Chapter 14

Biomolecules

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2 Mark Questions

1. How are amino acids classified?

Ans. Amino acids are classified as essential and non – essential amino acids.

The amino acids which can be synthesized in the body are known as non – essential amino acids e.g. Asparetic acid, Glycine etc.

The amino acids which cannot be synthesized in the body and must be obtained through diet are known as essential amino acids. E.g. Histidine, lysine.

2. Differentiate between fibrous and globular proteins.

Ans.

Fibrous Proteins	Globular Proteins
1. Their molecules have long thread like structure.	1. They have folded ball – like structure
2. they have helical or sheet structures	2. They may have three dimensional Shapes.
3. They are in soluble in water but soluble in strong acids and bases. e.g. Keratin, fibroin etc.	3. They are soluble in water, acids and Bases and salts. e.g. Egg albumin, casein insulin.

3. Differentiate between α - helical and β - pleated sheet structure.

Ans.

α - helical structure	β - pleated sheet structure

1. In this structure, formation of hydrogen Bonding between amide groups within the same chain causes the peptide chains to coil up into a spiral structure like a right handed screw. e.g. α - keratin, skin, wool etc.	1. In this structure, the long peptide chains lie side by side in a zig-zag manner to form a flat sheet. Each chain is held to the two neighboring Chains by hydrogen bonds. These sheets can slide upon one another in three dimensional structures. e.g. fibroin present in silk etc.

4. What do you understand by secondary structure of proteins?

Ans. The secondary structure of protein refers to the shape in which a long polypeptide chain can exist arising due to regular folding of the backbone of poly peptide chain due to hydrogen bonding between > C = O and , - N –H group of poly peptide chain.

5. What is denaturation of proteins? Explain with examples.

Ans. Disruption of the native conformation of a protein by changing its environment like PH value, temperature etc. resulting into loss of its biological activity is called denaturation of proteins. During denaturation, secondary and tertiary structures get destroyed while primary structure remains same e.g., coagulation of egg albumin by boiling.

6. How are enzymes named? Give an example.

Ans. Enzymes are generally named after the compound upon which they work. e.g. enzyme that catalyses the hydrolysis of maltose into glucose is named maltase.

Some times enzymes are named after the reaction where they are used. e.g. the enzymes which catalyze reduction of other is called oxidoreductase.

7. Give an example of enzyme catalysed reaction.

Ans. Example of enzyme catalysed reaction –

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} \xrightarrow{\text{Maltase}} \underset{\text{Glucose}}{2\,C_6H_{12}O_6}$$

8. What are vitamins? Give two examples.

Ans. Vitamins are organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism. e.g. vitamins A, B, C, D etc.

9. How are vitamins classified?

Ans. Vitamins are classified into two groups depending upon their solubility's-

(i) Fat soluble vitamins – which are soluble in fats and oils. e.g. vitamins A, D, E & K.

(ii) Water soluble vitamins – which are soluble in water e.g. vitamins B& C.

10. Write the disease caused by deficiency of vitamins A, B_2, B_6, B_{12}, C, D E and K.

Ans.

Vitamin	Deficiency disease
A	Xerophthalmia, Night blindness
B_2	digestive disorders
B_6	Convulsions
B_{12}	Pernicious anaemia
C	Scurvy
D	Rickets
E	Muscular weakness
K	Increased blood clotting time.

11. Glucose or sucrose are soluble in water but cyclohexane or benzene (simple six membered ring compounds) are insoluble in water. Explain.

Ans. A glucose molecule contains five -OH groups while a sucrose molecule contains eight -OH groups. Thus, glucose and sucrose undergo extensive H-bonding with water.

Hence, these are soluble in water.

But cyclohexane and benzene do not contain -OH groups. Hence, they cannot undergo H-bonding with water and as a result, are insoluble in water.

12. What is glycogen? How is it different from starch?

Ans. Glycogen is a carbohydrate (polysaccharide). In animals, carbohydrates are stored as glycogen.

Starch is a carbohydrate consisting of two components - amylose (15 - 20%) and amylopectin (80 - 85%).

However, glycogen consists of only one component whose structure is similar to amylopectin. Also, glycogen is more branched than amylopectin.

13. What are essential and non-essential amino acids? Give two examples of each type.

Ans. Essential amino acids are required by the human body, but they cannot be synthesised in the body. They must be taken through food. For example: valine and leucine

Non-essential amino acids are also required by the human body, but they can be synthesised in the body. For example: glycine, and alanine

14. What type of bonding helps in stabilising the α-helix structure of proteins?

Ans. The H-bonds formed between the -NH group of each amino acid residue and

the $>C=O$ group of the adjacent turns of the α-helix help in stabilising the helix.

15. What is the effect of denaturation on the structure of proteins?

Ans. As a result of denaturation, globules get unfolded and helixes get uncoiled. Secondary and
tertiary structures of protein are destroyed, but the primary structures remain unaltered. It can be said that during denaturation, secondary and tertiary-structured proteins get converted into primary-structured proteins. Also, as the secondary and tertiary structures of a protein are destroyed, the enzyme loses its activity.

16. How are vitamins classified? Name the vitamin responsible for the coagulation of blood.

Ans. On the basis of their solubility in water or fat, vitamins are classified into two groups.

(i) Fat-soluble vitamins: Vitamins that are soluble in fat and oils, but not in water, belong to this group. For example: Vitamins A, D, E, and K

(ii) Water-soluble vitamins: Vitamins that are soluble in water belong to this group. For example: B group vitamins (B_1, B_2, B_6, B_{12}, etc.) and vitamin C

However, biotin or vitamin H is neither soluble in water nor in fat.

Vitamin K is responsible for the coagulation of blood.

17. Why are vitamin A and vitamin C essential to us? Give their important sources.

Ans. The deficiency of vitamin A leads to xerophthalmia (hardening of the cornea of the eye) and night blindness. The deficiency of vitamin C leads to scurvy (bleeding gums).

The sources of vitamin A are fish liver oil, carrots, butter, and milk. The sources of vitamin C are citrus fruits, *amla,* and green leafy vegetables.

18. The two strands in DNA are not identical but are complementary. Explain.

Ans.In the helical structure of DNA, the two strands are held together by hydrogen bonds between specific pairs of bases. Cytosine forms hydrogen bond with guanine, while adenine forms hydrogen bond with thymine. As a result, the two strands are complementary to each other.

19. What are the different types of RNA found in the cell?

Ans. (i) Messenger RNA (m-RNA)

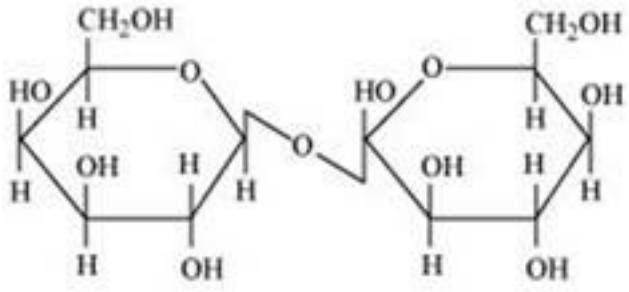
(ii) Ribosomal RNA (r-RNA)

(iii) Transfer RNA (t-RNA)

3 Mark Questions

1.What are the expected products of hydrolysis of lactose?

Ans. Lactose is composed of β-D-galactose and β-D-glucose. Thus, on hydrolysis, it gives β-D-galactose and β-D-glucose.

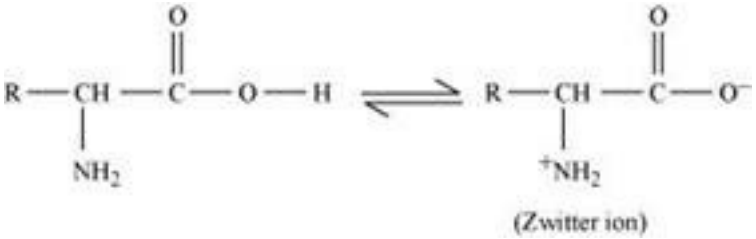


Lactose

$$\underset{\text{Lactose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\text{D-(+)-Glucose}}{C_6H_{12}O_6} + \underset{\text{D-(+)-Galactose}}{C_6H_{12}O_6}$$

2.The melting points and solubility in water of amino acids are generally higher than that of the corresponding halo acids. Explain.

Ans. Both acidic (carboxyl) as well as basic (amino) groups are present in the same molecule of amino acids. In aqueous solutions, the carboxyl group can lose a proton and the amino group can accept a proton, thus giving rise to a dipolar ion known as a zwitter ion.



(Zwitter ion)

Due to this dipolar behaviour, they have strong electrostatic interactions within them and with water. But halo-acids do not exhibit such dipolar behaviour.

For this reason, the melting points and the solubility of amino acids in water is higher than those of the corresponding halo-acids.

3. When RNA is hydrolysed, there is no relationship among the quantities of different bases obtained. What does this fact suggest about the structure of RNA?

Ans. A DNA molecule is double-stranded in which the pairing of bases occurs. Adenine always pairs with thymine, while cytosine always pairs with guanine. Therefore, on hydrolysis of DNA, the quantity of adenine produced is equal to that of thymine and similarly, the quantity of cytosine is equal to that of guanine.

But when RNA is hydrolyzed, there is no relationship among the quantities of the different bases obtained. Hence, RNA is single-stranded.

4. What are monosaccharides?

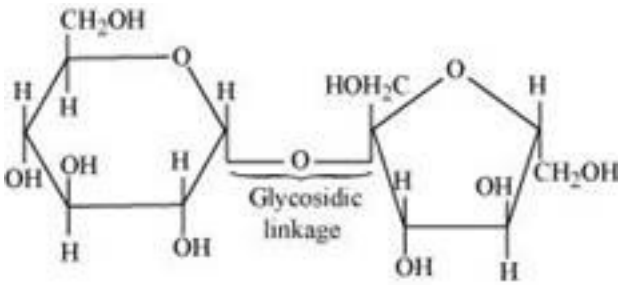
Ans. Monosaccharides are carbohydrates that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone.

Monosaccharides are classified on the bases of number of carbon atoms and the functional group present in them. Monosaccharides containing an aldehyde group are known as aldoses and those containing a keto group are known as ketoses. Monosaccharides are further classified as trioses, tetroses, pentoses, hexoses, and heptoses according to the number of carbon atomsthey contain. For example, a ketose containing 3 carbon atoms is called ketotriose and an aldose containing 3 carbon atoms is called aldotriose.

5. What do you understand by the term glycosidic linkage?

Ans. Glycosidic linkage refers to the linkage formed between two monosaccharide units through an oxygen atom by the loss of a water molecule.

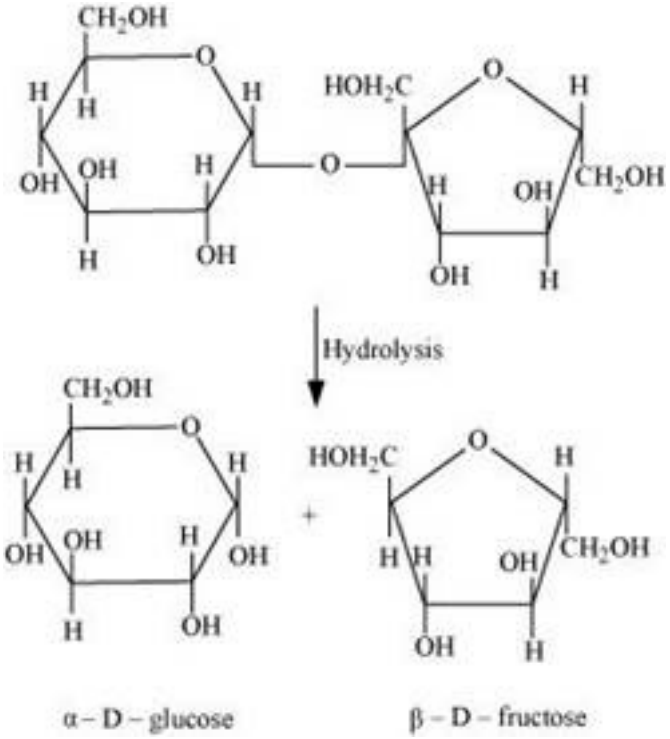
For example, in a sucrose molecule, two monosaccharide units, α-glucose and β-fructose, are joined together by a glycosidic linkage.



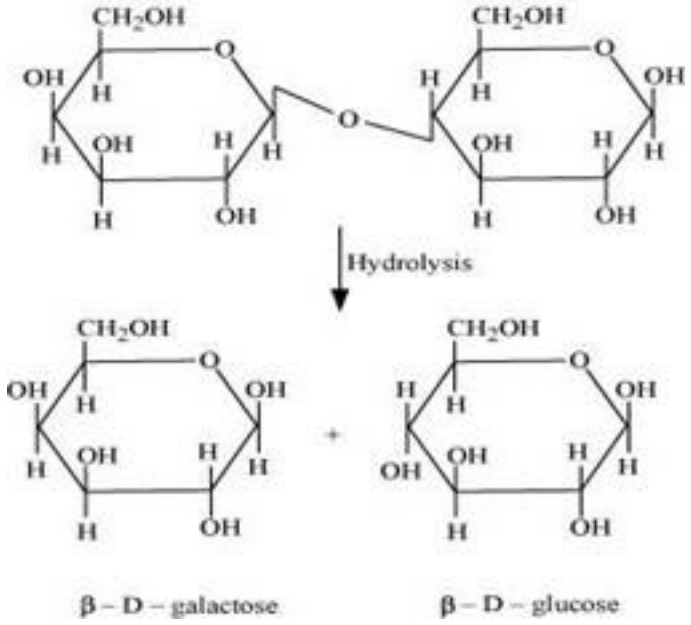
Surcose

6. What are the hydrolysis products of (i)sucrose and (ii)lactose?

Ans. (i) On hydrolysis, sucrose gives one molecule of α-D glucose and one molecule of β-fructose.



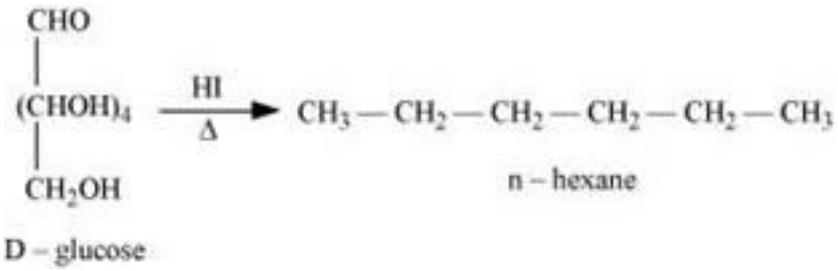
(ii) The hydrolysis of lactose gives β-galactose and β-glucose.



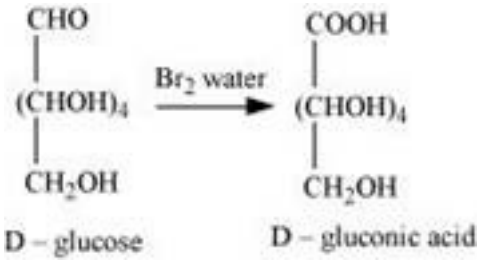
7. What happens when D-glucose is treated with the following reagents?

(i) HI (ii) Bromine water (iii) HNO_3

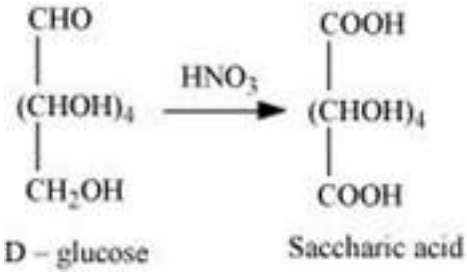
Ans. (i) When D-glucose is heated with HI for a long time, n-hexane is formed.



(ii) When D-glucose is treated with Br_2 water, D- gluconic acid is produced.



(iii) On being treated with HNO_3, D-glucose get oxidised to give saccharic acid.



8. Enumerate the reactions of D-glucose which cannot be explained by its open chain structure.

Ans. (1) Aldehydes give 2, 4-DNP test, Schiff's test, and react with $NaHSO_4$ to form the hydrogen sulphite addition product. However, glucose does not undergo these reactions.

(2) The pentaacetate of glucose does not react with hydroxylamine. This indicates that a free -CHO group is absent from glucose.

(3) Glucose exists in two crystalline forms - α and β. The α form (m.p. = 419 K) crystallises from a concentrated solution of glucose at 303 K and the β form (m.p = 423 K) crystallises from a hot and saturated aqueous solution at 371 K. This behavior cannot be explained by the open chain structure of glucose.

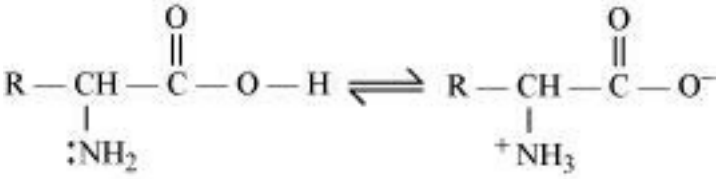
9. Differentiate between globular and fibrous proteins.

Ans.

Fibrous protein		Globular protein	
1.	It is a fibre-like structure formed by the polypeptide chain. These proteins are held together by strong hydrogen and disulphide bonds.	1.	The polypeptide chain in this protein is folded around itself, giving rise to a spherical structure.
2.	It is usually insoluble in water.	2.	It is usually soluble in water.
3.	Fibrous proteins are usually used for structural purposes. For example, keratin is present in nails and hair; collagen in tendons; and myosin in muscles.	3.	All enzymes are globular proteins. Some hormones such as insulin are also globular proteins.

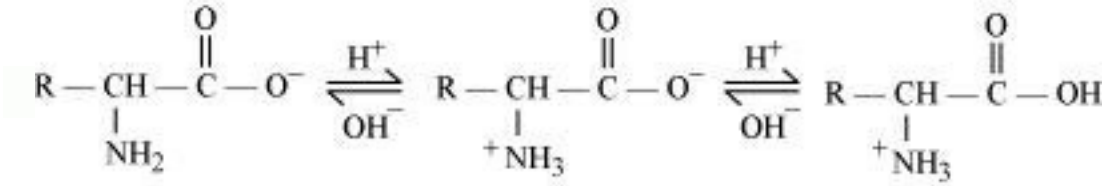
10. How do you explain the amphoteric behavior of amino acids?

Ans.I n aqueous solution, the carboxyl group of an amino acid can lose a proton and the amino group can accept a proton to give a dipolar ion known as zwitter ion.



Zwitter ion

Therefore, in zwitter ionic form, the amino acid can act both as an acid and as a base.



Thus, amino acids show amphoteric behaviour.

11. What are enzymes?

Ans. Enzymes are proteins that catalyse biological reactions. They are very specific in nature and catalyse only a particular reaction for a particular substrate. Enzymes are usually named after the particular substrate or class of substrate and sometimes after the particular reaction.

For example, the enzyme used to catalyse the hydrolysis of maltose into glucose is named as maltase.

Again, the enzymes used to catalyse the oxidation of one substrate with the simultaneous reduction of another substrate are named as oxidoreductase enzymes.

The name of an enzyme ends with '– ase'.

12. What are nucleic acids? Mention their two important functions.

Ans. Nucleic acids are biomolecules found in the nuclei of all living cells, as one of the constituents of chromosomes. There are mainly two types of nucleic acids - deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Nucleic acids are also known as polynucleotides as they are long-chain polymers of nucleotides.

Two main functions of nucleic acids are:

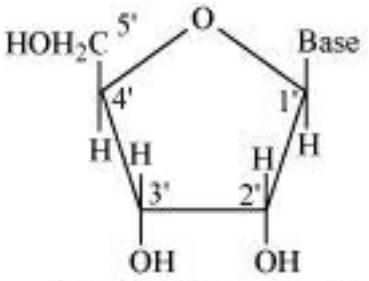
(i) DNA is responsible for the transmission of inherent characters from one generation to the next. This process of transmission is called heredity.

(ii) Nucleic acids (both DNA and RNA) are responsible for protein synthesis in a cell. Even though the proteins are actually synthesised by the various RNA molecules in a cell, the message for the synthesis of a particular protein is present in DNA.

13. What is the difference between a nucleoside and a nucleotide?

Ans. A nucleoside is formed by the attachment of a base to $1'$ position of sugar.

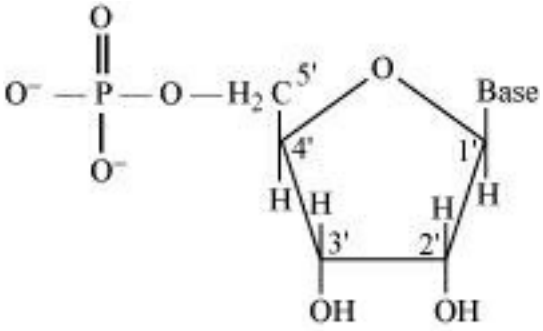
Nucleoside = Sugar + Base



Structure of a nucleoside

On the other hand, all the three basic components of nucleic acids (i.e., pentose sugar, phosphoric acid, and base) are present in a nucleotide.

Nucleotide = Sugar + Base + Phosphoric acid

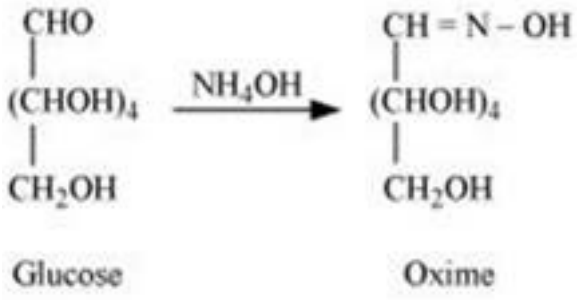


Structure of a nucleotide

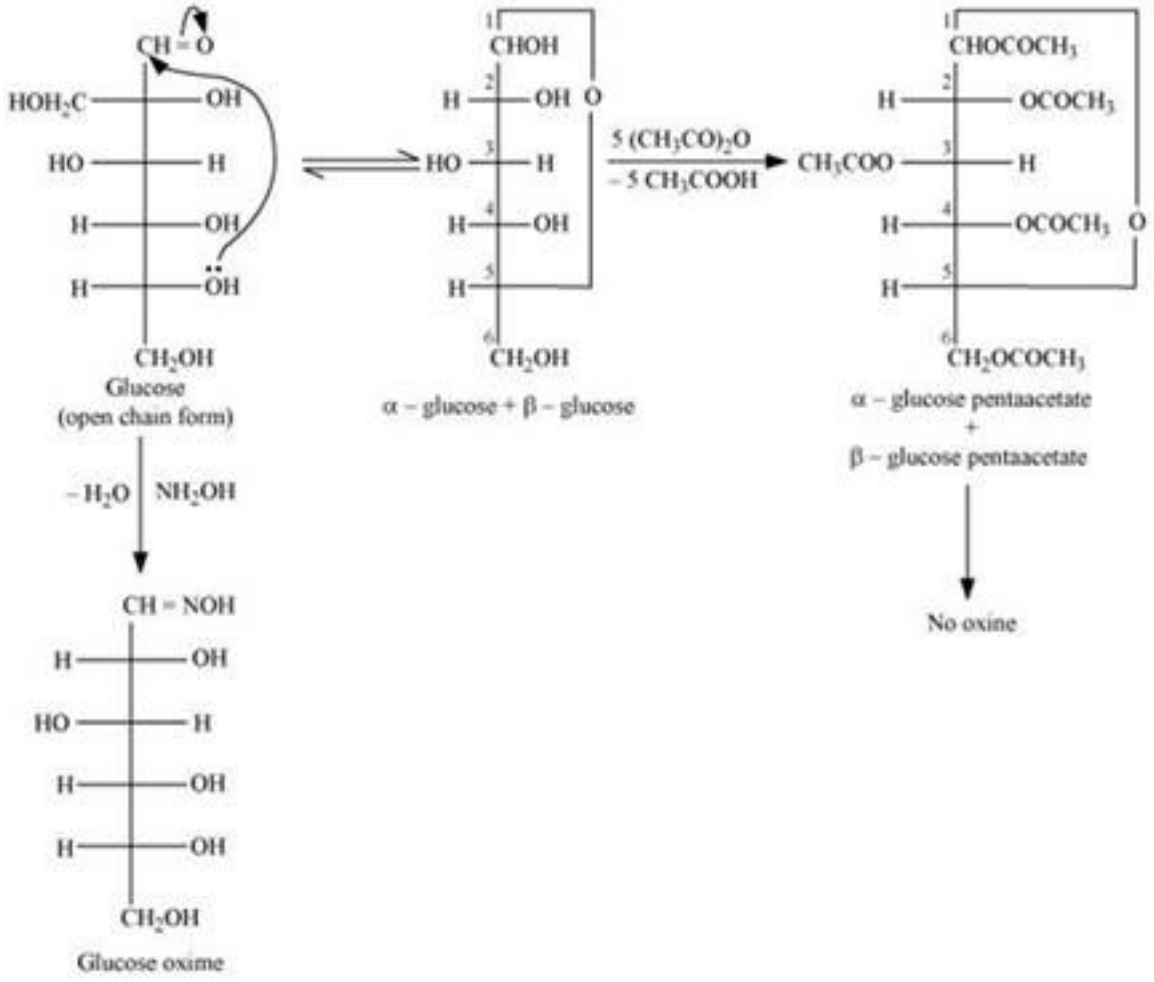
5 Mark Questions

1. How do you explain the absence of aldehyde group in the pentaacetate of D-glucose?

Ans. D-glucose reacts with hydroxylamine (NH_2OH) to form an oxime because of the presence of aldehydic (-CHO) group or carbonyl carbon. This happens as the cyclic structure of glucose forms an open chain structure in an aqueous medium, which then reacts with NH_2OH to give an oxime.

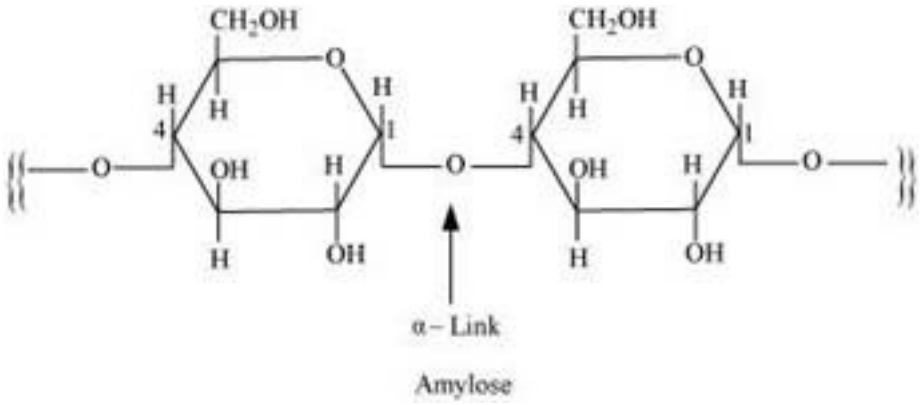


But pentaacetate of D-glucose does not react with NH_2OH . This is because pentaacetate does not form an open chain structure.



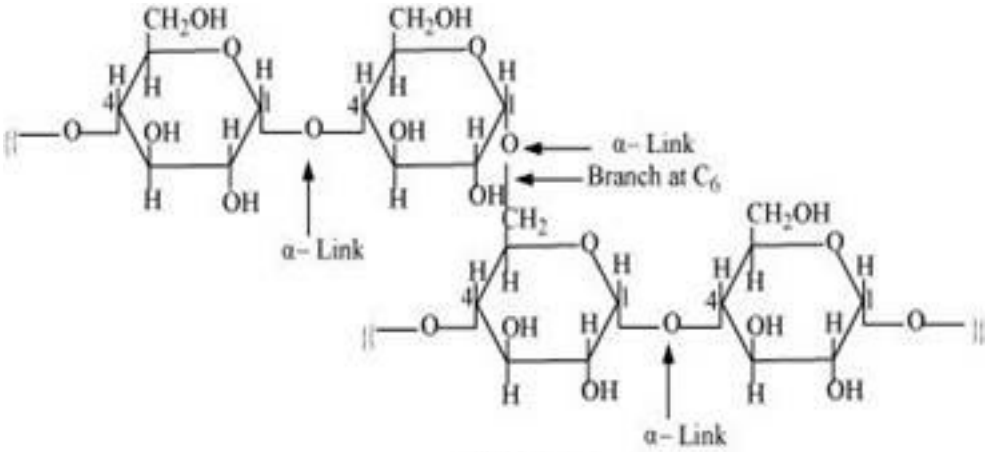
2. What is the basic structural difference between starch and cellulose?

Ans. Starch consists of two components - amylose and amylopectin. Amylose is a long linear chain of α-D-(+)-glucose units joined by $C_1 - C_4$ glycosidic linkage (α-link).



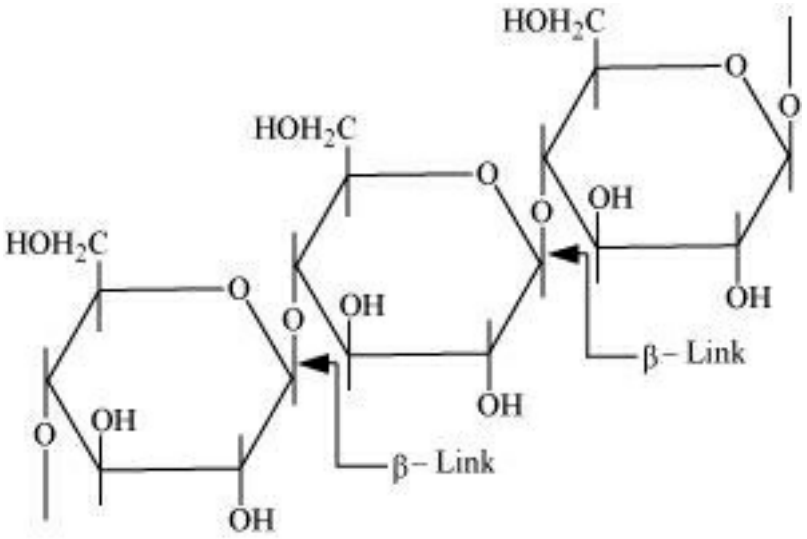
Amylose

Amylopectin is a branched-chain polymer of α-D-glucose units, in which the chain is formed by $C_1 - C_4$ glycosidic linkage and the branching occurs by $C_1 - C_6$ glycosidic linkage.



Amylopectin

On the other hand, cellulose is a straight-chain polysaccharide of β -D-glucose units joined by $C_1 - C_4$ glycosidic linkage (β -link).

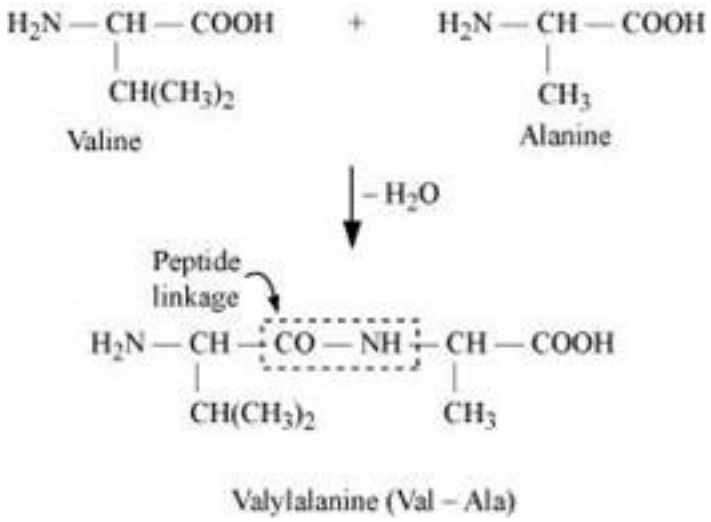


3. Define the following as related to proteins

(i) Peptide linkage (ii) Primary structure (iii) Denaturation.

Ans. (i) Peptide linkage:

The amide formed between -COOH group of one molecule of an amino acid and $-NH_2$ group of another molecule of the amino acid by the elimination of a water molecule is called a peptide linkage.



(ii) Primary structure:

The primary structure of protein refers to the specific sequence in which various amino acids are present in it, i.e., the sequence of linkages between amino acids in a polypeptide chain. The sequence in which amino acids are arranged is different in each protein. A change in the sequence creates a different protein.

(iii) Denaturation:

In a biological system, a protein is found to have a unique 3-dimensional structure and a unique biological activity. In such a situation, the protein is called native protein. However, when the native protein is subjected to physical changes such as change in temperature or chemical changes such as change in pH, its H-bonds are disturbed. This disturbance unfolds the globules and uncoils the helix. As a result, the protein loses its biological activity. This loss of biological activity by the protein is called denaturation. During denaturation, the secondary and the tertiary structures of the protein get destroyed, but the primary structure remains unaltered.

One of the examples of denaturation of proteins is the coagulation of egg white when an egg is boiled.

4. What are the common types of secondary structure of proteins?

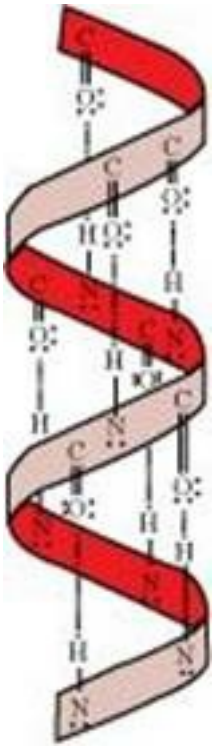
Ans. There are two common types of secondary structure of proteins:

(i) α-helix structure

(ii) β pleated sheet structure

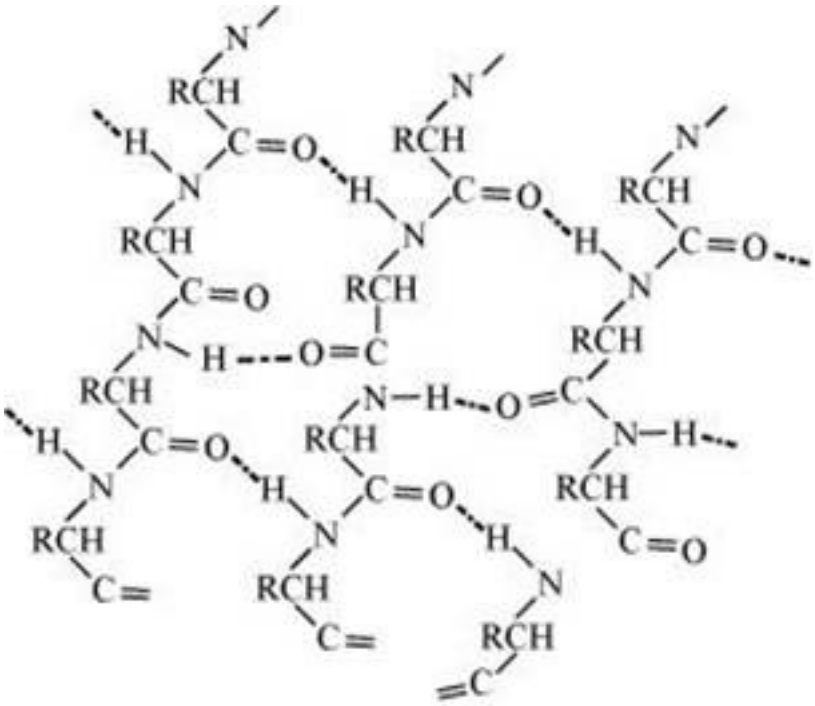
α- Helix structure:

In this structure, the -NH group of an amino acid residue forms H-bond with the $>C=O$ group of the adjacent turn of the right-handed screw (α-helix).



β pleated sheet structure:

This structure is called so because it looks like the pleated folds of drapery. In this structure, all the peptide chains are stretched out to nearly the maximum extension and then laid side by side. These peptide chains are held together by intermolecular hydrogen bonds.



5. Write the important structural and functional differences between DNA and RNA.

Ans. The structural differences between DNA and RNA are as follows:

DNA		RNA	
1.	The sugar moiety in DNA molecules is β-D-2 deoxyribose.	1.	The sugar moiety in RNA molecules is β-D-ribose.
2.	DNA contains thymine (T). It does not contain uracil (U).	2.	RNA contains uracil (U). It does not contain thymine (T).
3.	The helical structure of DNA is double-stranded.	3.	The helical structure of RNA is single-stranded.

The functional differences between DNA and RNA are as follows:

DNA		RNA	
1	DNA is the chemical basis of heredity.	1	RNA is not responsible for heredity.
2	DNA molecules do not synthesise proteins, but transfer coded message for the synthesis of proteins in the cells.	2	Proteins are synthesised by RNA molecules in the cells.