetic acid is treated with sodium hydroxide to form sodium acetate and water.

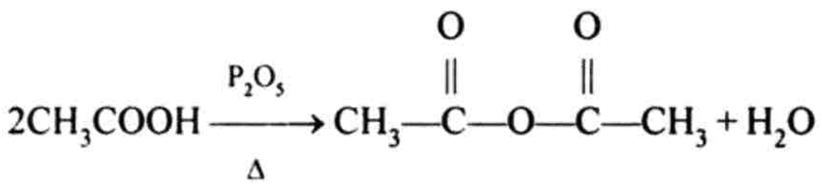
$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{NaOH} \longrightarrow \underset{\text{Sodium ethanoate}}{CH_3COONa} + \underset{\text{Water}}{H_2O}$$

Then, sodium ethanoate is heated with sodalime to get methane.

$$\underset{\text{Sodium ethanoate}}{CH_3COONa} + \underset{\substack{\text{Sodium hydroxide}\\\text{(from sodalime)}}}{NaOH} \longrightarrow \underset{\text{Methane}}{CH_4} + \underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3}$$

Acetic acid to acetic anhydride:

Acetic acid dehydrates on heating strongly in the presence of phosphorus pentaoxide.



34. How carboxylic acids can be obtained from Alkene?

Ans:

Oxidative cleavage of alkenes

Alkenes when heated with alkaline $KMnO_4$ are cleavaged at the double bond to form Carboxylic acids.

$$H_3C\text{-}CH{=}CH\text{-}CH_3 + 4[O] \longrightarrow 2CH_3COOH$$

2-butene ethanoic acid

35. How acetic acid reacts with PCl_5 and $SOCl_2$?

Ans:

PCl_3:

Acetic acid reacts with phosphorus trichloride to give acid halide.

$$3CH_3COOH + PCl_3 \longrightarrow 3CH_3COCl + H_3PO_3$$

$SOCl_2$:

Acetic acid reacts with thionyl chloride to give acid halide.$CH_3COOH + SOCl_2 \longrightarrow CH_3COCl + SO_2 +$ HCl

36. Write down structural formulas of the following:

(i) Valeric acid (ii) Propionic acid (iii) Oxalic acid
(iv) Benzoic acid (v) Acetic anhydride (vi) Acetyl chloride

Ans:

Name	Structural Formula
Valeric acid	$H_3C - CH_2 - CH_2 - CH_2 - COOH$
Propionic acid	$H_3C-CH_2-\overset{\overset{O}{\|}}{C}-OH$
Oxalic acid	$\begin{matrix} COOH \\ \vert \\ COOH \end{matrix}$
Benzoic acid	$C_6H_5 - \overset{\overset{O}{\|}}{C} - OH$
Acetic anhydride	$H_3C - \overset{\overset{O}{\|}}{C} - O - \overset{\overset{O}{\|}}{C} - CH_3$
Acetyl chloride	$H_3C - \overset{\overset{O}{\|}}{C} - Cl$

37. Write down the names of the following compounds by IUPAC.

Ans:

Structure	IUPAC Name
$HOOC - CH_2 - COOH$	1, 3-propane dioic acid.
	1, 3-benzene dicarboxylic acid
$H - \overset{\overset{O}{\|}}{C} - OH$	Methanoic acid
$CH_3 - COOC_2H_5$	Ethyl acetate
$NH_2 - CH_2 - COOH$	α-aminoethanoic acid
$HCOOC_3H_7$	n-propyl formate