BIOMOLECULES

TOPIC-1

Carbohydrates

VERY SHORT ANSWER QUESTIONS

1. Define carbohydrates.

Ans: Old Definition: The group of compounds known as carbohydrates received their general name because of early observations that they often have the formula $C_x(H_2O)_y$ - that is, they appear to be hydrates of carbon.

New definition: Carbohydrates are defined as polyhydroxy aldehydes or polyhydroxy ketones or substances which give these on hydrolysis and contain at least one chiral carbon atom. It may be noted here that aldehydic and ketonic groups in carbohydrates are not present as such but usually exist in combination with one of the hydroxyl group of the molecule in the form of hemiacetals and hemiketals respectively.

2. **What are the limitations of old definition?**

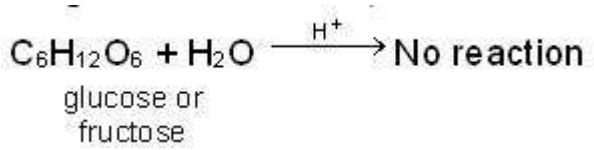
Ans: Limitations of the old definition: The above definition could not survive long due to the following reasons:

(i) A number of compounds such as rhamnose, ($C_6H_{12}O_5$) and 2-deoxyribose ($C_5H_{10}O_4$) are known which are carbohydrates by their chemical behaviour but cannot be represented as hydrates of carbon.

(ii) There are other substances like formaldehyde (HCHO, CH_2O) and acetic acid [CH_3COOH, $C_2(H_2O)_2$] which do not behave like carbohydrates but can be represented by the general formula, $C_x(H_2O)_y$.

3. What are monosachharides?

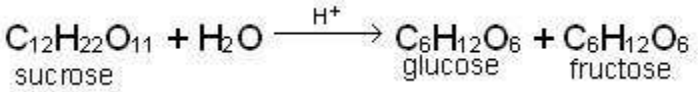
Ans: **Monosaccharides**: The monosaccharides are polyhydroxy aldehydes or polyhydroxy ketones which cannot be decomposed by hydrolysis to give simpler carbohydrates. Examples are glucose and fructose, both of which have molecular formula, $C_6H_{12}O_6$.

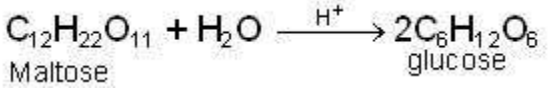


4. What are oligo sachharides?

Ans: **Oligosaccharides**: The oligosaccharides (Greek, oligo, few) are carbohydrates which yield a definite number (2-9) of monosaccharide molecules on hydrolysis. They include,

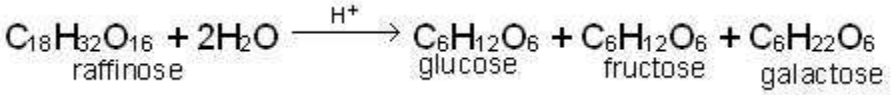
(a) Disaccharides, which yield two monosaccharide molecules on hydrolysis. Examples are sucrose and maltose, both of which have molecular formula, $C_{12}H_{22}O_{11}$.





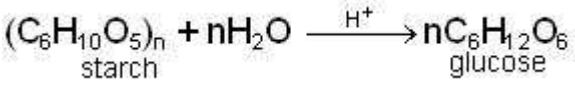
5. What are tri-sachharides?

Ans: **Trisaccharides,** which yield three monosaccharide molecules on hydrolysis. Example is raffinose, which has molecular formula, $C_{18}H_{32}O_{16}$.



6. What are poly-sachharides?

Ans: Polysaccharides: The polysaccahrides are carbohydrates of high molecular weight which yield many monosaccharide molecules on hydrolysis. Examples are starch and cellulose, both of which have molecular formula, $(C_6H_{10}O5)_n$.

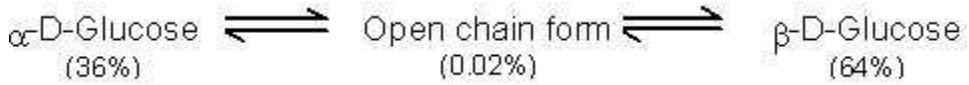


In general, the monosaccharides and oligosaccharides are crystalline solids, soluble in water and sweet to taste. They are collectively known as sugars. The polysaccharides, on the other hand, are amorphous, insoluble in water and tasteless. They are called non-sugars. The carbohydrates may also be classified as either reducing or non-reducing sugars. All those carbohydrates which have the ability to reduce Fehling's solution and Tollen's reagent are referred to as reducing sugars, while others are non-reducing sugars. All monosaccharides and the disaccharides other than sucrose are reducing sugars.

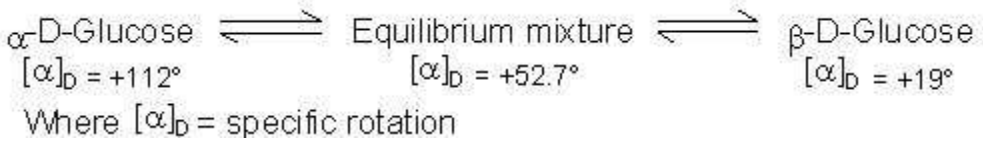
7. Explain mutarotation.

Ans: **MUTAROTATION**

The two stereoisomeric forms of glucose, i.e., α-D-glucose and β-D-glucose exist in separate crystalline forms and thus have different melting points and specific roations. For example α-D-glucose has a m.p. of 419 K with a specific rotation of +112° while β-D-glucose has a m.p. of 424 K and has a specific rotation of +19°. However, when either of these two forms is dissolved in water and allowed to stand, it gets converted into an equilibrium mixture of α-and β-forms through a small amount of the open chain form.



As a result of this equilibrium, the specific rotation of a freshly prepared solution of α-D-glucose gradually decreases from of +112° to +52.7° and that of β-D-glucose gradually increases from +19° to +52.7°.



This change in specific rotation of an optically active compound in solution with time, to an equilibrium value, is called mutarotation. During mutarotation, the ring opens and then recloses either in the inverted position or in the original position giving a mixture of α-and-β-forms. All reducing carbohydrates, i.e., monosaccharides and disacchardies (maltose, lactose etc.) undergo mutarotation in aqueous solution.

8. **Explain the classificatio of carbohydrates based on taste.**

Ans: Sugars: Sugars are monosaccharides and oligosaccharides are crystalline solids soluble in water and sweet in taste are called sugars.

Nonsugars : These are polysaccharides which are amorphous solids insoluble in water and taste less called reducing sugars while others which do not reduced.

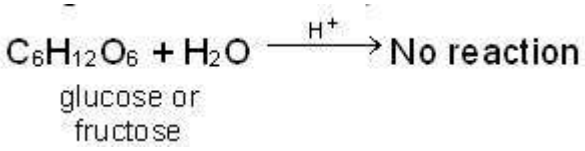
SHORT ANSWER QUESTIONS

1. Explain the classification of Carbohydrates.

Ans: Classification Of Carbohydrates

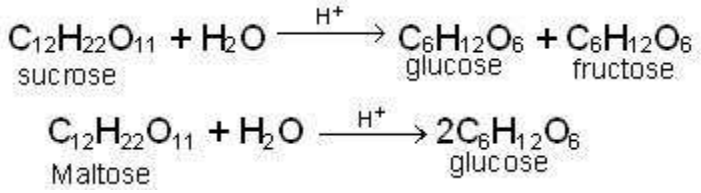
The carbohydrates are divided into three major classes depending upon whether or not they undergo hydrolysis, and if they do, on the number of products formed.

(i) **Monosaccharides**: The monosaccharides are polyhydroxy aldehydes or polyhydroxy ketones which cannot be decomposed by hydrolysis to give simpler carbohydrates. Examples are glucose and fructose, both of which have molecular formula, $C_6H_{12}O_6$.

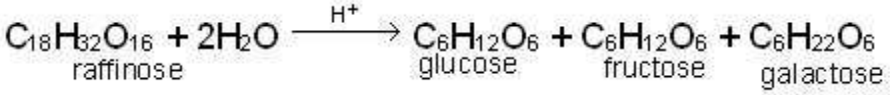


ii) **Oligosaccharides**: The oligosaccharides (Greek, oligo, few) are carbohydrates which yield a definite number (2-9) of monosaccharide molecules on hydrolysis. They include,

(a) Disaccharides, which yield two monosaccharide molecules on hydrolysis. Examples are sucrose and maltose, both of which have molecular formula, $C_{12}H_{22}O_{11}$.

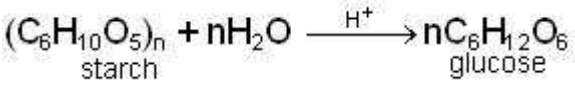


(b) **Trisaccharides**, which yield three monosaccharide molecules on hydrolysis. Example is raffinose, which has molecular formula, $C_{18}H_{32}O_{16}$.



(c) **Tetrasaccharides**, etc.

(iii) Polysaccharides: The polysaccahrides are carbohydrates of high molecular weight which yield many monosaccharide molecules on hydrolysis. Examples are starch and cellulose, both of which have molecular formula, $(C_6H_{10}O5)_n$.

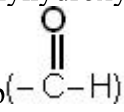


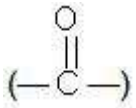
In general, the monosaccharides and oligosaccharides are crystalline solids, soluble in water and sweet to taste. They are collectively known as sugars. The polysaccharides, on the other hand, are amorphous, insoluble in water and tasteless. They are called non-sugars. The carbohydrates may also be classified as either reducing or non-reducing sugars. All those carbohydrates which have the ability to reduce Fehling's solution and Tollen's reagent are referred to as reducing sugars, while others are non-reducing sugars. All monosaccharides and the disaccharides other than sucrose are reducing sugars.

2. Explain how mono-sachharideas are classified.

Ans: MONOSACCHARIDES

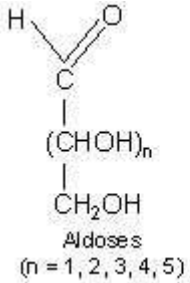
The monosaccharides are the basis of carbohydrate chemistry since all carbohydrates are either monosaccharides or are converted into monosaccharides on hydrolysis. The monosaccharides are polyhydroxy aldehydes or polyhydroxy ketones. There are,

1. The Aldoses, which contain an aldehyde group 

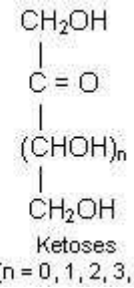
2. The Ketoses, which contain a ketone group 

The aldoses and ketoses are further divided into sub-groups on the basis of the number of carbon atoms in their molecules, as trioses, tetroses, pentoses, hexoses, etc. To classify a monosaccharide completely, it is necessary to specify both, the type of the carbonyl group and the number of carbon atoms present in the molecule. Thus monosaccharides are generally referred to as aldotrioses, aldotetroses, aldopentoses, aldohexoses, ketohexoses, etc.

The aldoses and ketoses may be represented by the following general formulas.

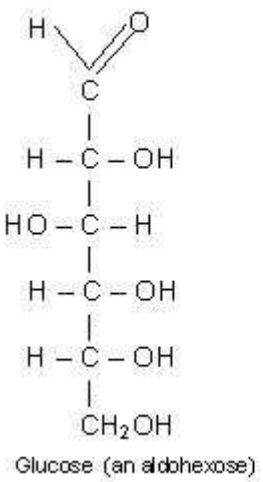


Aldoses
(n = 1, 2, 3, 4, 5)

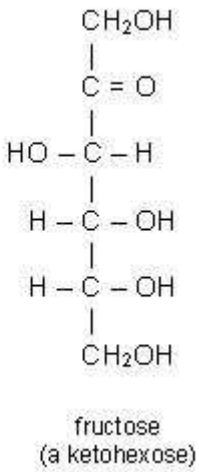


Ketoses
(n = 0, 1, 2, 3, 4)

Glucose and fructose are specific examples of an aldose and a ketose.



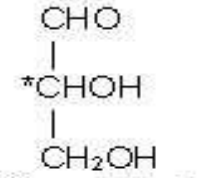
Glucose (an aldohexose)



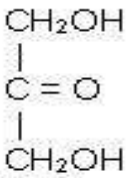
fructose
(a ketohexose)

3. **Explain what are trioses?**

Ans: **<u>Trioses</u> :** D and L Terminology: The simplest of all carbohydrates that fit the definition we have given for carbohydrates are the trioses, glyceraldehyde and dihydroxyacetone. Glyceraldehyde is aldotriose, and dihydroxyacetone is a ketotriose.

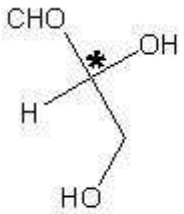


Glyceraldehyde
(an aldotriose)

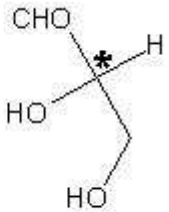


Dihydroxyacetone
(a ketotriose)

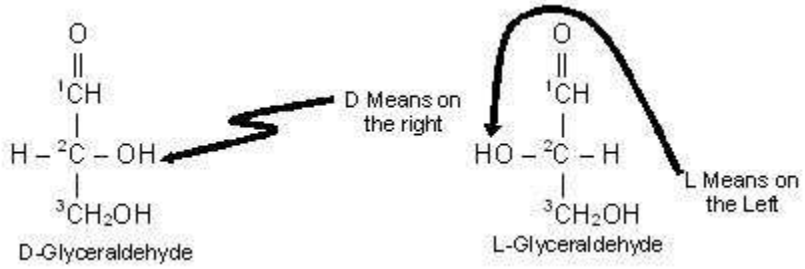
Glyceraldehyde cont¬ains one asymmetric carbon atom (marked by an asterisk) and can thus exist in two optically active forms, called the D-form and the L-form. Clearly, the two forms are mirror images that cannot be superimposed, that is they are enantiomers.



D-Glyceraldehyde

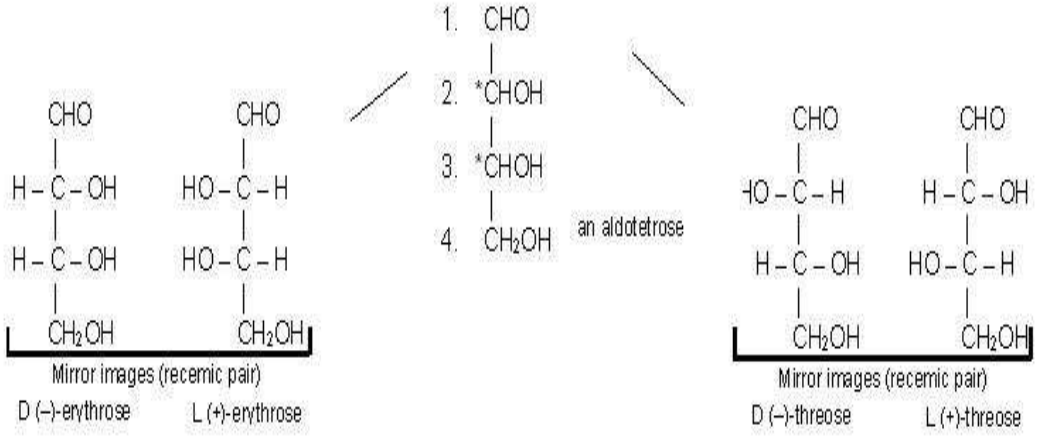


L-Glyceraldehyde



4. **Explain what are aldotetroses?**

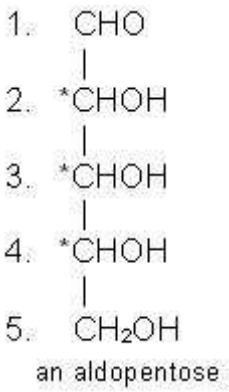
Ans: **Aldotetroses:** If we examine the general formula of an aldotetrose, we see that they contain two asymmetric carbon atoms (marked by asterisks).
This means that 2^2 or 4 optical isomers are possible. They may be represented as the following two pairs:



All four isomers have been prepared synthetically. The D- and L-erythrose are mirror images, that is, they are enantiomers. They have exactly the same degree of rotation but in opposite directions. Equal amounts of the two would constitute a racemic mixture, that is, a mixture that would allow a plane-polarised light to pass through the solution unchanged but could be separated into detrorotatory and laevorotatory isomers. The same comments hold for D- and L-threose. However, D-erythrose and L-threose are not images, that is, they are diastereomers (optical isomers that are not mirror images are called diastereomers), and the degree of rotation of each would probably differ.

5. **Explain what are aldopentoses?**

Ans: **Aldopentoses :** If we examine the general formula of an aldopentose, we see that they contain three asymmetric carbon atoms.
This means that 2^3 or 8 optical isomers are possible. These are:
- D(–) xylose, L(+)-xylose, D(–) xylose, L(–)xylose, D(–) arabinose, L(+)-arabinose, D(–)-ribose, L(+)-ribose

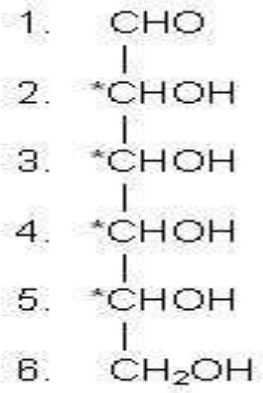


an aldopentose

6. Explain what are aldohexoses?

Ans: **Aldohexoses: If** we examine the general formula of aldohexose, we see that it contains four asymmetric carbon atoms. This means that 2^4 or 16 optical isomers are possible. D and L forms of altrose, allose glucose, mannose, galactose, talose, arabinose and idose

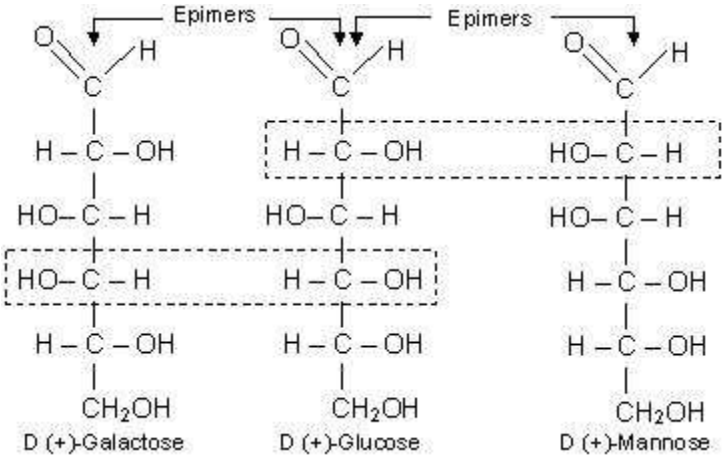
Only three of the sixteen possible aldohexoses are found in nature (all sixteen isomers have been prepared synthetically). They are D-glucose, D- mannose, and D-galactose. No one of these three optical iosmers is a mirror image of any of the others, so all three are diastereomers of each other.



an aldohexose

7. **Explain what are epimers?**

Ans: **Epimers** : A pair of diastereomers that differ only in the configuration about of a single carbon atom are said to be epimers. e.g D(+)- glucose is epimeric with D(+) -mannose and D(+) -galactose as shown below:

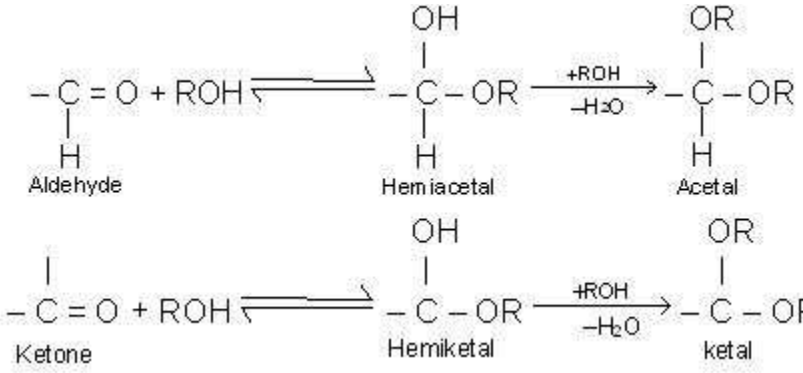


LONG ANSWER QUESTIONS

1. Explain the structure of Glucose.

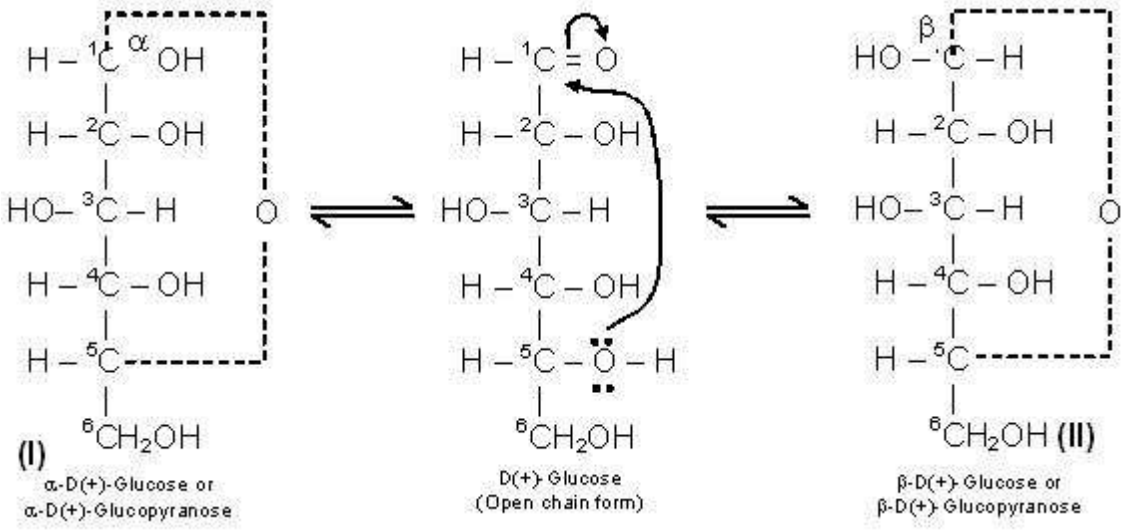
Ans: Cyclic structure of Monosaccharides

We know that aldoses (and ketoses) react with alcohols to give first hemiacetals (and hemiketals) and then acetals (and ketals), i.e.



Since monosaccharides contain a number of hydroxyl groups and an aldehyde or a keto group, therefore, any one of the –OH groups (usually C4 or C5 in aldohexoses and C5 or C6 in ketohexoses) may combine with the aldehyde or the keto group to form intramolecular hemiacetal or hemiketal.

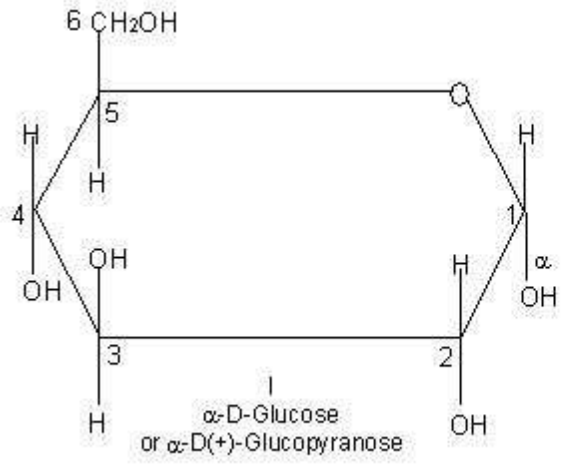
Cyclic Structure of Glucose – Anomers

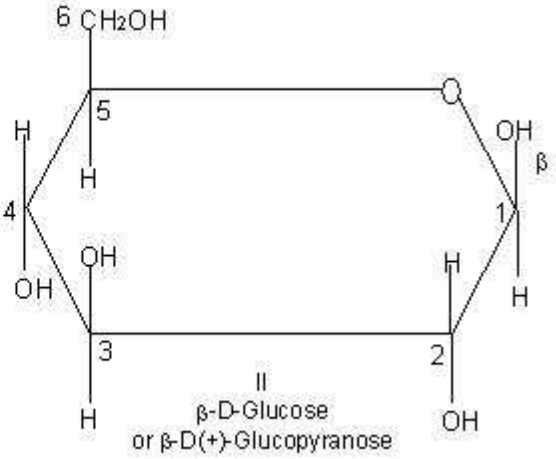


We know monosaccharides have cyclic hemiacetal or hemiketal structures. To illustrate, let us first consider the example of D-glucose. During hemiacetal formation C_5 – OH of glucose combines with the C_1 – aldehydic group. As a result, C_1 becomes chiral or asymmetric and thus has two possible arrangements of H and OH groups around it. In other words, D-glucose exists in two stereoisomeric forms, i.e., α-D-glucose and β-D-glucose as shown below:

In α-D-glucose, the OH group at C_1 is towards right while in β-D-glucose, the OH group at C_1 is towards left. Such pair of stereoisomers which differ in configuration only around C_1 are called anomers and the C_1 carbon is called Anomeric carbon (or glycosidic carbon. The cyclic structures of monosaccharides can be better represented by Haworth Projection formulae. To get such a formula for any monosaccharide (say α-and β-D-glucose), draw a hexagon with its oxygen atom at the upper right hand corner. Place all the groups (on C_1, C_2, C_3 and C_4) which are present on left hand side in structures I and II, above the plane of the ring and all those groups on the right hand side below the plane of the ring.

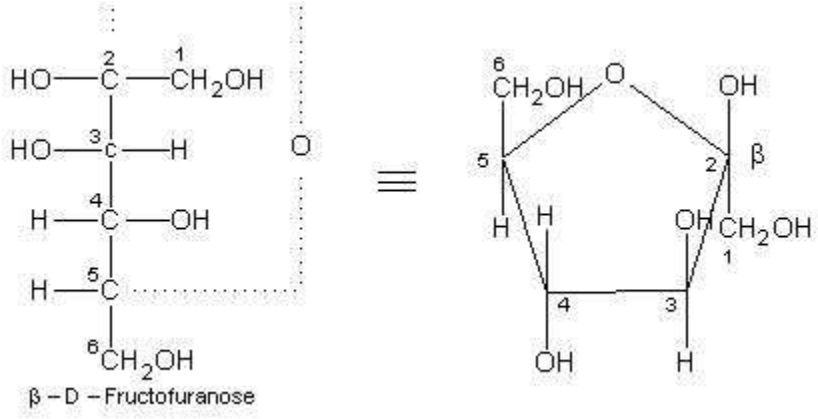
The terminal – CH_2OH group is always placed above the plane of the hexagon ring (in D-series). Following the above procedure, Haworth Projection Formulae for α-D-glucose (I) and β-D-glucose (II) are obtained as shown below:





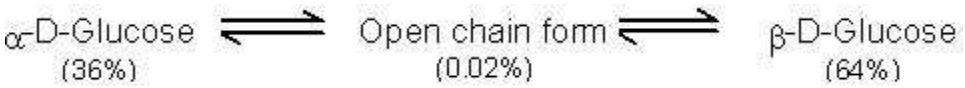
2. **Explain the structure of Fructose.**

Ans: **<u>Cyclic structure of Fructose:</u>** Like glucose, fructose also has a cyclic structure. Since fructose contains a keto group, it forms an intra molecular hemiketal. In the hemiketal formation, C_5– OH of the fructose combines with C_2-keto group. As a result, C_2 becomes chiral and thus has two possible arrangements of CH_2OH and OH group around it. Thus, D-fructose exists in two stereoisomeric forms, i.e., α-D-fructopyranose and β-D fructopyranose. However in the combined state (such as sucrose), fructose exists in furanose form as shown below:

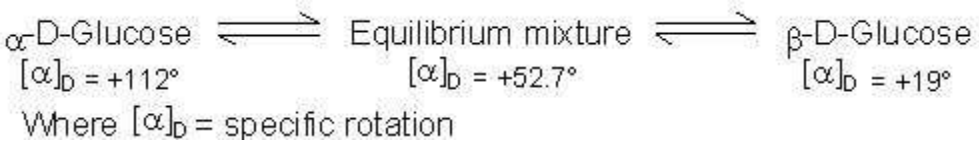


<u>MUTAROTATION</u>

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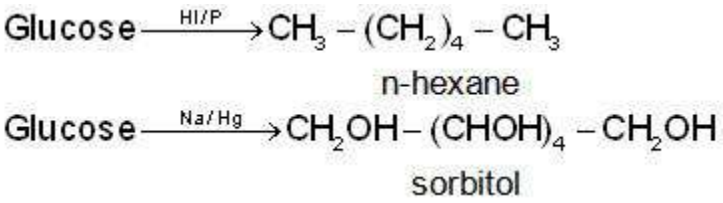


This change in specific rotation of an optically active compound in solution with time, to an equilibrium value, is called mutarotation. During mutarotation, the ring opens and then recloses either in the inverted position or in the original position giving a mixture of α-and-β-forms. All reducing carbohydrates, i.e., monosaccharides and disacchardies (maltose, lactose etc.) undergo mutarotation in aqueous solution.

3. **Explain the reactions of Glucose.**

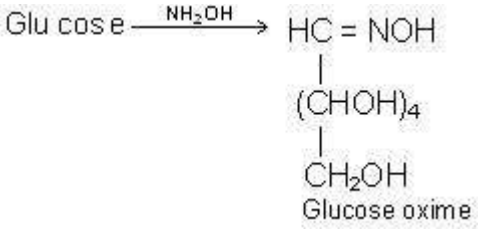
Ans: **<u>REACTIONS OF GLUCOSE</u>**

(a) **With HI/P**: It undergoes reduction to form n-hexane while with sodium amalgam it forms sorbitol.

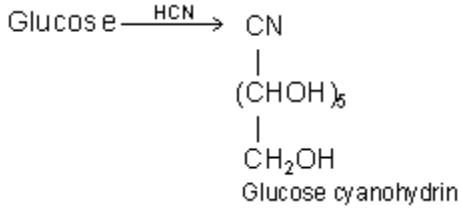


(b) **With H_2O**: It forms neutral solution

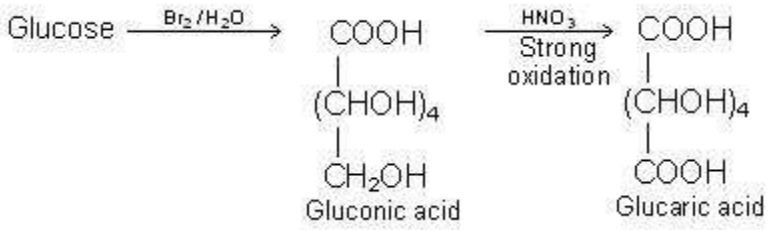
(c) **With Hydroxylamine (NH_2OH)**



(d) **With HCN**: It forms addition product cyanohydrin

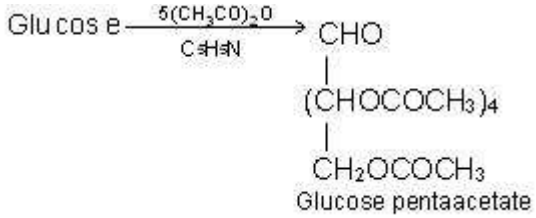


(e) **Oxidation**: Glucose on oxidation with Br_2 gives gluconic acid which on further oxidation with HNO_3 gives glucaric acid

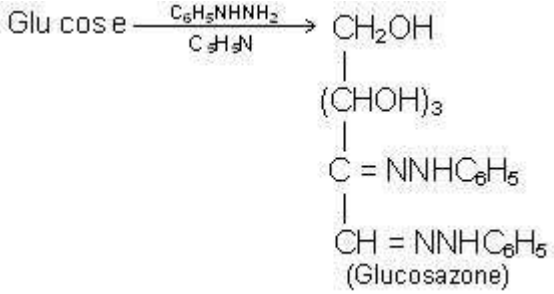


(f) With Tollen reagent and Fehling solution. Glucose forms silver mirror and red ppt. of Cu_2O respectively.

(g) With acetic anhydride. In presence of pyridine glucose forms pentaacetate.

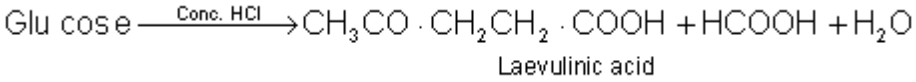


(h) **With phenylhydrazine**: it forms glucosazone

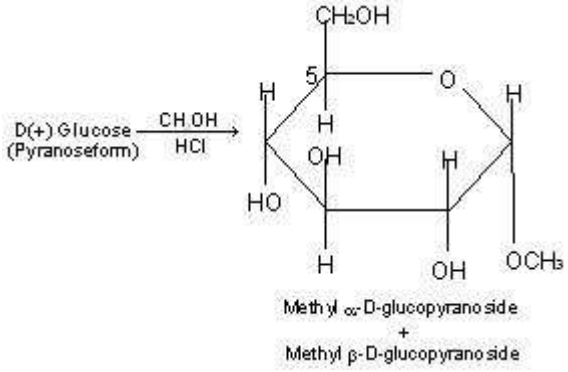


(j) **Glycoside formation**: When a small amount of gaseous HCl is passed into a solution of D (+) glucose in methanol, a reaction takes place that results in the formation of anomeric methyl acetals.

(i) **With conc. HCl acid**: Glucose gives laevulinic acid

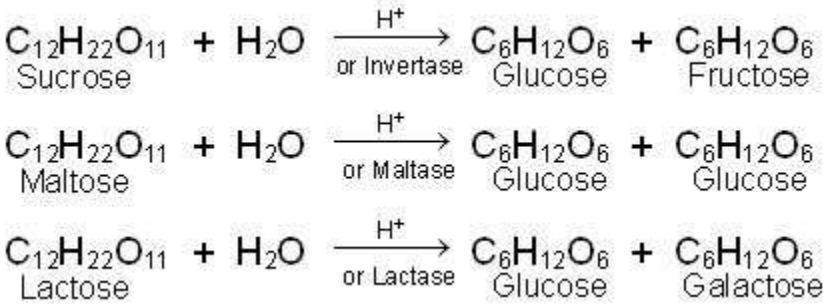


(j) **Glycoside formation**: When a small amount of gaseous HCl is passed into a solution of D (+) glucose in methanol , a reaction takes place that results in the formation of anomeric methyl acetals.



4. **Explain Disachharides.**

Ans: **<u>DISACCHARIDES</u>:** Carbohydrates which upon hydrolysis give two molecules of the same or different monosaccharides are called disaccharides. Their general formula is $C_{12}H_{22}O_{11}$. The three most important disaccharides are sucrose, maltose, and lactose. Each one of these on hydrolysis with either an acid or an enzyme gives two molecules of the same or different monosaccharides as shown below:

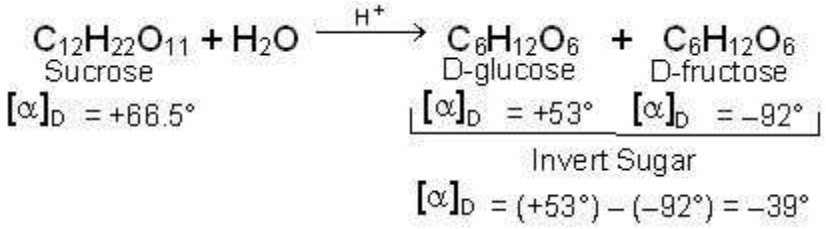


Disaccharides may also be considered to be formed by a condensation reaction between two molecules of the same or different monosaccharides with the eliminatioin of a molecule of water. This reaction involves the formation of an acetal from a hemiacetal and an alcohol – in which one of the monosaccharides acts as the hemiacetal while the other acts as the alcohol.

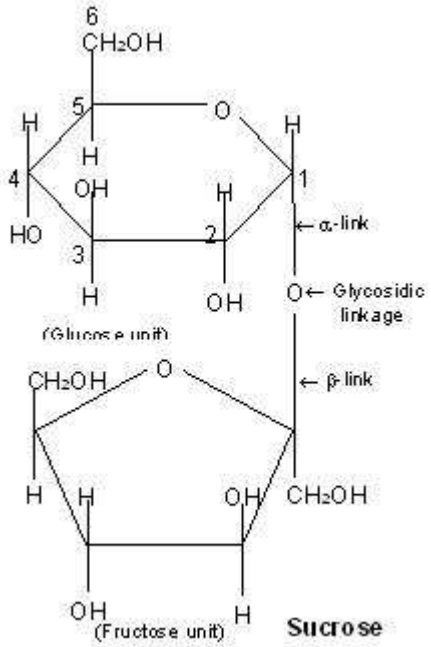
Sucrose

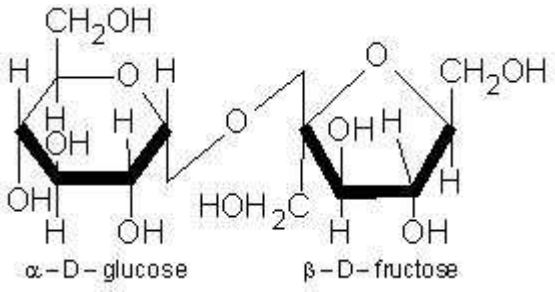
It is formed by condensation of one molecule of glucose and one molecule of fructose. Unlike maltose and lactose, it is non-reducing sugar since both glucose (C_1 - α) and fructose (C_2 -β) are connected to each other through their reducing centres. Its structure is shown below:

Hydrolysis: (Invert Sugar or Invertose). Hydrolysis of sucrose with hot dilute acid yields D-glucose and D-fructose.



Sucrose is dextrorotatory, its specific rotation being +66.5%, D-glucose is also dextrorotatory, $[\alpha]_D = +53°$, but D-fructose has a large negative rotation, $[\alpha]_D = -92°$. Since D-fructose has a greater specific rotation than D-glucose, the resulting mixture is laevorotatory. Because of this the hydrolysis of sucrose is known as the inversion of sucrose, and the equimolecular mixture of glucose and fructose is known is invert sugar or invertose.





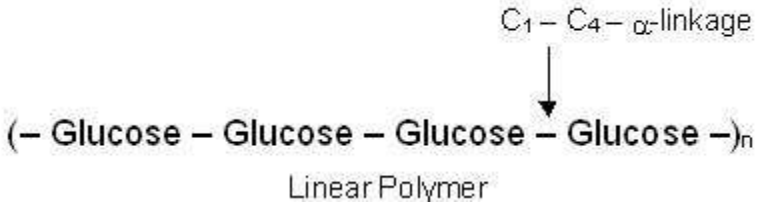
5. **Explain poly-sachharides.**

Ans: POLYSACCHARIDES: Polysaccharides are formed when a large number (hundreds to even thousands) of monosaccharide molecules join together with the elimination of water molecule. Thus, polysaccharides may be regarded as condensation polymers in which the monosaccharides are joined together by glycosidic linkages. Some important polysaccharides are:

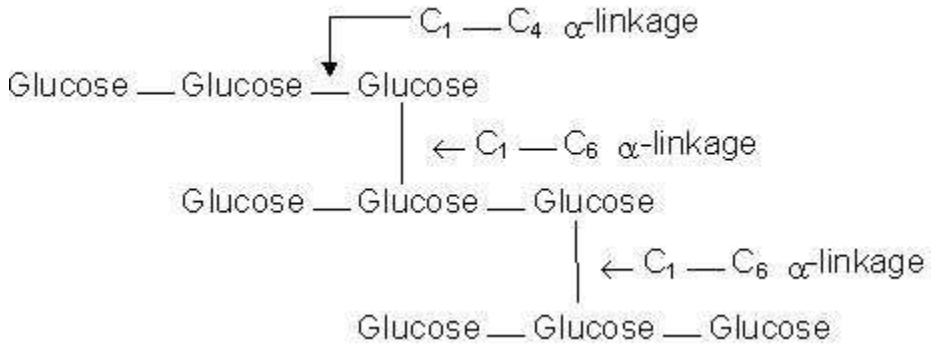
1. Cellulose
2. Starch
3. Glycogen
4. Gums and
5. Pectins

Starch: It is a polymer of glucose. Its molecular formula is $(C_6H_{10}O_5)n$ where the value of n (200 – 1000) varies from source to source. It is the chief food reserve material or storage polysaccharide of plants and is found mainly in seeds, roots, tubers, etc. Wheat, rice, potatoes, corn, bananas etc., are rich sources of starch. Starch is not a single compound but is a mixture of two components – amylose (10 to 20%) and amylopectin (20 to 80%). Both amylose and amylopectin are polymers of α-D-glucose.

Amylose is a linear polymer of α-D-glucose. It contains about 200 glucose units which are linked to one another through α-linkage involving C_1 of one glucose unit with C_4 of the other as shown below:



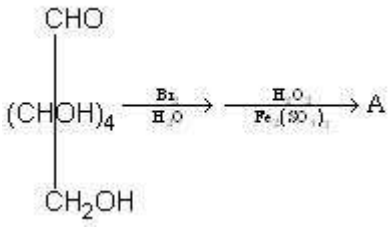
Amylopectin, on the other hand, is a highly branched polymer. It consists of a large number (several branches) of short chains each containing 20-25 glucose units which are joined together through α-linkages involving C_1 of one glucose unit with C_4 of the other. The C_1 of terminal glucose unit in each chain is further linked to C_6 of the other glucose unit in the next chain through $C_1 – C_6$ α-linkage. This gives amylopectin a highly branched structure as shown below.-



Hydrolysis: Hydrolysis of starch with hot dilute acids or by enzymes gives dextrins of varying complexity, maltose and finally D-glucose. Starch does not reduce Tollen's reagent and Fehling's solution.

Uses: It is used as a food. It is encountered daily in the form of potatoes, bread, cakes, rice etc. It is used in coating and sizing paper to improve the writing qualities. Starch is used to treat textile fibres before they are woven into cloth so that they can be woven without breaking. It is used in manufacture of dextrins, glucose and ethyl alcohol. Starch is also used in manufacture of starch nitrate, which is used as an explosive.

Amylopectin is a branched chain saccharides consist of α - D – glucose unit join straight chain by α, 1, 4 linkage & both the straight chain are ionized α - 1, 6 linkage.
Solved example:



BIOMOLECULES

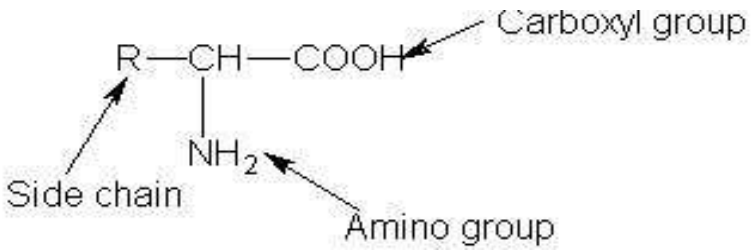
Topic: 2

AMINO ACIDS

VERY SHORT ANSWER QUESTIONS

1. **What are amino acids?**

Ans: Amino acids are organic compounds of both, an amino group & carboxylic group. They are represented by general formula:



2. **What is the importance of amino acids?**

Ans: These amino acids are very important because they are the building blocks of protein.

3. **Which among the following statements are true for glycine?**
   1. It exists in crystalline form 2. It is optically active
   3. It is soluble in water 4. It can form Zwitter ions
   (A) 1, 2 and 3 (B) 1, 2 and 4
   (C) 1, 3 and 4 (D) 2, 3 and 4

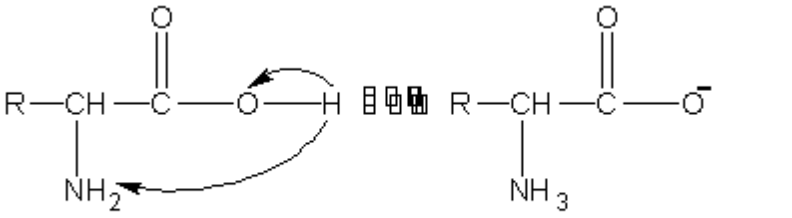
Ans: (C) It is ionic so it exists in crystalline form. Because it is ionic so it soluble in water. Because acidic and basic groups are present in the same molecule, so

4. **What is zwitter ion?**

Ans: ZWITTER ION

(i) Amino acids contain both acidic carboxyl group -(COOH) and basic amino group in the same molecules.

(ii) In aqueous solution, the acidic carboxyl group can lose a proton and basic amino group can gain a proton in a kind of internal acid – base reaction.



Dipolar ion or Zwitter ion

5. What are essential amino acids?

Ans: Essential amino acids: These must be supplied to our diet as are not synthesized in body.
Some of them are
(1) Valine (2) Leucine (3) Isoelucine (4) Phenylalanine (5) Arganine (5) Threonine (6) Tryptophan (7) Methionine (8) Lysine (9) Arginine (10) Histadine

Note: Histidine and arginine are essential i.e. can be synthesized but not in quantities sufficient to permit normal growth.

6. What are non-essential amino acids?

Ans: Non – Essential Amino acids: These amino acids are synthesized in body.
Some of them are
These are as follows:
(1) Glycine (2) Alanine (3) Tyrosine (4) Serine (5) Cystine (6) Proline (7) Hydroxyprocine (8) Cysteine (9) Aspartic acid (10) Glutonic acid

7. **What are the physical properties of amino acids?**

Ans: Physical properties of amino acid
(i) Amino acids are generally, crystalline substance having sweet taste.
(ii) They melt with decomposition at higher temperature (more than 200°C).
(iii) They are soluble in water but insoluble in organic solvents

8. **What is isoelectric point?**

Ans: <u>ISOELECTRIC POINT</u>
When ionized form of amino acid is placed in an electric field it will migrate towards the opposite electrode. Depending upon the pH of the medium following three thing may happen. In acidic medium, the cation move towards cathode. In basic medium, the anion move towards anode. The Zwitter ion does not move towards any of the electrodes. At a certain pH (i.e. H^+ concentration), the amino acid molecules show no tendency to migrate towards any of the electrodes and exists as a neutral dipolar ion, when placed in electric field is **known as isoelectric**

point. All amino acids do not have the same isoelectric point & it depends upon the nature of R – linked to α- carbon atom.

SHORT ANSWER QUESTIONS

1. **Explain the classification of Amino acid.**

Ans: Amino acids are classified in to two categories.

1. **Essential amino acids**
These must be supplied to our diet as are not synthesized in body.
Some of them are
(1) Valine (2) Leucine (3) Isoelucine (4) Phenylalanine (5) Arganine (5) Threonine
(6) Tryptophan (7) Methionine (8) Lysine (9) Arginine (10) Histadine

Note: Histidine and arginine are essential i.e. can be syntrhesized but not in quantities sufficient to permit normal growth.

2. Non – Essential Amino acids
These amino acids are synthesized in body.
Some of them are
These are as follows:
(1) Glycine (2) Alanine (3) Tyrosine (4) Serine (5) Cystine (6) Proline (7) Hydroxyprocine (8) Cysteine (9) Aspartic acid (10) Glutonic acid

2. **How amino acids are synthesized?**

Ans: <u>Synthesis of α - amino acids</u>
Protein can be hydrolyzed by refluxing with dilute hydrochloric acid to give a mixture of α - amino acids. The resulting mixture can be separated by
(a) fractional crystallization.
(b) Fractional distillation of their ester followed by hydrolysis (Fischer's method)
(c) Selective precipitation as salt with phosphotungstic and picric acid.
(d) Distribution of amino acid between n – butanol saturated with water (Dakin's method).
(e) Column, paper and gas chromatography.
(f) Electrophoresis.

By amination of α- halo acid

(i) $Cl-CH_2-COOH + 3NH_3 \xrightarrow[(-NH_4Cl)]{50^0C} H_2N-CH_2-COO^-NH_4^+ \xrightarrow{H^+/H_2O} H_2N-CH_2-COOH$

Chloro acetic acid (excess) Glycine

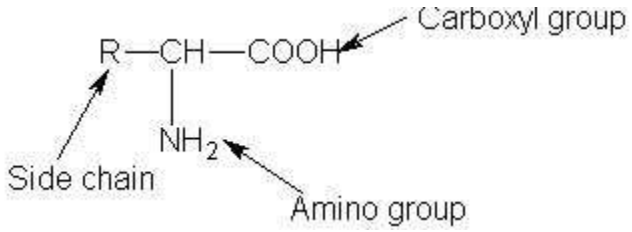
(ii) $H_3C-\underset{\underset{Br}{|}}{CH}-COOH + 3NH_3 \xrightarrow[(-NH_4Cl)]{50^0C} H_3C-\underset{\underset{NH_2}{|}}{CH}-COO\bar{N}H_4^+ \xrightarrow{H^+/H_2O} H_3C-\underset{\underset{NH_2}{|}}{CH}-COOH$

Alanine

LONG ANSWER QUESTIONS

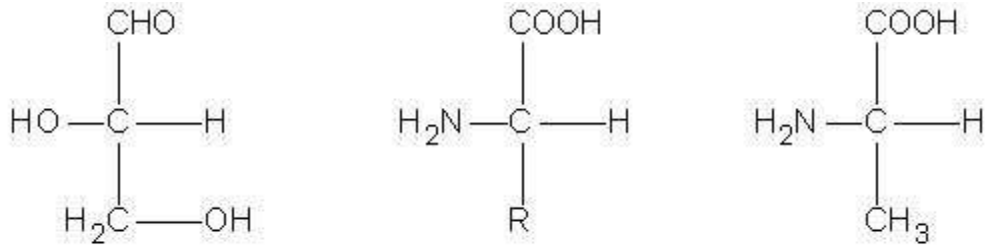
1. Explain the synthesis, physical and chemical properties of amino acids.

Ans: Amino acids are organic compounds of both, an amino group & carboxylic group. They are represented by general formula:



These amino acids are very important because they are the building blocks of protein.

(iv) Protein is the natural polymer moving α - amino acids as monomer. With the exceptions of glycine. All the other amino acids have chiral carbon & have two optically active isomers. All naturally occurring amino acids are in L – series in which $–NH_2$ group on the left and –OH group in the right as L – glyceraldehydes.

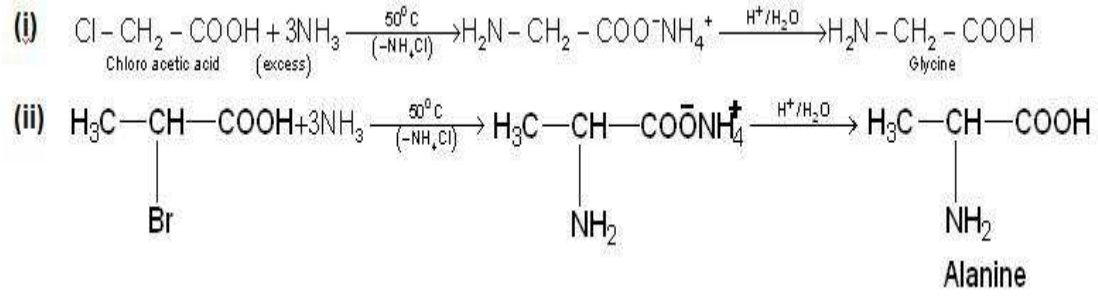


L - Glyceraldehyde L - Alanine

I. Synthesis of α - amino acids

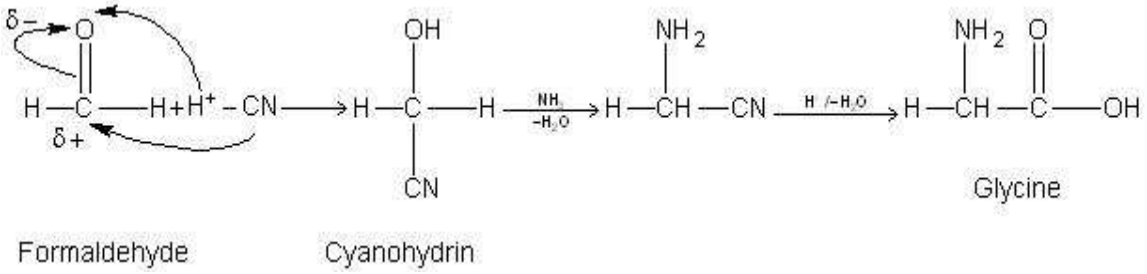
Protein can be hydrolyzed by refluxing with dilute hydrochloric acid to give a mixture of α - amino acids. The resulting mixture can be separated by fractional crystallization. Fractional distillation of their ester followed by hydrolysis (Fischer's method). Selective precipitation as salt with phosphotungstic and picric acid. Distribution of amino acid between n – butanol saturated with water (Dakin's method). Column, paper and gas chromatography and Electrophoresis.

By amination of α- halo acid

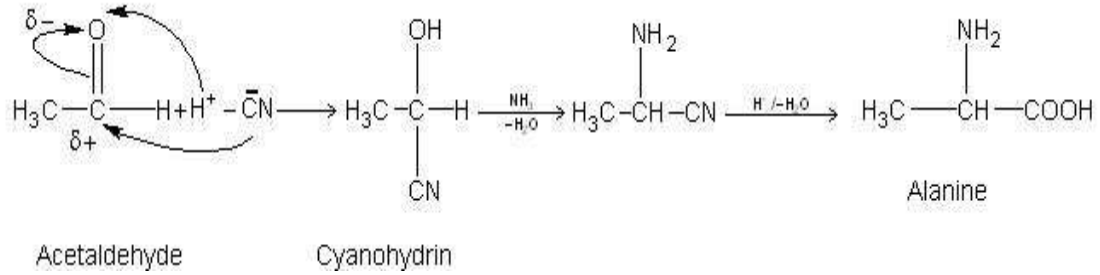


By Strecker Synthesis

(i)



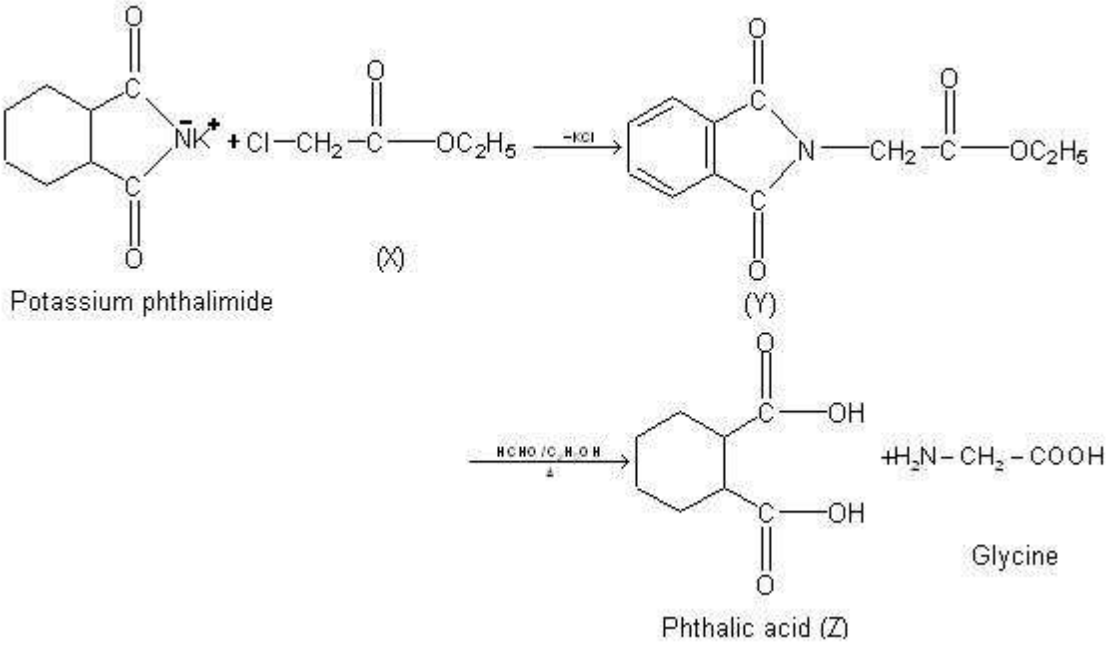
(ii)



Note: Generally the aldehyde is treated with a mixture of ammonium chloride and potassium cyanide in aqueous solution

$$NH_4Cl + KCN \xrightarrow{\text{Aqueous}} NH_4CN + KCl$$

$$NH_4CN \xrightarrow{\text{Aqueous}} NH_3 + HCN$$

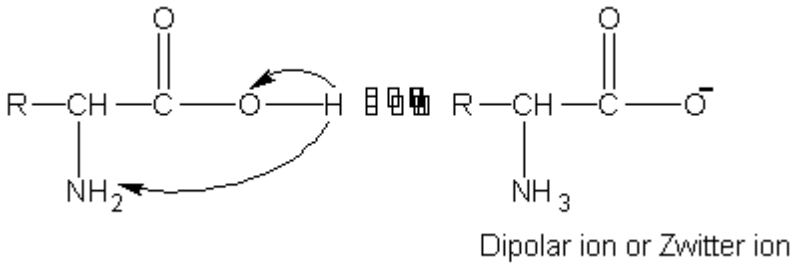


II. Physical properties of amino acid

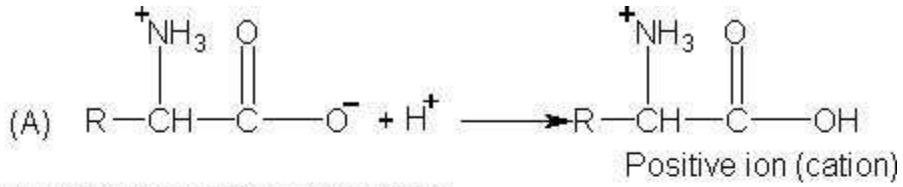
(i) Amino acids are generally, crystalline substance having sweet taste.
(ii) They melt with decomposition at higher temperature (more than 200°C).
(iii) They are soluble in water but insoluble in organic solvents

ZWITTER ION

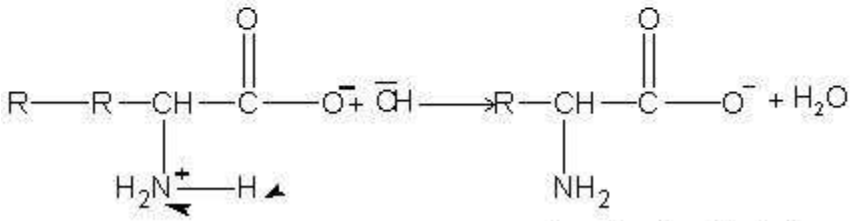
(i) Amino acids contain both acidic carboxyl group -(COOH) and basic amino group in the same molecules.
(ii) In aqueous solution, the acidic carboxyl group can lose a proton and basic amino group can gain a proton in a kind of internal acid – base reaction.



(iii) The product of this internal reaction is called a Dipolar or a Zwitter ion.
(iv) The Zwitter ion is dipolar, changed but overall electrically neutral and contain both a positive and negative charge.
(v) Amino acid in the dipolar ion form are amphoteric in nature.
(vi) Depending upon the pH of the solution, the amino acid can donate or accept proton.



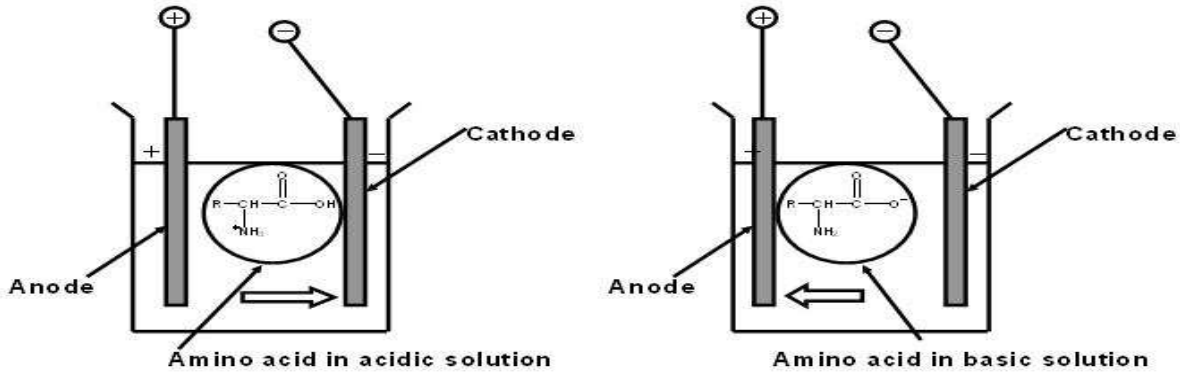
(B) An amino acid in basic solution



ISOELECTRIC POINT

(i) When ionized form of amino acid is placed in an electric field it will migrate towards the opposite electrode.
(ii) Depending upon the pH of the medium following three thing may happen.
   (a) In acidic medium, the cation move towards cathode.
   (b) In basic medium, the anion move towards anode.
   (c) The Zwitter ion does not move towards any of the electrodes.
(iii) At a certain pH (i.e. H^+ concentration), the amino acid molecules show no tendency to migrate towards any of the electrodes and exists as a neutral dipolar ion, when placed in electric field is known as isoelectric point.
(iv) All amino acids do not have the same isoelectric point & it depends upon the nature of R – linked to α- carbon atom.

(v) Amino acids have minimum aqueous solubility at isoelectric point.



Effect of electric field on an amino acid ion Acidic and Basic solution

IV. Chemical Properties

Amino acids show the following characteristic reactions.
1.Reaction of the carboxyl group.
2.Reaction of the amino group.
3.Reaction involving both the carboxyl and the amino group.

1. Reaction of the carboxyl group

a) **Reaction with base**

(i) $H_3N^+ - CH_2 - COO^- + NaOH \longrightarrow H_2N - CH_2 - COO^-Na^+ + H_2O$

Glycine — Sodium amino acetate

(ii) $H_3C-CH(NH_3^+)-COO^- + NaOH \longrightarrow H_3C-CH(NH_2)-COO^-Na^+ + H_2O$

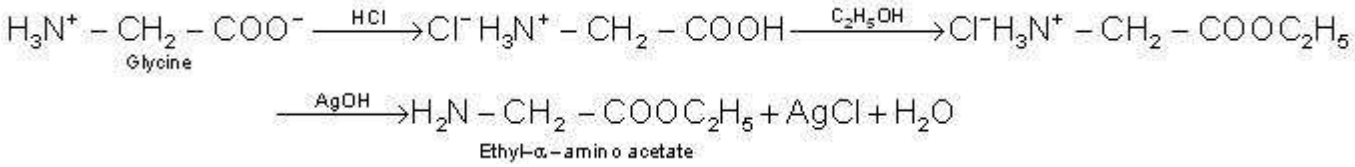
Alanine — Sodium, α– amino propionate

Mechanism:

$H_3C-CH(NH_3^+)-C(=O)-O^- + Na^+ - OH^- \longrightarrow H_3C-CH(NH_2)-C(=O)-ONa + H_2O$

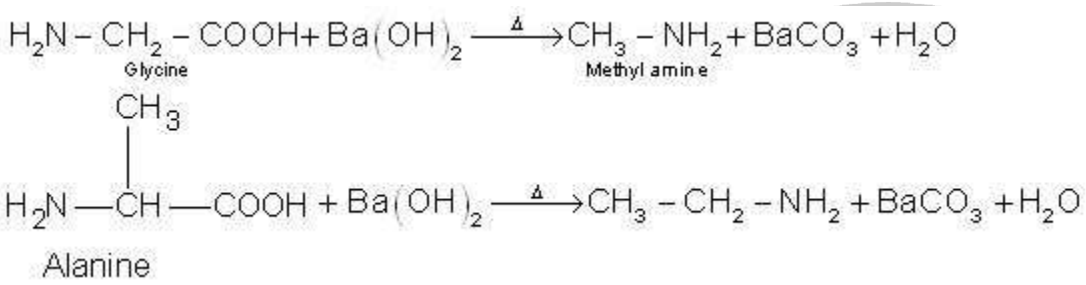
Alanine — Sodium, α– amino propionate

b) Esterification

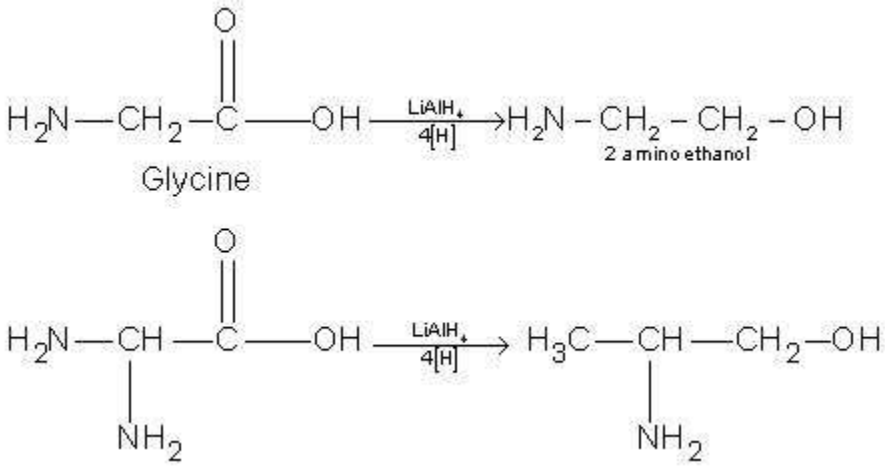


Note: HCl first converts the dipolar ion into an acid which is subsequently esterified.

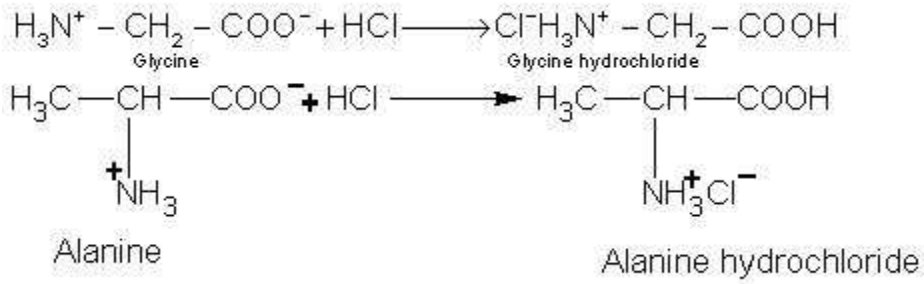
c) **Decarboxylation**



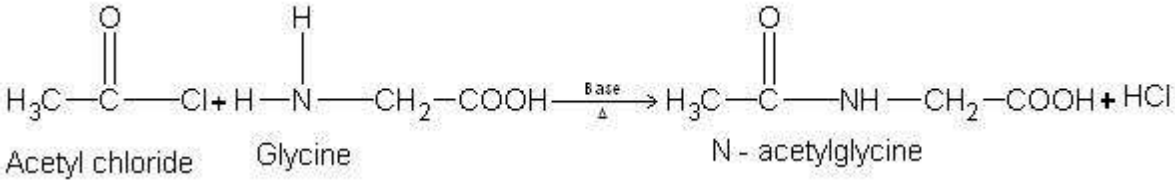
d) Reduction

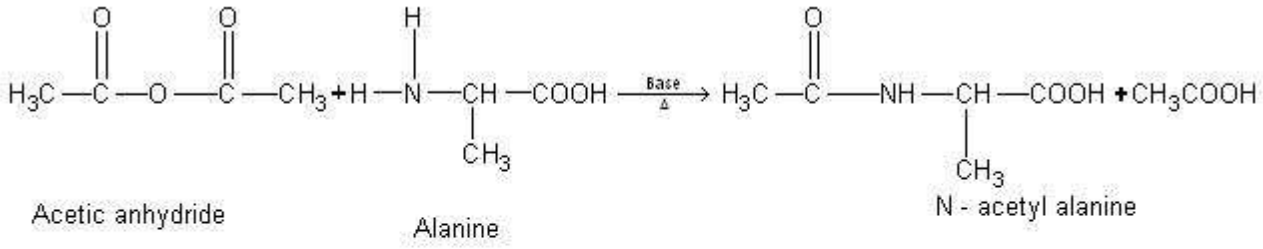


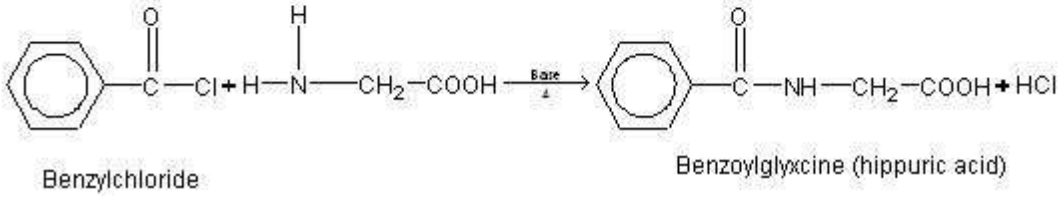
e) Reaction with strong acid



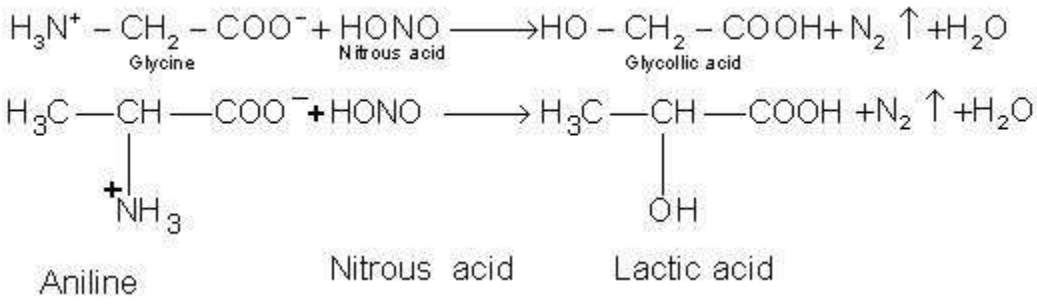
f) Acetylation







g) Reaction with Nitrous acid



Note: (i) This reaction forms the basis of the "van slyke method" for the estimation of amino acids.

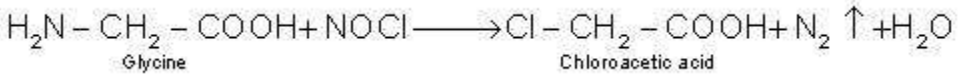
(ii) The nitrogen is evolved (one half comes from the amino acid) quantitatively and its volume measured.

Reaction with Nitrosyl halide

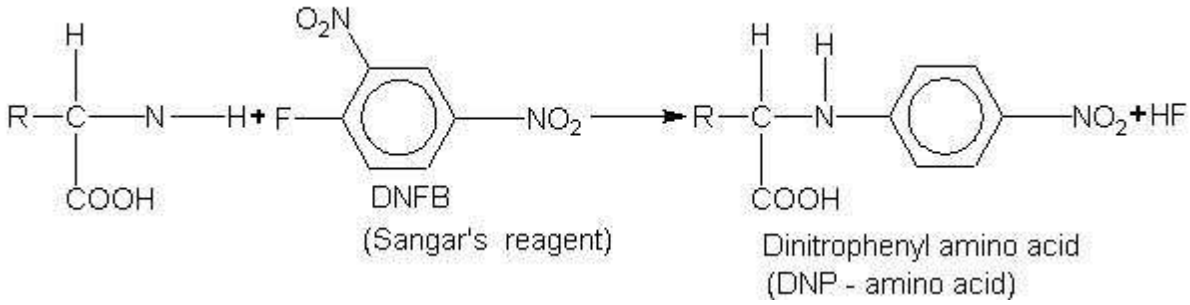
(i) This reaction forms the basis of the "van slyke method" for the estimation of amino acids.

(ii) The nitrogen is evolved (one half comes from the amino acid) quantitatively and its volume measured.

h) Reaction with Nitrosyl halide



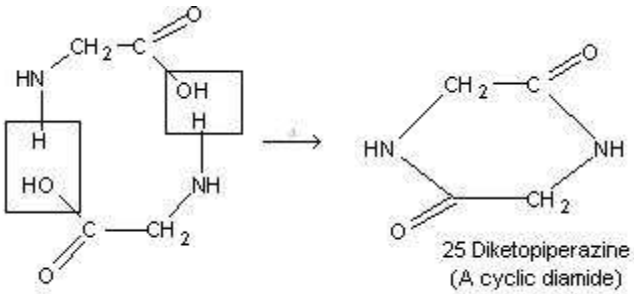
Reaction with 2, 4 – Dintrofluorobenzene (DNFB)



2.Reaction involving both the carboxyl & the amino group

Effect of heat

α - amino acids undergo dehydration on heating (200°C) to give diketo piperazines



Glycine (2 moles)

25 Diketopiperazine
(A cyclic diamide)

BIOMOLECULES

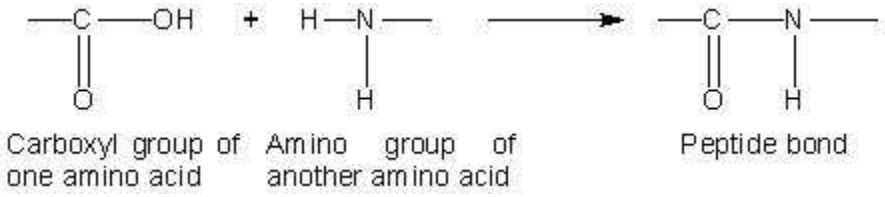
Topic: 3

PEPTIDES- PROTEINS- STRUCTURE

VERY SHORT ANSWER QUESTIONS

1. **What is peptide?**

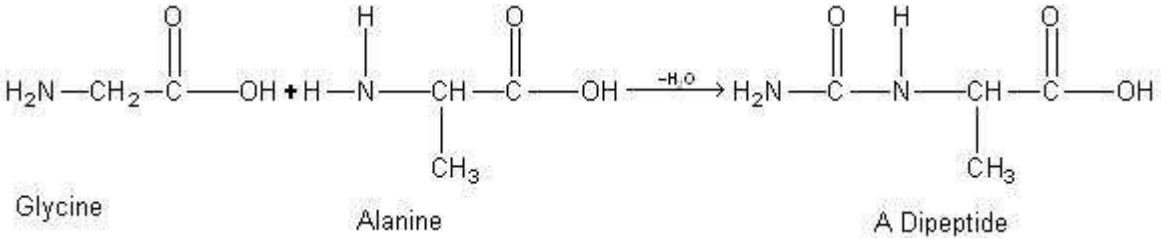
Ans:) Proteins are formed by joining the carboxyl group of one amino to the α - amino group of another acid. The bond formed between two amino acids by the elimination of water molecules is called peptide linkage.



The product formed by linking amino acid molecules through peptide linkage -CO - NH - is called a peptide.

2. **What is dipeptide?**

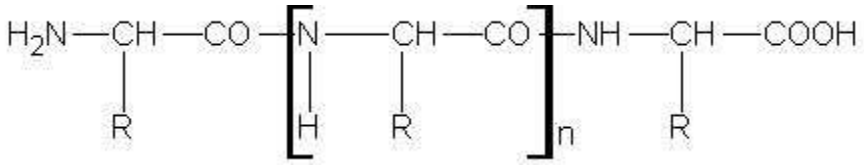
Ans: When two amino acids combined in this way the resulting product is called a dipeptide.



Peptide are further designated as tri, tetra or penta peptides accordingly as they contain three, four or five amino acid molecules, same or different

3. **What is polypeptide?**

Ans: If a large number of α - amino acids (100 to 1000) are joined by peptide bonds the resulting polyamide is called polypeptide.



By convention a peptide having molecular weight upto 10,000 is called polypeptide.

4. **What is protein?**

Ans: By convention a peptide having molecular weight upto 10,000 is called polypeptide. While a peptide having a molecular mass more than 10,000 is called a protein.

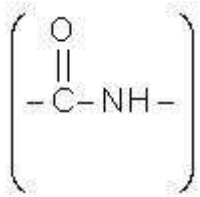
SHORT ANSWER QUESTIONS

1. **What are different tests performed on proteins?**

Ans: Tests of protein

Biuret test

(i) On adding a dilute of copper sulphite to alkaline solution of protein, a violet colour is developed.

(ii) This test is due to the presence of peptide  linkage.

Millon's test

(a) Millon's reagent consists of mercury dissolved in nitric acid (forming a mixture of mercuric & mercurous nitrates).

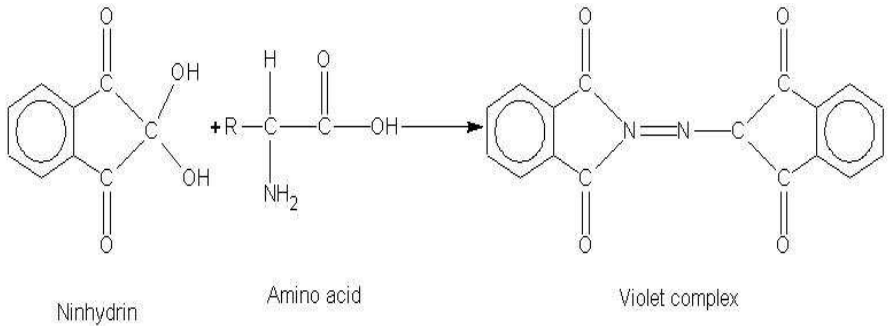
(b) When millon's reagent is added to a protein, a white ppt is formed, which turn brick red on heating.

(c) This test is given by protein which yield tyrosine on hydrolysis (due to the presence of phenolic group).

Nihydrin test

(i) This test is given by all proteins.

(ii) When protein is boiled with a dilute solution of ninhydrin, a violet colour is produced.



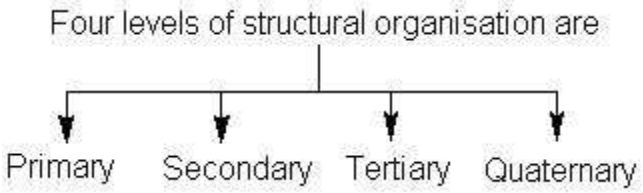
2. **What are the uses of proteins?**
3. **Ans: <u>Uses of Proteins</u>**

(i) Protein constitute as essential part of our food, meat, eggs, fish, cheese provide protein to human beings.
(ii) Casein (a milk protein) is used in the manufacture of artificial wool & silk.
(iii) Amino acid needed for medicinal use & feeding experiment, are prepared by hydrolysis of proteins.
(iv) Gelatin is used in desserts, salads, candies bakery goods etc.
(v) Leather is obtained by tanning the protein of animal hides.
(vi) Hemoglobin present in blood is responsible for carrying oxygen and CO_2.
(vii) Hormones control various processes.
(viii) Enzymes are the proteins produces by living system & catalyse specific biological reaction.

4. **Explain how many structures of proteins can exist?**

Ans : Structure of Proteins
(i) Proteins have three dimensional structures.
(ii) There are number of factors which determine the exact shape of proteins.

Structure of Proteins



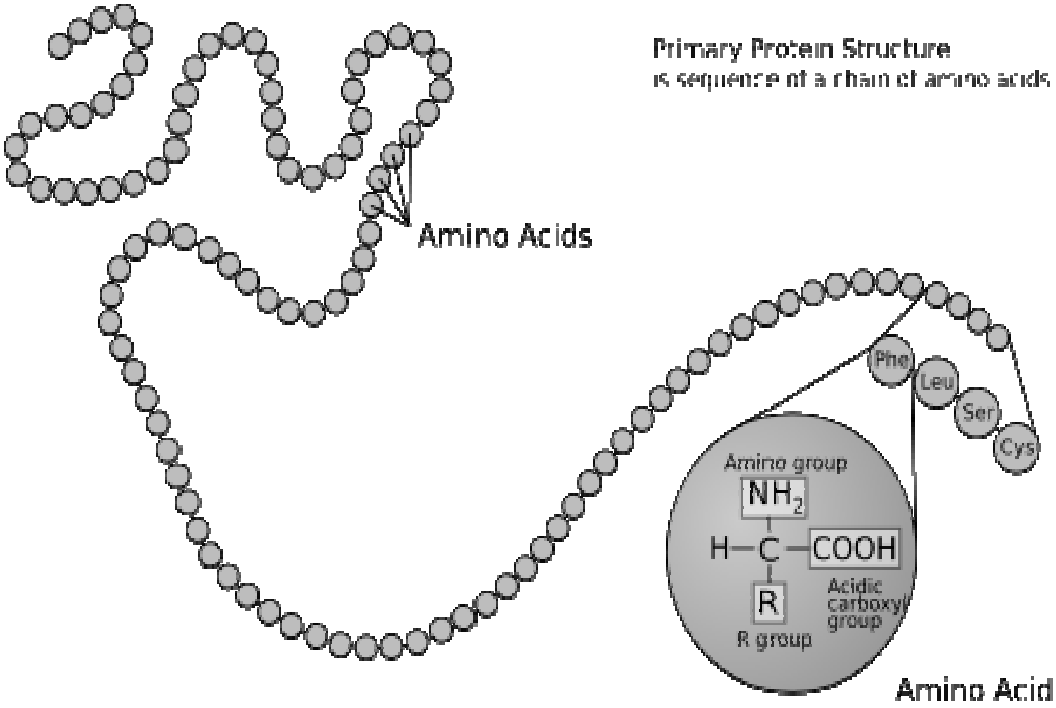
LONG ANSWER QUESTIONS

1. **Explain the primary structure of protein.**

Primary structure

(i) This type of structure was given by Friedrich Sanger in 1953 in Insulin.
(ii) Primary structure is conformed by single polypeptide chain in a linear manner.
(iii) All amino acid are attached in a straight chain by peptide bond.

In general, polypeptides are unbranched polymers, so their primary structure can often be specified by the sequence of amino acids along their backbone. However, proteins can become cross-linked, most commonly by disulfide bonds, and the primary structure also requires specifying the cross-linking atoms, e.g., specifying the cysteines involved in the protein's disulfide bonds. Other crosslinks include desmosine.The chiral centers of a polypeptide chain can undergo racemization. In particular, the L-amino acids normally found in proteins can spontaneously isomerize at the C^{α} atom to form D-amino acids, which cannot be cleaved by most proteases. Finally, the protein can undergo a variety of posttranslational modifications, which are briefly summarized here. The N-terminal amino group of a polypeptide can be modified covalent



2. Explain the secondary structure of protein.

Ans: Secondary structure:

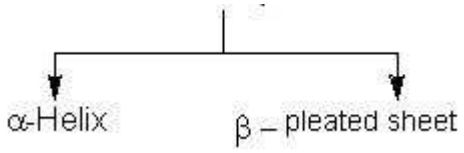
(i) The fixed configuration of polypeptide skeleton is referred to as the secondary structure of protein.

(ii) It gives information

(a) About the manner in which the protein chain is folded and bent.

(b) About the nature of the bond which stabilizes this structure

(iii) This structure of protein is mainly of two types



(A) α-Helix

(a) The chain of α-amino acids coiled as a right handed screw (called α-helix) because of the formation of hydrogen bond.

(b) The spiral is held together by H-bonds between N–H and C = O group vertically adjacent to one another.

(c) X-Ray studies have shown that there are approximately 3.6 amino acid unit for each turn in helix.

(d) Such proteins are elastic i.e., they can be stretched.

(e) On stretching weak H-bonds break up and the peptide act like a spring.

(f) The hydrogen bonds are reformed on releasing the tension.

e.g. Myosin, Keratin, Tropomysin.

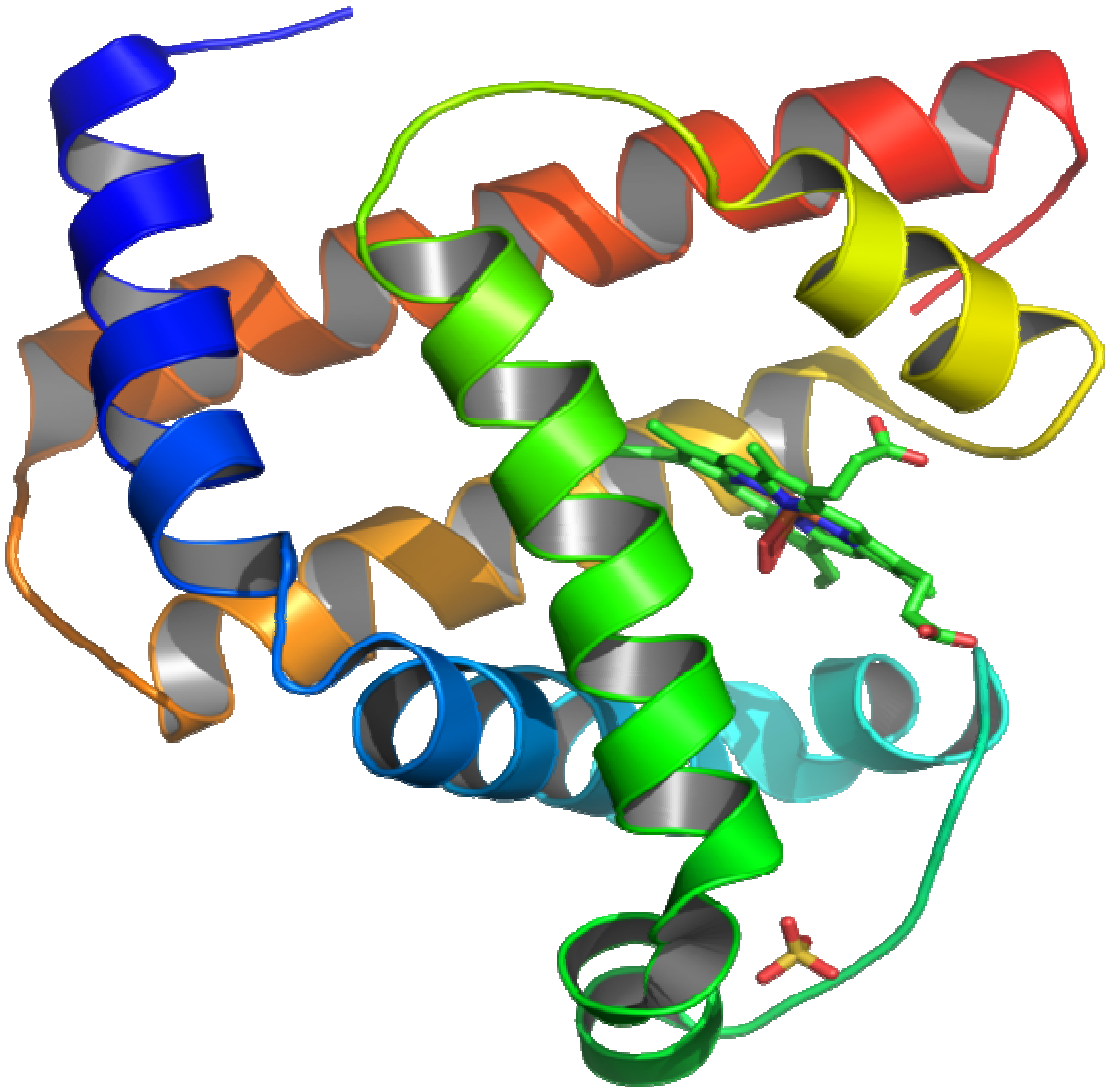
(B) Beta-pleated sheet

(a) Polypeptide chains are arranged side by side.

(b) The chains are held together by a very large number of hydrogen bond between C = O and NH of different chains.

(c) These sheets can slide over each other to form a three dimensional structure called a beta pleated sheet.

e.g. Silk has a beta pleated structure.



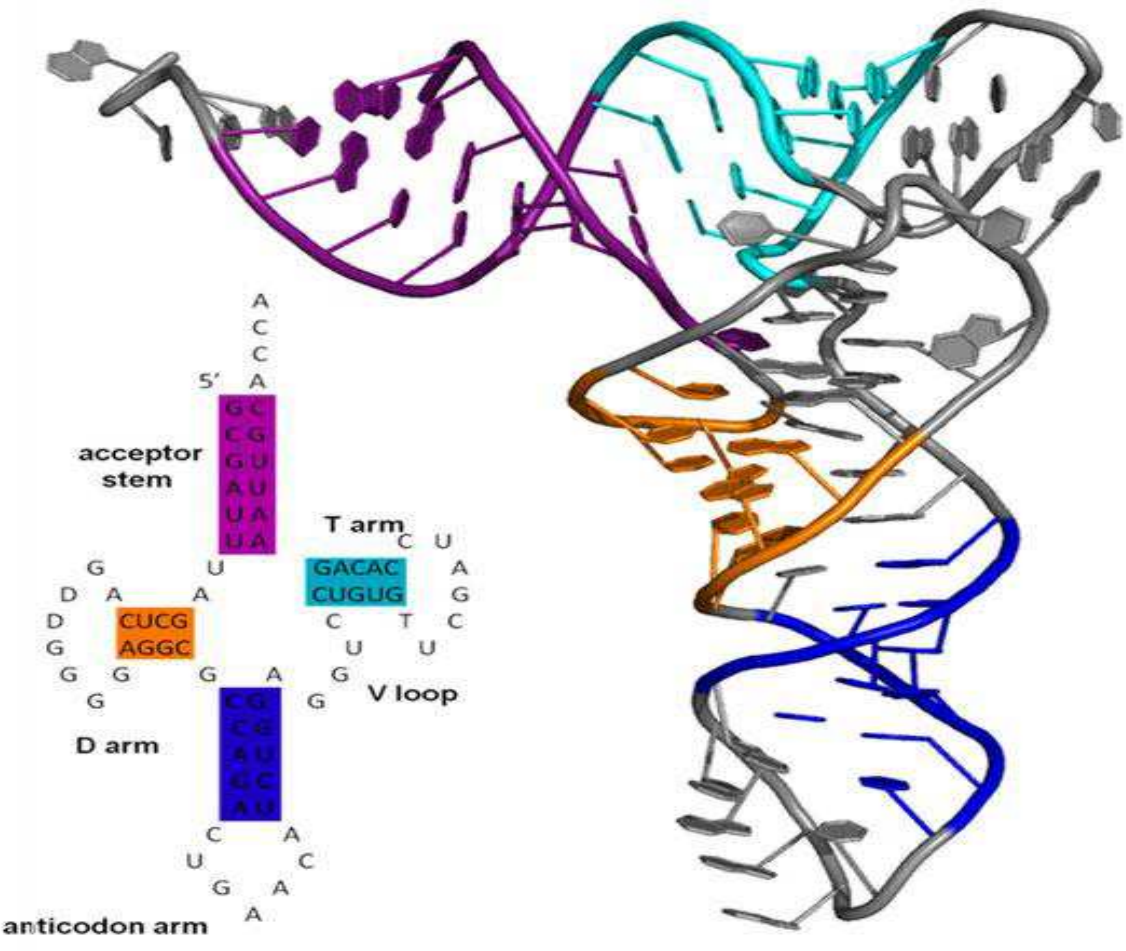
3. **Explain the tertiary structure of Proteins.**

Ans: Tertiary structure

(i) It refers to the arrangement and interrelationship of the twisted chain of protein into specific layer or fibres.

(ii) This tertiary structure is maintained by weak inter atomic force such as, H-bonds hydrophobic bond, van der Waals' force and disulphide bonds (eg Insulin).

e.g. Protein of tobacco mosaic virus (TMV); Myoglobin; Hemoglobin



4. **Explain the quaternary structure of protein.**

Ans: Quaternary structure

(i) When two or more polypeptide chain united by the force other than covalent bond i.e., peptide and disulphide bonds.

(ii) It refers to final three dimensional shape that results from twisting bonding and folding of the protein helix.

(iii) It is most stable structure.

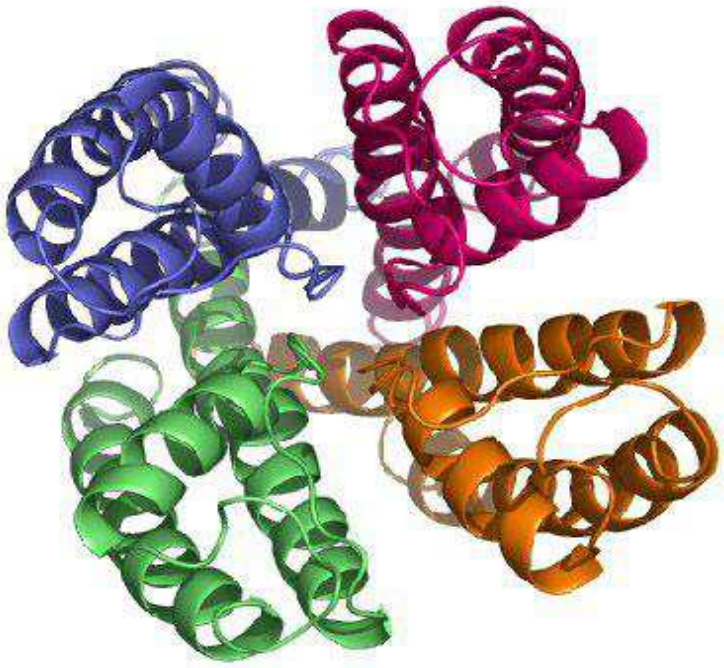
Quaternary structure refers to the association of multiple individual protein chains into a single protein with multiple subunits. The arrangement of the subunits gives rise to a stable structure, which can usually be dissociated in the laboratory, but is very strongly bound *in vivo*.

- The subunits may be identical or different
- When they are different, each subunit tends to have a different function

Common shorthand for describing such proteins is to use Greek letters for each type of subunit, and subscript numeral to specify numbers of units.

- A protein designated a_2bg consists of two a units and one each of b and g.

The subunits usually are held together by hydrophobic interactions, the clustering serving to reduce exposure of hydrophobic side chains to the solvent. Occasionally, ionic interactions between carboxylate and amino side chains may contribute.



5. Explain the classification of proteins.

Classification of Proteins

There are two methods for classifying proteins.

(i) Classification according to **Composition**

(ii) Classification according to **Functions**

I. **Classification according to Composition**

Simple proteins

(i) Simple proteins are those which yield only α-amino acids upon hydrolysis.

(ii) Simple proteins are composed of chain of amino acid unit only joined by peptide linkage.

Examples are:
Egg (albumin); Serum (globulins); Wheat (Glutelin); Rice (Coryzenin)

Conjugated proteins

(i) Conjugated proteins are those which yield α - amino acids plus a non protein material on hydrolysis.

(ii) The non protein material is called the prosthetic group.

Example:

Casein in milk (prosthetic group is phosphoric acid); Hemoglobin (prosthetic group is Nucleic acid); Chlolesterol (prosthetic group – lipid).

According to molecular shape, proteins are further classified into two types.

(A) **Fibrous protein**

(a) These are made up of polypeptide chain that are parallel to the axis & are held together by strong hydrogen and disulphide bonds.

(b) They can be stretched & contracted like thread.

(c) They are usually insoluble in water.

Example:

Keratin (hair, wool, silk & nails); Myosin (muscle)

(B) Globular Proteins

(a) These have more or less spherical shape (compact structure).

(b) α - amino helix are tightly held bonding; H – bonds, disulphide bridges, ionic or salt bridges:

Examples:

Albumin (egg)

II. **Classification According to functions**

The functional classification includes following groups.

Structural proteins

These are the fibrous proteins such as collagen (skin, cartilage & bones) which hold living system together.

Blood proteins

(i) The major proteins constituent of the blood are albumin hemoglobin & fibrinogen.

(ii) Their presence contribute to maintenance of osmotic pressure, oxygen transport system & blood coagulation respectively.

BIOMOLECULES

Topic:4

NUCLEIC ACIDS - CHEMICAL COMPOSITION AND STRUCTURE OF DNA AND RNA, TRANSCRIPTION AND TRANSLATION

VERY SHORT ANSWER QUESTIONS

1. **What are nucleic acids?**

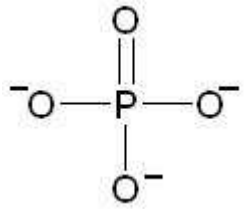
Ans: Nucleic acids are biologically important polymers which are present in all living cells, also called as polynucleotides because repeating structural unit is nucleotide.
There are two types of nucleic acids
(i) **DNA** (deoxyribonucleic acid)
(ii) **RNA** (Ribonucleic acid)

2. **What do nucleic acids contain?**

Ans: Composition of nucleic acids
1. A phosphate group
2. Sugar
3. Nitrogenous bases

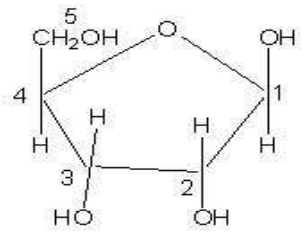
3. **What is the structure of sugar group?**

Ans: . Phosphate Group: Phosphate group in nucleic acid is:

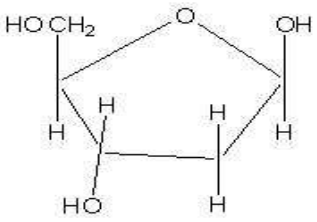


4. **What are the sugar groups present in nucleic acid?**

Ans: Sugar: Two types of sugars present in nucleic acids.
RNA (D – ribose)
DNA (D – deoxyribose)



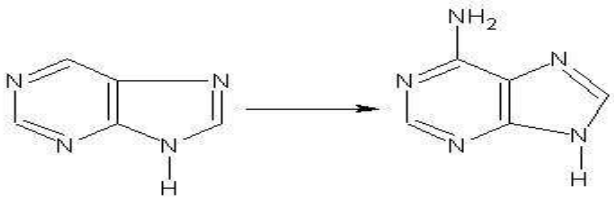
D-ribose



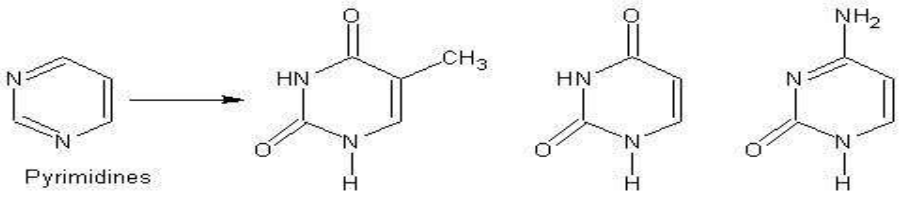
D-deoxyribose

5. **What are the nitrogen bases present in nucleic acids?**

Ans: Nitrogenous bases: Two types
(i) Purines – Adenine (A) and Guanine (G)
(ii) Pyrimidines – Cytosine (C), thymine (T) and uracil (U)



Purines Adenine (A) Guanine (G)



Pyrimidines Thymine (T) Uracil (U) Cytosine (C)

SHORT ANSWER QUESTIONS

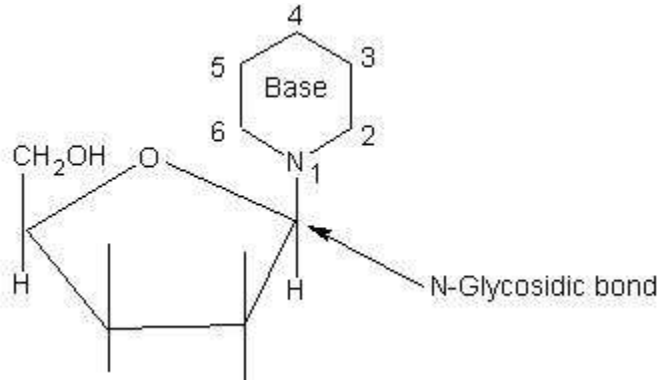
1. **Write the differences between DNA and RNA.**

Ans: DNA and RNA

	DNA		RNA
1.	Sugar present in DNA is 2-deoxyribose.	1.	Sugar is D-ribose.
2.	It contains cytosine and thymine as pyrimidine.	2.	It contains cytosine and uracil as pyrimidine.
3.	It has double stranded a - helix structure.	3.	It has single stranded a - helix.
4.	DNA occurs in the nucleus of cell.	4.	RNA occurs in cytoplasm of the cell.
5.	Controls transmission of hereditary material.	5.	It controls the synthesis of proteins.

2. **Explain what are nucleosides?**

Ans: <u>Nucleosides</u>: Nucleoside contains only two basic components of nucleic acids (a pentose sugar and a nitrogenous base). During their formation, 1- position of pyrimidine or 9 – position of purine moiety is linked to C_1 of sugar (ribose or deoxyribose) by α - linkage.



General structure of a nucleoside

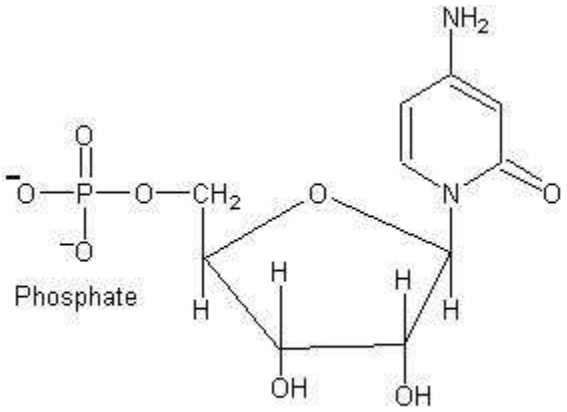
Depending upon the type of sugar present, nucleosides are of two types:

(i) Ribonucleosides and

(ii) Deoxyribonucleosides

3. What are nucleotides?

Ans: Nucleotides: Nucleotides contains all the three basic components of nucleic acids. Nucleotides are nucleoside monophosphates.
They are of two types depending upon the type of sugar – Ribonucleotides and Deoxyribonucleotides. Nucleotide may be represented as follows.

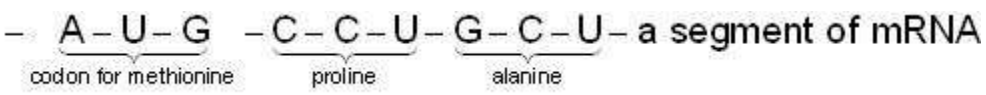


E.g: Structure of cytidine monophosphate

4. Explain how protein is synthesized?

Ans: Protein synthesis: It is a fast process and about 20 amino acids are added in one second. It may be noted that translation is always unidirectional but transcription can sometimes be reversed. (RNA is copies into DNA) This is called reverse transcription (occurs in Retroviruses).
Genetic Code
Segment of DNA is called gene and each triplet of nucleotides is called a codon that specifies one amino acid. This relationship between nucleotide triplets and amino acids is called genetic code.

E.g.



LONG ANSWER QUESTIONS

1. Explain the structure of DNA.

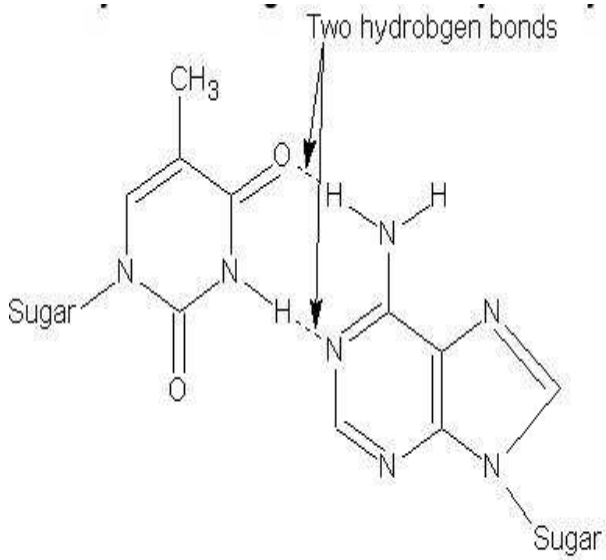
Structure of DNA: Primary structure and its double helix: Sequence in which four nitrogen bases are attached to the sugar phosphate backbone of a nucleotide chain is called primary structure.

Watson and crick in 1953 proposed that DNA polymers form a duplex structure consisting of two strands of polynucleotide chain coiled around each other in the form of a double helix. Bases of one strand of DNA are paired with bases on the other strand by means of hydrogen bonding. According to Chargaff rule – Thymine and adenine can be joined by 2 hydrogen bonds (T = A) while cytosine and guanine can be joined by three hydrogen bonds.

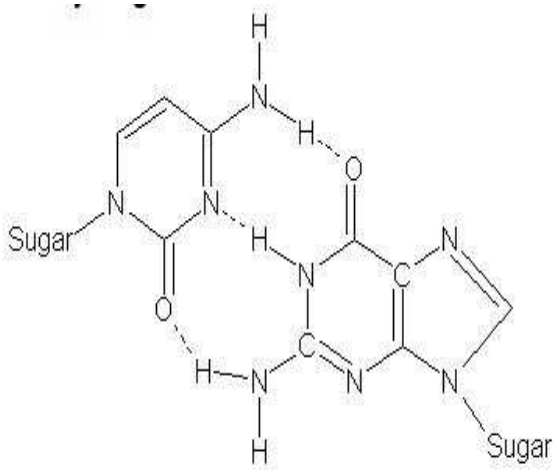
Deoxyribonucleic acid or **DNA** is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms (with the exception of RNA viruses). The main role of DNA molecules is the long-term storage of information. DNA is often compared to a set of blueprints, like a recipe or a code, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules. The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information. Along with RNA and proteins, DNA is one of the three major macromolecules that are essential for all known forms of life.

DNA consists of two long polymers of simple units called nucleotides, with backbones made of sugars and phosphate groups joined by ester bonds. These two strands run in opposite directions to each other and are therefore anti-parallel. Attached to each sugar is one of four types of molecules called nucleobases (informally, *bases*). It is the sequence of these four nucleobases along the backbone that encodes information. This information is read using the genetic code, which specifies the sequence of the amino acids within proteins. The code is read by copying stretches of DNA into the related nucleic acid RNA, in a process called transcription.

Within cells, DNA is organized into long structures called chromosomes. These chromosomes are duplicated before cells divide, in a process called DNA replication. Eukaryotic organisms (animals, plants, fungi, and protists) store most of their DNA inside the cell nucleus and some of their DNA in organelles, such as mitochondria or chloroplasts. In contrast, prokaryotes (bacteria and Achaea) store their DNA only in the cytoplasm. Within the chromosomes, chromatin proteins such as histones compact and organize DNA. These compact structures guide the interactions between DNA and other proteins, helping control which parts of the DNA are transcribed.

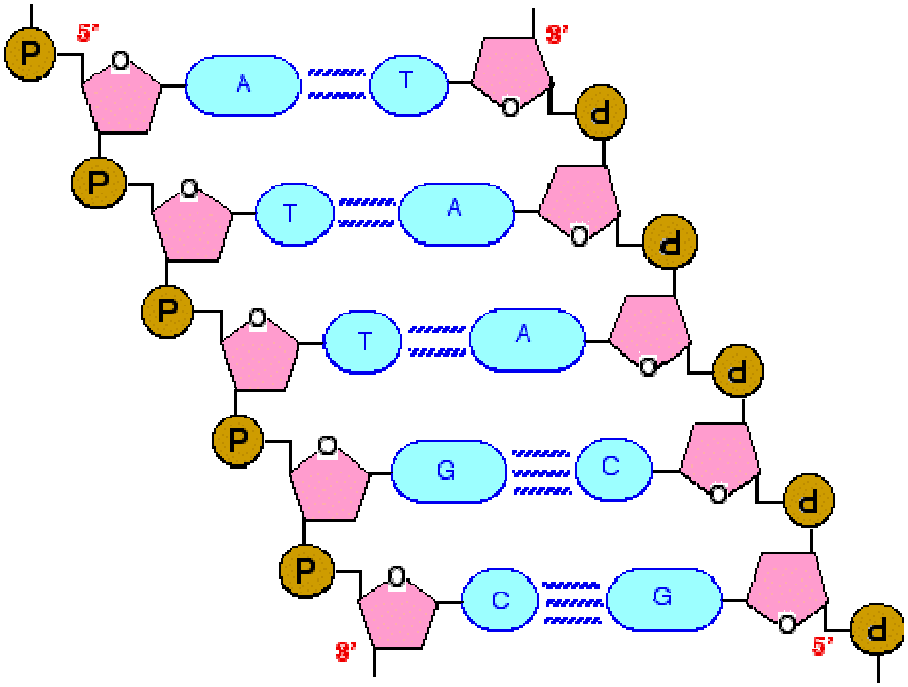


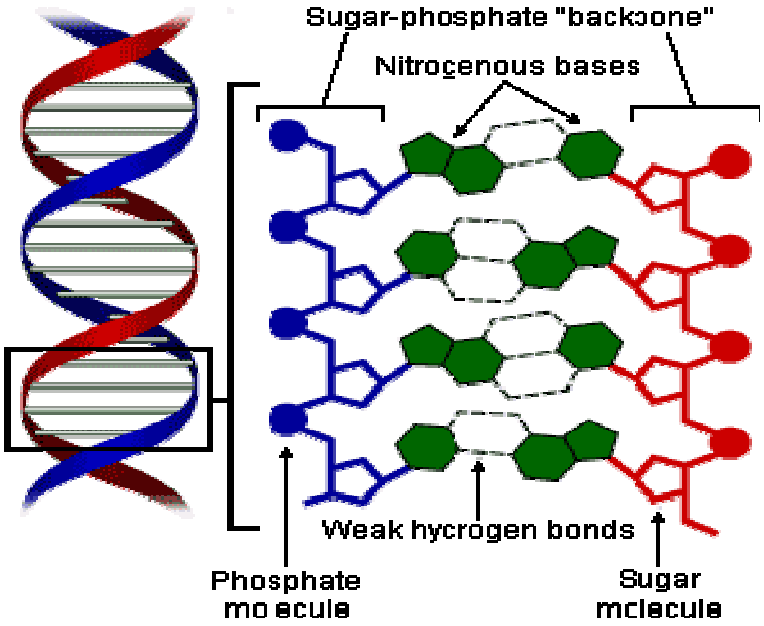
(Thymine = Adenine)



Pairing of cytosine and guanine

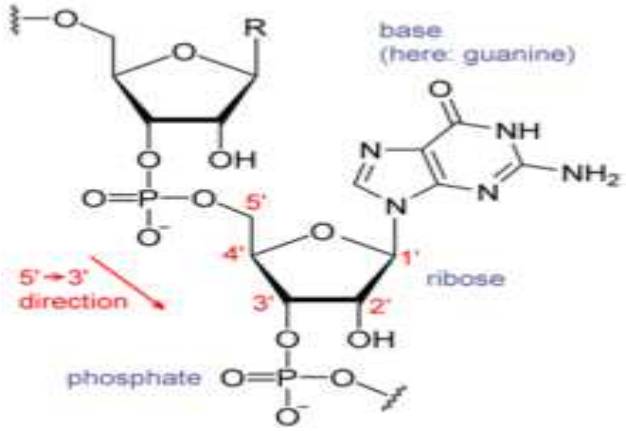
(C≡G)





2. **Explain the structure of RNA.**

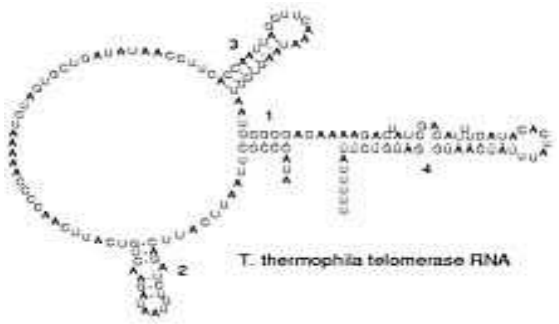
Ans: Structure of RNA: Each nucleotide in RNA contains a ribose sugar, with carbons numbered 1' through 5'. A base is attached to the 1' position, in general, adenine (A), cytosine (C), guanine (G), or uracil (U). Adenine and guanine are purines, cytosine, and uracil are pyrimidines. A phosphate group is attached to the 3' position of one ribose and the 5' position of the next. The phosphate groups have a negative charge each at physiological pH, making RNA a charged molecule (polyanion). The bases may form hydrogen bonds between cytosine and guanine, between adenine and uracil and between guanine and uracil. However, other interactions are possible, such as a group of adenine bases binding to each other in a bulge, or the GNRA tetraloop that has a guanine–adenine base-pair.



Chemical structure of RNA

An important structural feature of RNA that distinguishes it from DNA is the presence of a hydroxyl group at the 2' position of the ribose sugar. The presence of this functional

group causes the helix to adopt the A-form geometry rather than the B-form most commonly observed in DNA. This results in a very deep and narrow major groove and a shallow and wide minor groove. A second consequence of the presence of the 2'-hydroxyl group is that in conformationally flexible regions of an RNA molecule (that is, not involved in formation of a double helix), it can chemically attack the adjacent phosphodiester bond to cleave the backbone.

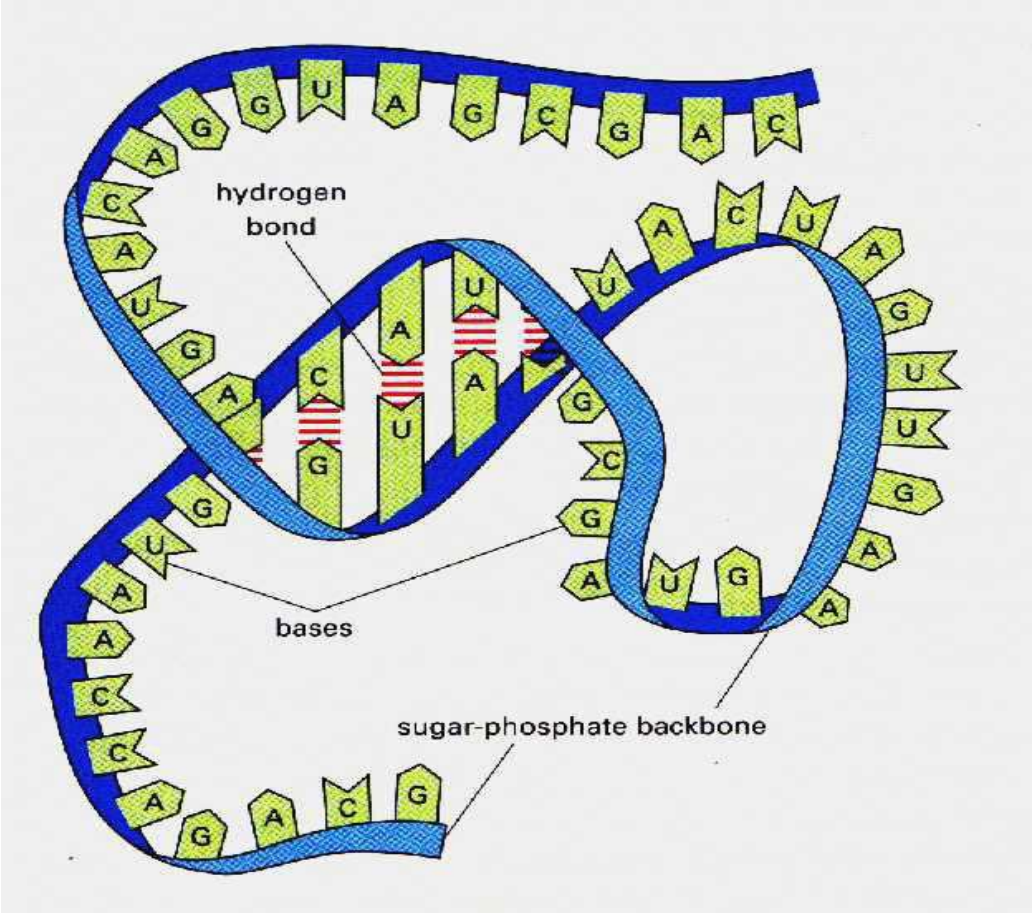


Secondary structure of a telomerase RNA

RNA is transcribed with only four bases (adenine, cytosine, guanine and uracil), but these bases and attached sugars can be modified in numerous ways as the RNAs mature. Pseudouridine (Ψ), in which the linkage between uracil and ribose is changed from a C–N bond to a C–C bond, and ribothymidine (T) are found in various places (the most notable ones being in the TΨC loop of tRNA). Another notable modified base is hypoxanthine, a deaminated adenine base whose nucleoside is called inosine (I). Inosine plays a key role in the wobble hypothesis of the genetic code.

There are nearly 100 other naturally occurring modified nucleosides, of which pseudouridine and nucleosides with 2'-O-methylribose are the most common. The specific roles of many of these modifications in RNA are not fully understood. However, it is notable that, in ribosomal RNA, many of the post-transcriptional modifications occur in highly functional regions, such as the peptidyl transferase center and the subunit interface, implying that they are important for normal function.

The functional form of single stranded RNA molecules, just like proteins, frequently requires a specific tertiary structure. The scaffold for this structure is provided by secondary structural elements that are hydrogen bonds within the molecule. This leads to several recognizable "domains" of secondary structure like hairpin loops, bulges, and internal loops. Since RNA is charged, metal ions such as Mg^{2+} are needed to stabilize many secondary and tertiary structures.



3. **Explain the biological functions of nucleic acids.**

Ans: <u>Biological functions of nucleic acids</u>

Important functions are

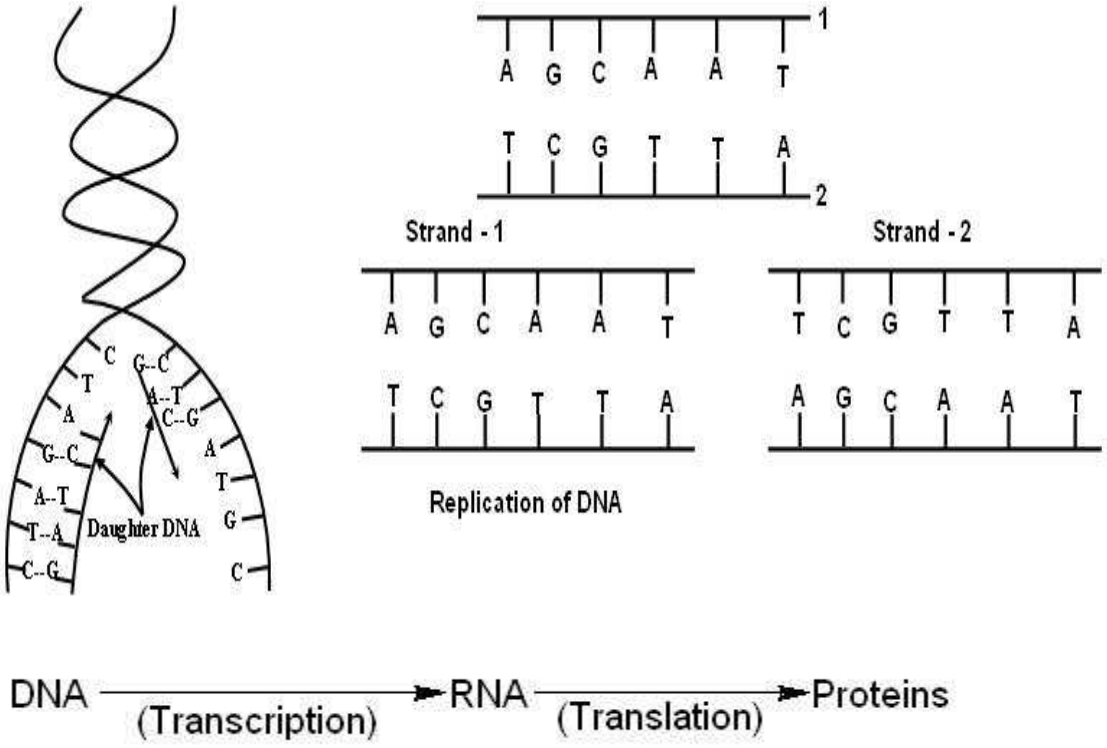
(1) Replication

(2) Protein synthesis → Transcription

(2) Protein synthesis → Translation

1. <u>Replication</u>

Process by which a single DNA molecule produces two identical copies of itself is called replication. Replication of DNA is an enzyme catalyzed process. In this process, two strands of DNA helix unwind and each strand serves as a template or pattern for the synthesis of a new strand. Newly synthesized complementary strand is an exact copy of the original DNA. In this way hereditary characteristics are transmitted from one cell to another.



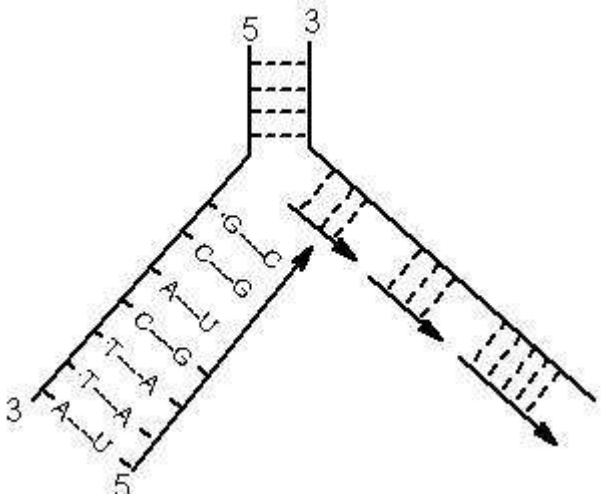
Transcription:

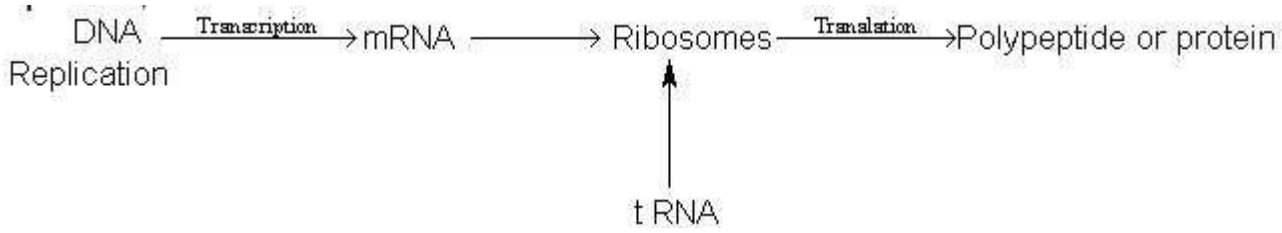
- It is the process of synthesis of RNA (mRNA) by using DNA as template. This process is similar to replication process. Differ in following ways.
- In transcription, ribose nucleotide assemble along the uncoiled template instead of deoxyribose nucleotide and base uracil (U) is substituted for the base thymine (T).
- Synthesis of RNA or DNA always takes place in 5' - 3' direction. Process is catalyzed by an enzyme RNA polymerase. In this way DNA transfers its genetic code to mRNA.
- After synthesis, RNA detaches from DNA and moves from nucleus to the cytoplasm where it acts as template for protein synthesis. DNA returns to its double helix structure.

Translation:

- It is the process of synthesis of protein. This process is directed by mRNA in the cytoplasm of cell with the help of tRNA (transfer RNA) and ribosomal particles (RNA – protein complex).
- The process occurs with the attachment of mRNA to ribosome particle mRNA then gives the message of the DNA and dictates the specific amino acid sequence for the synthesis of protein.

- 4 bases in mRNA act in the form of triplets and each triplet acts as a code for a particular amino acid. This triplet is called codon. There may be more than one codon for same amino acid. E.g. amino acid methionine has code AUG while glycine has 4 codons GGU, GGC, GGA, GGG.
- These codon expressed in mRNA is read by tRNA carrying anticodon and is translated into an amino acid sequence. This process is repeated again and again thus proteins are synthesized. After completion, it is released from ribosome.





BIOMOLECULES

Topic: 5

LIPIDS

VERY SHORT ANSWER QUESTIONS

1. **What are lipids?**

Ans: Lipids: The constituents of animals and plants soluble in organic solvents (ether, chloroform, carbon tetrachloride, hexane, benzene etc) but insoluble in water are called lipids. Lipids are naturally occurring carbon compounds related to fatty acids and esters of fatty acids. Lipids are important dietary components due to their high calorific value.

2. **What are common lipids?**

Ans: The common lipids are fats, oils, waxes, steroids, terpenes, phospholipids and glycolipids.
The above lipids are stored in adipose tissues and are present in all organism including viruses.
Lipids occur in seeds, nuts and fruits of plants. Lipids occur in adipose tissues, bone marrows and nervous tissues of animals. In the living cells lipids are present in cytoplasm and plasma membrane.

3. **How lipids are classified?**

Ans: Classification and Structures of Lipids:

- Lipids are classified into three groups
- Simple lipids (Homo lipids)
- Compound lipid (hetero lipids)
- Derived lipids (obtained from simple and compound lipids)

4. **What are waxes?**

Ans: Waxes: Waxes are insect secretions (or) protective coatings on animal furs and plant leaves. Waxes are chemically esters of long chain saturated (or) unsaturated fatty acids with long chain monohydric alcohols. The fatty acids range between C_{14} & $C_{36.}$ The alcohols range between C_{16} & $C_{36.}$ Free fatty acids, alcohols and some hydrocarbons are also present mixed with the ethers. Waxes have higher melting points than neutral fats.

Examples:–

1) Bee's wax: - Secreted by bees. It is a palmitic acid ester of myricyl alcohol. (C_{30} H_{61} OH)

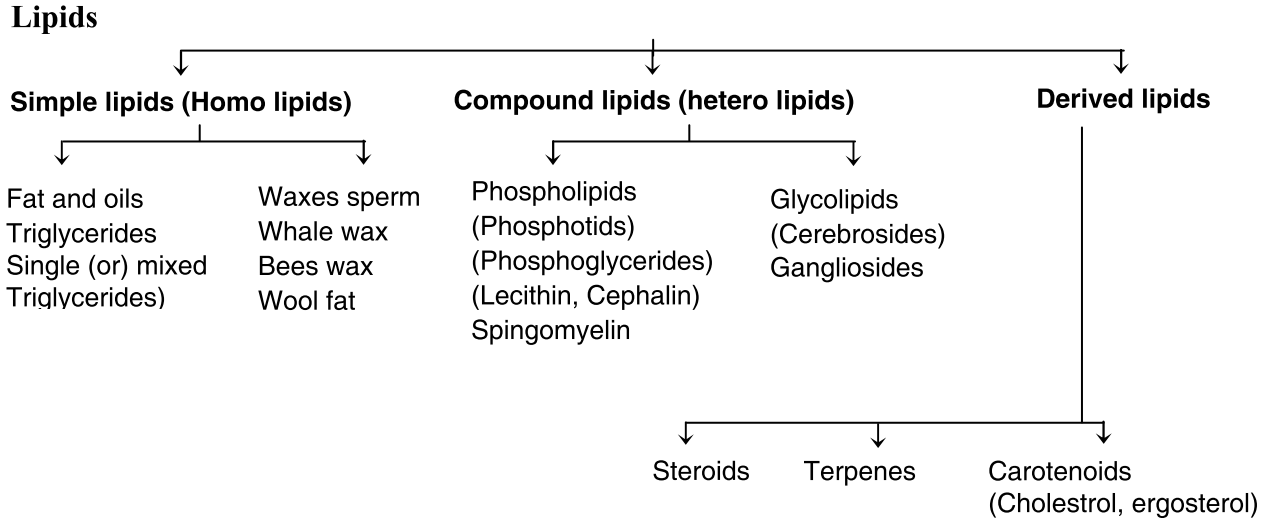
2) Spermacetic:- Palmitic acid ester of cetyl alcohol ($C_{16}H_{33}OH$). It is obtained from sperm whale oil.
3) Lanoline wool (or) fat: – Palmitic acid (or) Stearic acid (or) oleic acid ester of cholesterol. It is obtained from wool.

SHORT ANSWER QUESTIONS

1. Draw the flow diagram of classification of lipids.

Ans:

Some acids contain more than one double bond which is not conjugated.



2. Explain the biological importance of lipids.

Ans: Biological importance of lipids:-

- Fats are important food reserves of animals and plant cells.
- Simple lipids act as important sources of energy in our food supply.
- Phospholipids serve as structural materials of cells and tissues such as cell membrane.
- Phospholipids are used as detergents to emulsify fat for transport within the body.
- Cholesterol is the principal sterol of higher animals and abundant in nerve tissues and gallstones.
- Simple lipids can acts as heat insulators and shock absorbers for the living organism.
- Lipids are essential for the absorption or fat soluble vitamin like A, D, E & K.
- Enzyme activators.

LONG ANSWER QUESTIONS

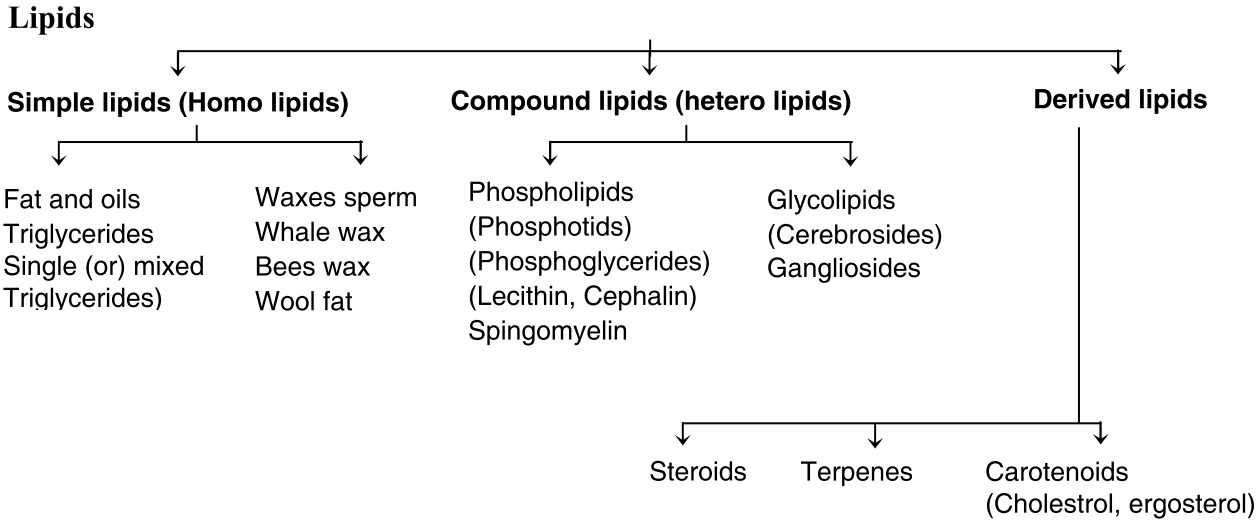
1. **Explain the classification of lipids.**

Classification and Structures of Lipids:

Lipids are classified into three groups

- Simple lipids (Homo lipids)
- Compound lipid (hetero lipids)
- Derived lipids (obtained from simple and compound lipids)

Some acids contain more than one double bond which are not conjugated.



i) Simple Lipids:

Simple lipids are alcohol esters of fatty acids which include neutral fats and waxes.

These fatty acids contain even number of carbon atoms and are both saturated and unsaturated carboxylic acids.

Simple lipids are known as triglycerides (or) triacyl glycerols.

Some simple lipids are solids (or) liquids at room temperature.

Solids are called fats and liquids are called oils.

- The structure of simple lipid is

$$\begin{array}{l} CH_2 - OCOR^1 \\ | \\ CH\ - OCOR^2 \\ | \\ CH_2 - OCOR^3 \end{array}$$

R^1, R^2, R^3 = Alkyl groups of fatty acids

R^1, R^2, R^3 = may be same (or) different.

ii) Compound lipids:

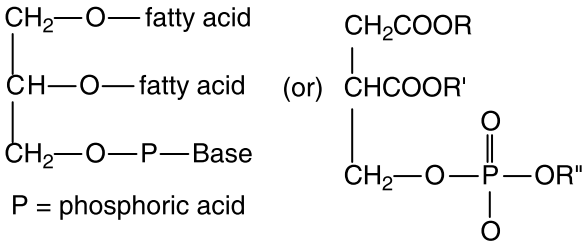
Compounds (or) Heterolipids contain additional groups such as phosphoric acid, nitrogen containing bases and other substituents.

Compound lipids are classified into

1) Phospholipids 2) Glycolipids 3) Terpenes.

1)Phospholipids

Phospholipids contain phosphoric acid, nitrogen containing bases and other substituents as additional groups.



Phospho lipid

- The common examples of phospholipids are Lecithins and Cephalins which are found principally in the brain, nerve cells, and liver of Animals.

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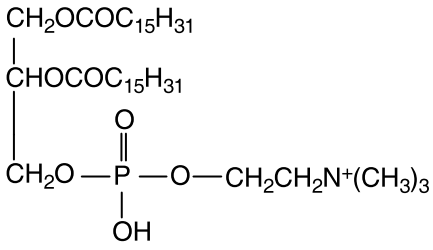
Phospholipids are further classified into

1) Glycerophosphatides
2) Phosphoinositides
3) Phosphosphingosides.

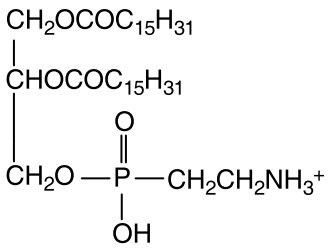
- **Glycerophosphatides** contain glycerol, Fatty acids, phosphoric acid and a base. The base may be choline, ethanolamine, serine (amino acid).
- **In phosphoinositides** the cyclic hexahydric alcohol (inositol) replaces the base.
- In phosphosphingosides glycerol is replaced by complex amino alcohol (sphingol).

- **Glycolipids** esters of fatty acids with carbohydrates and may contain nitrogen but no phosphorous.

Structure of some phospholipids



Lecithin



Cephalin

Derived fats:-

- **Terpenes** are polymers of 5-carbon unit called Isoprene. The side chains of A, E and K and the carotenes belong to this group.
- Derived fats are hydrolysis products of simple and compound lipids. The products include Glycerol, fatty acids, sphingosine (amino alcohol), steroids, terpenes & Carotenoids.
- Sterol means solid Alcohol.
- Cholestrol, ergosterol, bile acids, sex hormones, D–vitamin are the some of sterol derivatives.
- Sours of cholesterol are solid alcohol from bile, brain, nervous tissues, adrenal glands and egg yolk.
- Formula of cholesterol is C_{27} H_{45} OH.
- Ergosterol:- Solid alcohol present in fungi, yeast and ergot.
- Formula of Ergosterol is C_{28} H_{43}OH.

BIOMOLECULES

Topic: 6

HORMONES

VERY SHORT ANSWER QUESTIONS

1. What are hormones?

Ans: Hormones are molecules of carbon compounds that transfer biological information from one group of cells to distant tissue (or) organs. **Hormones** are also called **chemical messengers** because of the action of hormones as communication among cells.

2. **Where hormones are produced?**

Ans: Hormones are produced in ductless glands and they are called **endocrine glands**

3. What are growth hormones?

Ans: Plant hormones are called **growth hormones.**

4. What is Transmatic acid?

Ans: Transmatic acid is an open chain dicarboxylic acid with one double bond and induces cell division. Absicic acid is a sesquiterpene and induces prototropism.
Morphactin inhibits mitosis, formation of branches is promoted. These are derivatives of fluorine-9- carboxylic acid

5. What are the biological functions of hormones?

Ans: General Biological functions of animal hormones:

- Maintaining constant internal environment of organs.
- Ex. Insulin maintains constant sugar level in blood.
- Sex hormones develop secondary sexual characters.
- Adrenaline is responsible for some emergency reaction.
- Some metabolic reaction are controlled by hormones

SHORT ANSER QUESTIONS

1. **How hormones are classified?**

Ans: **Classification of Hormones**

Based on the structures of hormones these are classified into three main types.

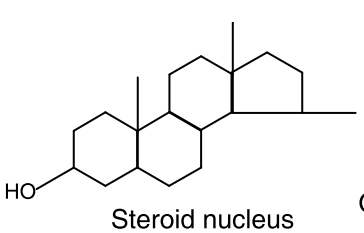
1) Steroid hormones 2) Protein hormones

3) Amine hormones.

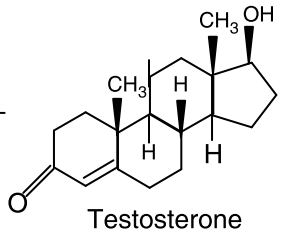
1. **Steroid hormones** are mostly secreted by testis, adrenal cortex of males and ovary.
   The common examples of steroid hormones are testosterone, dihydrotestosterone, and androgens.
   During puberty these stimulate the male sex characteristics.
   In females estrogens are female sex hormones which are produced in ovaries and are responsible for development of female sex characteristics during puberty.

2. **Protein hormones** are produced by pancreas, parathyroid, pituitary and gastro intestinal mucosa.
   The common examples of protein hormones are oxytoxin, vasopressin and Insulin.

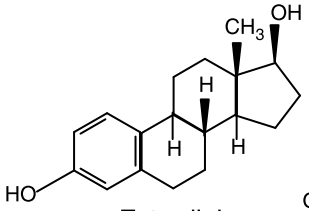
3. **Amino hormones** are produced by thyroid and adrenal medulla.
   Steroid hormones contain a steroid nucleus which is based on a four ring network consisting of three cyclohexane rings and one cyclopentane ring.



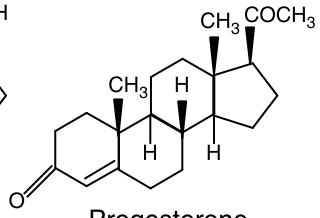
Steroid nucleus



Testosterone



Estradiol



Progesterone

- Hormones are required in trace amounts but are highly specific in their functions.
- Deficiency of any hormone leads to particular disease.
- Hormones are continuously produce but not stored in the body.
- Hormones are of Animal (or human) origin and plant origin.
- Hormones are carried to different parts of the body by the blood stream where they control the various body functions.
- The site of action of hormone is away from their origin.
- Hormones are generally proteins but not all of them are proteins.

- Hormones not only control different aspects of metabolism but also perform many other functions such as cell and tissue growth, heart rate, blood pressure, kidney function, secretion of digestive enzymes, the reproductive system etc.
- In mammals the secretion of hormones is controlled by the anterior lobe of the pituitary gland present at the base of the brain.

4. **What are plant hormones?**

Ans: Plant hormones:

Plant hormones regulate growth and physiological function at a site remote from the place of secretion. Plant hormones are produced by higher plants.

The plant hormones are

1) Auxins 2) Gibberlins
3) Cytokinins 4) Ethylene
5) Traumatic acid 6) Abscicic and
7) Morphactin.

- Auxins are cyclic carbon compounds and pentene derivatives.
- Auxine promote growth along the longitudinal axis.
- Gibberlinus are the derivatives of cyclic compound gibbane.
- Gibberlinus cause bolting (shoot elongations) and flowering.
- Cytokinins stimulate cell division, promote cell elongation and induce flowering in short day plants.
- Ethylene accelerates the colouring of harvested fruits like lemons, induces rooting and flowering.

LONG ANSWER QUESTION\

1. How hormones are classified?

Ans: Hormones are classified in to two categories;

I. Steroid hormones

Steroid hormones are two types.

1) Adrenal cortical hormones (cortico steroids)
2) Sex hormones.

1) Cortico steroids are mainly two types.

a) Mineralo corticoids b) Gluco corticoids.

a) Mineralo corticoids are produced by different cells in the adrenal cortex.

Mineralo corticoids useful for water–salt balance in the body. These cause excretion of potassium in urine.

b) Glucocorticoids are made by cortex. These are useful to modify certain metabolic reactions.

Gluco corticoids have anti–inflammatory effect.

2) Sex hormones are three types.

1) Male sex hormones (or) androgens

2) Female sex hormones (or) estrogens

3) Pregnancy hormones (or) progesterone.

Testosterone is the major male sex hormone produced by testes and responsible for the development of male secondary sexual characteristics such as deep voice, facial hair, sturdy physical structure.

Synthetic testosterone analogs are used in medicine to promote muscle and tissue growth. These are also used by athletes illegally to promote their muscle and tissue growth.

Estradiol is the main female sex hormone responsible for development of secondary female characteristics such as breast development, shrill voice, and long hair and participates in control of the menstrual cycle.

Progesterone is responsible for preparing the uterus for implantation of the fertilized egg. These are also useful as birth control agents.

II. Non steroid hormones:

Non-steroid hormones are mainly two types.

1) Peptide hormones

2) Amino acid derivative hormones.

1) **Peptide hormones** are peptide compounds.

Ex. Insulin, oxytocin.

Insulin is responsible for controlling the glucose level in our blood and its deficiency leads to the disease **diabetes**. Insulin is secreted by pancreas. Insulin is a dipeptide consisting of two peptide chains bound by three S-S bonds. One chain contained 21 amino acids and the other chain contained 30 amino acids. Sulphur bridges connect cysteine amino acids in the two chains. **Oxytocin** is produced by the pituitary gland.

Oxytocin induces lactation in breasts and helps in the contraction of uterus after child birth.

Amine hormones are amino acids and organic amine compounds.

Ex. Thyroxin, Adrenaline, & nor adrenaline.

Thyroxin is secreted by thyroid gland and it is responsible for the control of metabolism of some proteins, lipids and carbohydrates. Deficiency of thyroxin leads to the disease **goitre**. Addition of KI to table salt does not lead to the thyroxin deficiency. Adrenaline is responsible for maintenance of pulse rate and blood pressure. Non Adrenaline is secreted by adrenal glands and secretion of excess of non adrenaline in our body, when we are in anger causes hypertensions.

2) Amino acid derivatives:

Amino acid derivatives are thyroidal hormones.

e.g.: Thyroxin, Tri iodo thyroxin

Thyroidal hormones effect the general metabolism regardless of the specific activity. For this reason thyroid gland is called pace setter of the endocrine systems.

Site of Activity:

On the basis of site of activity hormones are divided into two categories. The first category effects the properties of plasma membrane.

Ex. All peptide hormones (Insulin, hormones of pituitary gland).

The hormones of other category are taken into the cell and carried to the cell nucleus and influence the gene expression.

BIOMOLECULES

Topic: 7

ENZYMES

VERY SHORT ANSWER QUESTIONS

1. What are enzymes?

Ans: Enzymes are the biocatalysts of life. They are defined as biocatalysts synthesized by living cells. They are simple or conjugate protein and specific in action.

2. What are different types of enzymes?

Ans: At present about 300 enzymes are recognized and classified into six classes by International Union of Biochemistry (IUB). They are: Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases and Ligases. However about ~10% i.e., 300 enzymes are commercially available.

3. What are the functions of enzymes?

Ans: The enzyme facilities a biochemical reaction by providing alternative lower activation energy pathways thereby increasing the rate of reaction. Enzymes being proteins having colloidal nature often get inactivated during reactions and have to be constantly replaced by synthesis in the body.

4. What is 'Holoenzyme'?

Ans: The functional unit of enzymes is called 'Holoenzyme'. This is made up of 'apoenzyme' which is a protein part and a non protein part called prosthetic group. The prosthetic group which is covalently attached with the enzyme is known as cofactor.

$$\text{Apoenzyme} + \text{Co-enzyme} \longrightarrow \text{Holoenzyne}$$

(Protein part) (Non protein part) (Active enzyme)

5. What is co-enzyme?

Ans: The prosthetic groups which get attached to the enzyme at the time of reaction are known as coenzymes.

SHORT ANSWER QUESTIONS

1. **What are the general characteristics of enzymes?**

Ans: General Characteristics of Enzymes

- Enzymes lower/ reduce the activation energy required to carry out the reaction.
- Enzymes themselves do not undergo any change, means they remain intact at the end of reaction.
- Enzymes are highly specific for their substrates.
- Enzymes are present in very less amount in body and have specific life span.
- Activator is the molecule that enhances the enzyme activity.
- Inhibitors are the molecules that reduces the enzyme activity

2. **On what factors the activities of enzymes depend?**

Ans : Activity of enzymes depends upon:

- Concentration of specific enzymes
- Concentration of its substrate
- pH of reaction
- Temperature of reaction
- Concentration of salts
- Presence of activator or inhibitor
- Time required to carry out the reaction
- Presence of proteolytic enzymes.

3. **What are the applications of industrial enzymes?**

Ans; Applications of Industrial Enzymes

a) Detergents

b) Starch hydrolysis and fructose production

c) Drinks

d) Textiles

e) Animal feed

f) Baking

g) Pulp and Paper

h) Leather

i) Special enzymes: Widely used in DNA-Technology

j) Enzymes in analytics: Alkaline phosphatase, glucose oxidase

k) Enzymes in personal care products: Tooth paste, enzyme solution for lens cleaning

l) Enzyme in chemical production: Formate dehydrogenase

The industrial enzyme market is growing at steady rate and requires improved production efficiency such that enzymes are available at low price and can be used in widest applications.

4. What are the advantages of microbial enzymes?

Ans; Advantages of Microbial Enzymes

1) Natural origin and nontoxic

2) Highly specific in nature

3) Work best under mild conditions of moderate temperature, neutral pH

4) Can act at low concentrations and rate of reaction can be controlled by adjusting temperature, pH, and amount of enzyme used

5) Can be easily inactivated once the reaction is completed

Microbial enzymes are also of high clinical value as they are used in surgical removal of foreign matter and dead tissue from wound. Some of them are streptokinase, crystalline trypsin, and chymotrypsin.

For clinical and therapeutic uses the microbial enzymes need to be of highest purity and crystalline in nature. As on date research is on towards utilization of the microbial enzymes at higher volume

LONG ANSWER QUESTIONS

1. **Explain the action of enzymes?**

Ans: Active site of an enzyme binds the substrate and forms Enzyme substrate complex. Active site is a small region on enzyme at which the substrate binds and participates in catalysis. The enzyme substrate complex formed release enzymes and products. Thus the free enzyme is available for reuse.

The enzymatic reaction proceeds this four stages.

i) Formation of complex between enzyme and substitute (ES)

ii) Conversion of this complex to in enzyme-intermediate complex (EI)

iii) Further conversion to a complex between enzyme and product (EP)

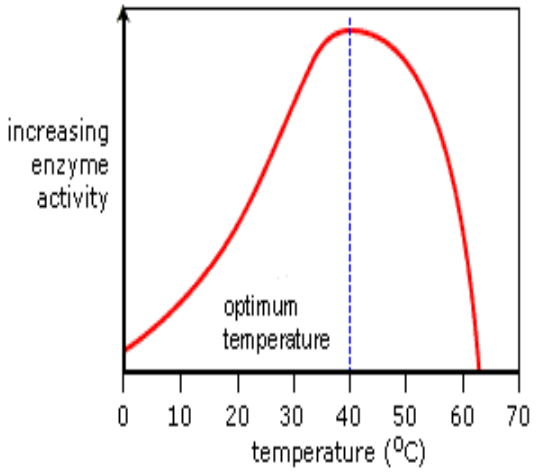
iv) Dissociation of the enzyme - product complex, leaving the enzyme unchanged.

$$E + S \rightleftharpoons ES \longrightarrow E + P$$

(Enzyme) + (Substrate) — (Enzyme - Substrate complex) — (Enzyme) + (Products)

2. **Explain the effect of temperature on enzymes.**

Ans**:** **Effect of Temperature in Enzymes:** Due to pertinacious nature, enzymes are very sensitive to heat. The rate of an enzyme action increases with rise in temperature, the rate of action increases 2 to 3 times for a rise in temperature of 10°C, i.e., the value of temperature quotient or Q_{10} is 2 to 3. But at higher temperatures, the value of coefficient does not remain constant and decreases rapidly. Above 60°C, the enzymes coagulate and thus become inactivated due to irreversible change in their chemical structure.



It has been observed that the initial velocity of reaction increases steadily with increase in temperature. After a certain temperature is passed, the cessation of activity comes earlier and fewer products are formed.

So the optimum temperature for enzyme activity is that at which two factors, increased initial rate and decreased active life of the enzyme are balanced to produce the most product in a reasonable time.

At 60°C to 70°C, in a liquid medium the enzymes are inactivated and destroyed. This destruction of enzymes at high temperature results in coagulation and denaturation. Thus as the temperature is raised, the reaction rate increases upto a certain limit and above that the enzymes get denatured. The temperature, at which the rate of reaction in maximum, is known as optimum temperature.

In general, the optimum temperature range for most enzymes varies between 30° and 45°C. Since enzymes are globular proteins, most are thermolabile and begin to denature at temperature between 45° and 50°C.

Mammalian enzymes often have optimum temperatures in the range 35°-45°C; where as the enzymes from the bacteria that live in volcanic hot springs may have optima of 80°C.

The enzymes of dry tissues like seeds and spores can endure still higher temperatures of about 100° to 120°C.

3. **Explain the nomenclature of enzymes.**

Ans: Enzyme Nomenclature or Naming of Enzyme: Numerous enzymes are known and being discovered and the list is endless, hence it was considered to have proper naming architecture for enzymes. Initially enzymes were named on source of production, location, type of reaction catalyzed, substrate on which they act, and product formed. It ended in endless list of enzymes in various living organisms irrespective of their order in animal or plant kingdom.

Hence International Union of Biochemist association framed Enzyme Commission and decided to classify enzymes based on some specific criteria and accepted that each enzyme should end by a suffix –ase. This was done keeping in view of increased number of enzymes and evolution of separate functional biomolecular class.

Scheme of Enzyme classification by IEC

The IEC gives a code and each letter contains its own significance in relation to that particular enzyme. During classification every enzyme is prefixed by **EC**, followed by the digits.

For example*:* oxidoreductases EC 1.1.1.1

(a)The first digit denotes "**Class**" of the enzyme

(b)The second digit indicates "**Sub-class**" of the enzyme

(c)The third digit gives "**Sub sub-class**" of the enzyme

(d)The fourth digit in the code is "**Serial number**" of the enzyme

The classification if as follows:

Group Name	Type of Reaction catalysed	Example
Oxidoreductases	Oxidation-reduction reactions	Alcohol oxidoreductase (EC 1.1)
Transferases	Transfer of functional groups	Methyltransferase(EC 2.1)
Hydrolases	Hydrolysis reactions	Lipase (EC 3.1)
Lyases	Addition to double bonds or single bonds	Decarboxylases (EC 4.1)
Isomerases	Isomerization reactions	Epimerases and Racemases (EC 5.1)
Ligases	Formation of bonds with ATP cleavage	Enzymes forming carbon-oxygen bonds (EC 6.1)

4. Explain the classification of enzymes.

Ans: Enzyme Classification

Class 1 Oxidoreductases: Enzymes involving in oxidation and reduction reactions in a metabolic process and enzymes representing this class are named as donor:acceptor oxidoreductase, or can alternately named as reductase and even as oxidase if oxygen is electron acceptor.

Class 2 Transferases: Enzymes catalyzing transfer of specific functional group. Named as acceptor group transferase or donor: acceptor group transferase.

$$X\text{-}Y + Z = X + Z\text{-}Y$$

Class 3 Hydrolases: Enzymes involved in hydrolysis of C-O, C-N, C-C by splitting of water molecule.

Class 4 Lyases: Enzymes involved in splitting of C-C, C-O, C-N without involving water molecule.

Class 5: Isomerases: Enzymes involved in interconversion of biomolecule from one isomeric form to the other. These enzymes can be referred as racemases, epimerases, cis-trans-isomerases, isomerases, tautomerases, mutases or cycloisomerases.

Class 6: Ligases: Eznymes capable of catalyzing the joining together 2 molecules with hydrolysis of diphosphate bond in ATP.

Enzymes are under use as since mankind has started. They were used in cheese manufacturing using yeasts and bacteria in food manufacturing. Enzymes which were isolated were first used in detergents earlier. The protein nature was discovered later and slowly the industrial applications also increased.

The world is slowly recognizing the industrial enzyme business and is under steady growth due to improved production technologies, engineered enzyme properties and new application fields. Most of the industrial enzymes are produced by microorganisms in biological reactors called as fermentors.

Basically large volumes of industrial enzymes are usually not purified but are often commercialized as concentrated liquids or granulated dry products. It is of higher importance that enzymes used in diagnostics or DNA-technology need to be highly purified. Enzymes which are isolated from biological sources are with several applications chemical industry.

5. **Explain the effect of P^H on enzymes.**

Ans: Effect of Ph on Enzymatic Activity: The pH represented as acidity or alkalinity of a medium or of a system has direct impact on the functioning of enzymes. Ph of a system affects the ionization state of the amino acids in the protein which can be acidic or basic in nature. It is known that acidic amino acids have carboxyl functional groups and basic amino acids possess amine functional groups as the side chains. As ionization of amino acids get altered the ionic bonds determining the 3-D shape of the protein also get altered. It results in differential recognition of substrates by enzymes and in turn slows down the active nature of enzymes.

It is proven that changes in pH affect the shape of enzyme but also differ with the charge of the substrates such that substrate is not able to bind to the active site and results in autocatalysis.

Variations in pH level to high or low can cause complete or total loss of the enzymatic activity and also the stability.

Regulation of Enzyme Activity with Ph

As explained above enzymes are particular regarding the pH changes in the environment and on analysis it is observed that they have specific optimum pH requirement at which they show maximum activity and in turn maximum conversion of substrate to product takes place.

Example of Enzymes with optimum pH

Lipase (Pancreas)	8.0
Lipase (stomach)	4.0-5.0
Lipase (Castor oil)	4.7
Pepsin	1.5-1.6
Trypsin	7.8-8.7
Urease	7.0
Invertase	4.5
Maltase	6.1-6.8
Amylase (Pancreas)	6.7-7.0
Amylase (Malt)	4.6-5.2
Catalase	7.0

From the above table it is obvious that different enzymes have different optimum pH levels at which they show optimum activity. The optimum range of pH for enzymes can range acidic to neutral and towards basic.

BIOMOLECULES

Topic: 8 VITAMINS

VERY SHORT ANSWER QUESTIONS

1. **Define vitamins?**

Ans: Vitamins are the organic compounds required for the normal maintenance and health of an organism in minute quantities and their absence cause specific deficiency diseases. These are required in diet in order to perform specific biological functions

2. **How vitamin D is produced?**

Ans: Vitamin D may be supplied through food or may be produced in the skin by irradiation of sterols with sunlight (UV light).

3. **What are fat soluble vitamins?**

Ans: These vitamins are soluble in fats, oils and in fat solvents like alcohol, etc. There are four fat soluble vitamins. They are: Vitamin A, Vitamin D, Vitamin E and Vitamin K.

4. **What are water soluble vitamins?**

Ans: These vitamins are soluble in water. They are again divided into B complex vitamins and non B complex vitamins. B-complex vitamins are - Thiamine (B_1), Riboflavine (B_2), Niacin (B_3), Pyridoxine (B_6), Biotin (B_7), pantothenic acid, Folic acid and Cyanocobalamine (B_{12}). Vitamin C is the non-B complex vitamin

SHORT ANSWER QUESTION

1. **How vitamins are classified?**

Ans: There are two types of vitamins

Water soluble vitamins - These vitamins are easily soluble and absorbed by our body but are not stored by the body. So, we need to take these vitamins daily in our diet. These vitamins are attained by our body through food which should always be prevented from overcooking that destroys vitamins. There are nine types of water soluble vitamins

- Thiamin
- Niacin
- Riboflavin
- Biotin
- Pyridioxine
- Panthothenic acid
- Vitamin B - 12
- Falate
- Vitamin C

Fat soluble vitamins - These vitamins are stored in body as fats and are absorbed by body through intestinal tract with the help of bile acid. We should always take proper intake of these vitamins as excess of these may cause irritability, weight loss, dry skin etc. Fat soluble vitamins are

- Vitamin A
- Vitamin K
- Vitamin D
- Vitamin E

2. **How vitamins are produced industrially?**

Ans: **Production of Vitamins:**

Vitamins can be produced on industrial scale by microorganisms.

For e.g.,

- Riboflavin (B_2) can be produced by Ashbya gossypii, Eremothecium ashybii
- Cobalamine (B_{12}) cause produced by bacteria propioni bacterium, Pseudomonas denitrificans, Bacillus megatherium, Streptomyces oleaceus
- a - Sorbode - a precursor of vitamin C can be produced from Acetobacter.

This is a fat soluble vitamin which is present mostly in animals. Its provitamins carotenes are found in plants. Vitamin A is necessary for vision and proper growth. It is necessary for maintenance of proper immune system to fight various infections. Cholesterol synthesis requires vitamin A. The carotenoids act as antioxidants and reduce risk of cancers

3. **What are the foods containing different types of vitamins?**

Ans: **Products Containing Different Types of Vitamins:**

1. **Vitamin A**: It helps in maintaining eyesight and healthy skin. It is present in eggs, milk, carrot, spinach and sweet potatoes etc.
2. **Vitamin B**: It includes vitamin B1, B2, B6, B12, niacin, folic acid, biotin, and pantothenic acid. Vitamin B generates energy for daily activities and maintains red blood cells. It is present in wheat, oats, seafood, leafy green vegetable, yogurt, beans and peas.
3. **Vitamin C:** It helps on strenghtning gums and muscles. Foods rich in Vitamin C include strawberries, tomatoes, broccoli, cabbage and etc.
4. **Vitamin D**: It is known as sunshine vitamin, because it is manufactured by body after exposure to sun. It is found in mushrooms, chickens breast, cows milk etc.
5. **Vitamin E**: It is important for the production of red blood cells and in the consumption of vitamin k .It helps in minimizing the appearance of wrinkles. It is present in avocado, blackberries, guava, mango, potatoes, pumpkins, almonds, eggs.
6. **Vitamin k:** It plays a critical role in blood clotting. It regulates blood calcium levels. It is present in blackberries, grapes, mango, beef etc.

LONG ANSER QUESTIONS

1. How vitamins are classified?

1. Fat soluble vitamins

These vitamins are soluble in fats, oils and in fat solvents like alcohol, etc. There are four fat soluble vitamins. They are: Vitamin A, Vitamin D, Vitamin E and Vitamin K.

These vitamins are stored in liver and are not readily excreted in urine and are not absorbed in the body unless fat digestion and absorption proceed normally. Among all the four vitamins only Vitamin K has a specific coenzyme function. Fat soluble vitamins are made up of one or more carbon units and hence they are called Isoprenoid compounds.

Their deficiency can cause malabsorptive disease.

Excess intake of these vitamins may cause hyper vitaminose

2. Water soluble vitamins

These vitamins are soluble in water. They are again divided into B complex vitamins and non B complex vitamins. B-complex vitamins are - Thiamine (B_1), Riboflavine (B_2),

Niacin (B_3), Pyridoxine (B_6), Biotin (B_7), pantothenic acid, Folic acid and Cyanocobalamine (B_{12}). Vitamin C is the non-B complex vitamin.
These vitamins are not stored in the body (except B_{12}). Hence, they are to be continuously supplied in the diet. The biochemical reactions of these vitamins is through co-enzymes. The common deficiency symptoms of these vitamins are Dermatitis, glossitis, diarrhea, depression, etc.

2. **Explain the deficiency of vitamins and products containing different types of vitamins.**

a) Deficiencies of Vitamins

As we studied earlier that water soluble vitamins are not stored in body so their deficiencies is most common.

- Lack of vitamin C causes infection and reduction in wound healing
- Lack of Thia min and Niacin causes mental confusion and muscle weakness.
- Deficiency of Riboflavin and vitamin B6 can cause dermatitis.
- Folate and vitamin B 12 deficiency cause anemia.

Deficiency of fat soluble vitamins

- Children having deficiency of vitamin D suffer disease called rickets.
- Vitamin A deficiency causes intestinal deficiency.
- Lack of vitamin K causes excessive bleeding.

We should take care of water soluble vitamins as they cannot be stored by body.

b) Products Containing Different Types of Vitamins

1 **Vitamin A**: It helps in maintaining eyesight and healthy skin. It is present in eggs, milk, carrot, spinach and sweet potatoes etc.

2 **Vitamin B**: It includes vitamin B1, B2, B6, B12, niacin, folic acid, biotin, and pantothenic acid. Vitamin B generates energy for daily activities and maintains red blood cells. It is present in wheat, oats, seafood, leafy green vegetable, yogurt, beans and peas.

3 **Vitamin C:** It helps on strengthening gums and muscles. Foods rich in Vitamin C include strawberries, tomatoes, broccoli, cabbage and etc.

4 **Vitamin D:** It is known as sunshine vitamin, because it is manufactured by body after exposure to sun. It is found in mushrooms, chickens breast, cows milk etc.

5 **Vitamin E**: It is important for the production of red blood cells and in the consumption of vitamin k .It helps in minimizing the appearance of wrinkles. It is present in avocado, blackberries, guava, mango, potatoes, pumpkins, almonds, eggs.

6 **Vitamin k:** It plays a critical role in blood clotting. It regulates blood calcium levels. It is present in blackberries, grapes, mango, beef etc.

3. Explain the foods rich in different vitamins.

Food Rich in Vitamin

1. Vitamin A:

It is very essential vitamin. It gives good vision, renew our body tissue, and it gives the normal growth.

Food which is rich in vitamin A:

- Carrot
- Mango's
- Sweet potato
- Spinach
- Ghee
- Cheese
- Egg
- Milk

2. Vitamin B:

It is a very important metabolic activity – it is used to help make energy.

The vitamin B complexes are,

Vitamin B1, B2, B3, B5, B6, B12.

Vitamin B1: it is also said to be thiamin it is a water soluble vitamin.

Vitamin B2: it is also said to be riboflavin.

Vitamin B3: it is also said to be niacin.

Vitamin B6: it is also said to be pyridoxine.

Vitamin B12: it is necessary for proteins, carbohydrates, and proteins.

Food which is rich in vitamin B:

- Brazil nuts
- Potato
- Banana
- Oats
- Beef
- Green vegetables

3. Vitamin C:

Vitamin is very important for maintaining body tissues. It is used strengthen the body vessels.

Food which is rich in vitamin C

- Strawberry
- Peppers
- Tomato
- Mangoes
- Raspberry
- Orange
- Peaches
- Cauliflower
- Kiwi fruit
- Green cabbage.

4. Vitamin D:

It gives strong bones, and it is used to forming strong teeth.

Food which is rich in vitamin D:

- Cod liver oil
- Tuna
- Fish
- Milk
- Herring
- Egg yolks

5. Vitamin E:

It is very important vitamin to maintain a nerve and healthy reproductive system.

Food which is rich in vitamin E:

- Nuts and seeds
- Wheat

- Grains
- Leafy green vegetables
- egg

6. Vitamin K:

It is used for blood clotting and it is used to make kidney tissue and bone.

Food which is rich in vitamin k:

- Mustard greens
- Beet greens
- Cabbage
- Kale
- Milk
- Liver
- Fish oil
- Onions
- Peas
- Soybean oil