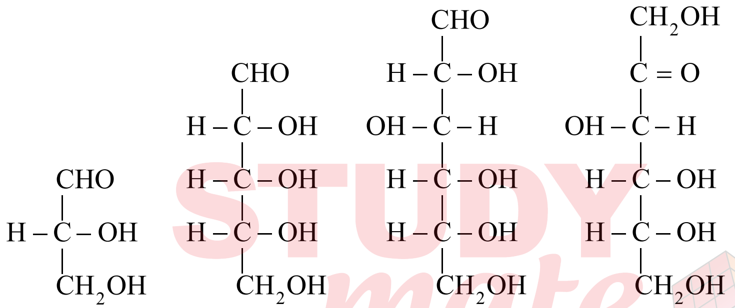
1. What are monosaccharides?

Sol. Monosaccharides are carbohydrates which cannot be hydrolysed to smaller molecules. Their general formula is $(CH_2O)_n$, where n = 3–7.

These are of two types: These which contain an aldehyde group (– CHO) are called aldoses and those which contain a keto (C = O) group are called ketoses.

They are further classified as trioses, tetroses, pentoses, hexoses and heptoses accordingly, as they contain 3, 4, 5, 6 and 7 carbon atoms, respectively. For example,



2. What are reducing sugars?

Sol. Carbohydrates which reduce Fehling's solution to red precipitate of Cu_2O or Tollen's reagent to metallic Ag are called reducing sugars. All monosaccharides (both aldoses and ketoses) and disaccharides except sucrose are reducing sugars. Thus, D-(+)-glucose, D-(+)-galactose, D-(–)-fructose, D-(+)-maltose and D-(+)-lactose are reducing sugars.

3. Write two main functions of carbohydrate in plants.

Sol. (a) Structural material for plant cell walls: The polysaccharides cellulose acts as the chief structural material of the plant cell walls.

(b) Reserve food material: The polysaccharide starch is the major reverse food material in the plants. It is stored in seeds and acts as the reverse food material for the tiny plant till it is capable of making its own food by photosynthesis.

4. Classify the following into monosaccharides and disaccharides.

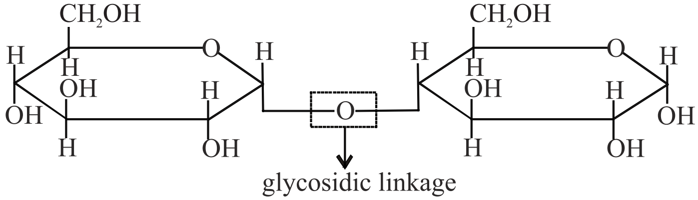
Ribose, 2-deoxyribose, maltose, galactose, fructose and lactose.

Sol. **Monosaccharides:** Ribose, 2-deoxyribose, galactose and fructose.

Disaccharides: Maltose and lactose.

5. What do you understand by the glycoside linkage?

Sol. The ethereal or oxygen linkage through which two monosaccharides are joined together by the loss of a water molecule to form a molecule of disaccharide is called the glycosidic linkage. The glycosidic linkage in maltose molecule is shown below:



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

Sol. Starch is not a single compound but is a mixture of two components – a water soluble component called amylose (15–20%) and water insoluble component amylopectin (80–85%). Amylose is a linear polymer of α-D-glucose. But both glycogen and amylopectin are branched polymers of α-D-glucose; rather glycogen is more highly branched than amylopectin. Whereas, amylopectin chains consists of 20–25 glucose units, glycogen chains consist of 10–14 glucose units.

7. What are the hydrolysis products of (a) sucrose, and (b) lactose?

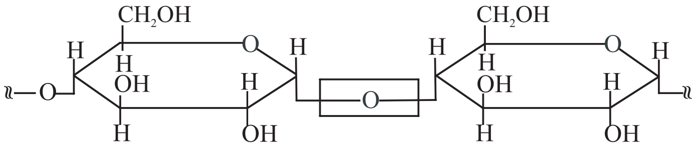
Sol. Both sucrose and lactose are disaccharides. Sucrose on hydrolysis gives one molecule each of glucose and fructose, but lactose on hydrolysis gives one molecule each of glucose and galactose.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or Invertase}]{H_3O^+} \underset{\text{D–(+)–Glucose}}{C_6H_{12}O_6} + \underset{\text{D–(–)–Fructose}}{C_6H_{12}O_6}$$

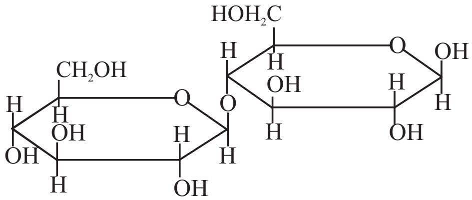
$$\underset{\text{Lactose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or Lactose}]{H_3O^+} \underset{\text{D–(+)–Glucose}}{C_6H_{12}O_6} + \underset{\text{D–(+)–Galactose}}{C_6H_{12}O_6}$$

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

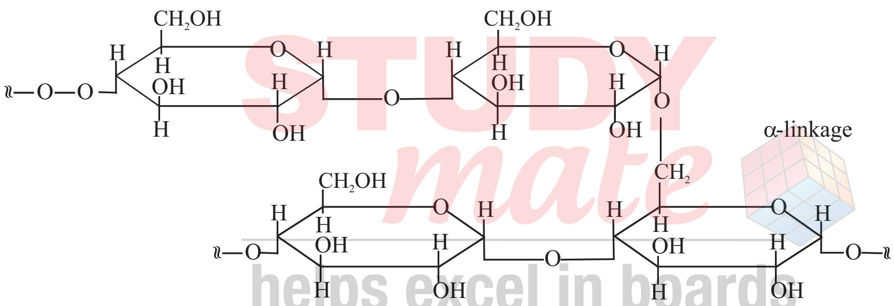
Sol. Starch consists of amylose and amylopectin. Amylose is a linear polymer of α-D-glucose while cellulose is a linear polymer of β-D-glucose. In amylose, C^{-1} of one glucose unit is connected to C^{-4} of the other through α-glycosidic linkage. However in cellulose, C^{-1} of one glucose unit is connected to C^{-4} of the other through β-glycosidic linkage. Amylopectin on the other hand has highly branched structure.



α-glycosidic linkage
Structure of amylose



β-linkage
Structure of cellulose



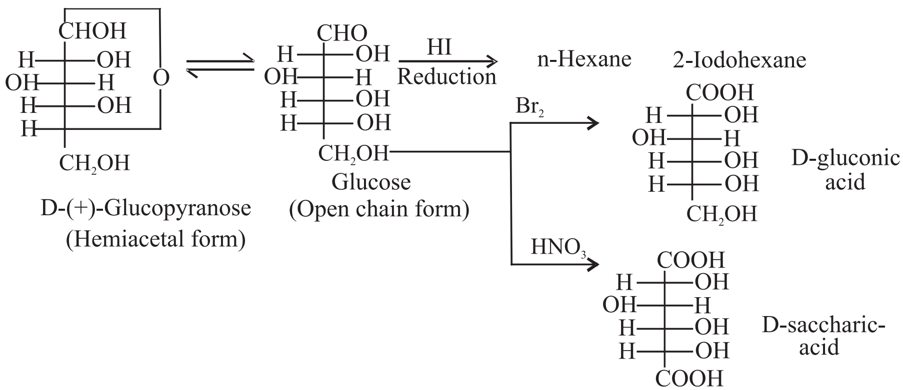
Structure of amylopectin

9. What happens when D-glucose is treated with the following reagent?

(a) HI (b) Bromine

(c) HNO_3

Sol.



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

Sol. (a) D (+)-glucose does not undergo certain characteristics reactions of aldehydes (e.g. glucose does not form $NaHSO_3$ addition product).

(b) Glucose reacts with NH_4OH to form an oxime but glucose pentaacetate does not. This implies that the aldehydic group is absent in glucose pentaacetate.

(c) D-(+)-glucose exists in two stereoisomeric forms (i.e. α-glucose and β-glucose).

(d) Both α-D-glucose and β-D-glucose undergo mutarotation in aqueous solution. Although the crystalline forms of α-and β-D (+)-glucose are quite stable in aqueous solution but each form slowly changes into an equilibrium mixture of both.

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

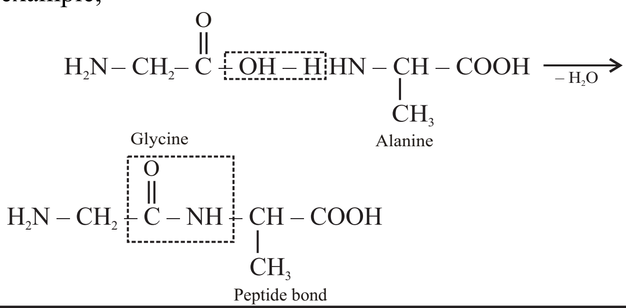
Sol. α-Amino acids which are needed for health and growth of human beings but are not synthesised by the human body are called essential amino acids. For example, valine, leucine, phenylalanine, etc. On the other hand, α-amino acids which are needed for health and growth of human beings and are synthesised by the human body are called non-essentials amino acids. For example, glycine, alanine, aspartic acid, etc.

12. Define the following related to proteins:

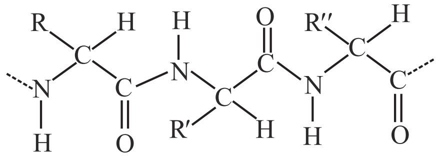
(i) Peptide bond (ii) Primary structure

(iii) Denaturation

Sol. (i) **Peptide bond:** Proteins are condensation polymers of α-amino acids in which the same or different α-amino acids are connected by peptide bonds. Chemically, a peptide bond is an amide linkage formed between –COOH group of one α-amino acid and NH_2– group of the other α-amino acid by loss of a molecule of water. For example,



(ii) **Primary structure:** Proteins may contain one or more polypeptide chains. Each polypeptide chain has a large number of α-amino acids which are linked to one another in a specific manner. The specific sequence in which the various amino acids present in a protein are linked to one another is called its primary structure. Any change in the sequence of α-amino acids creates a different protein.



(iii) **Denaturation:** Each protein in the biological system has a unique three-dimensional structure and has specific biological activity. This is called native form of a protein. When a protein in its native form is subjected to physical changes such a change in temperature, pH, etc., hydrogen bonds are broken. As a result, soluble forms of proteins such as globular proteins undergo coagulation or precipitation to give fibrous proteins which are insoluble in water. This coagulation also results in loss of biological activity of the proteins. That is why coagulation proteins are called denaturated proteins. During denaturation, 2° and 3° structures of proteins are destroyed but 1° structure remains intact.

The most common example of denaturation of proteins is the coagulation of albumin present in the white of an egg. When the egg is boiled hard, the soluble globular protein present in it is denatured and is converted into insoluble fibrous protein.

13. What are common types of secondary structures of proteins?

Sol. The conformation which the polypeptide chains assume as a result of hydrogen bonding is called secondary structure of the proteins. The two types of secondary structures are α-helix and β-pleated sheet structure.

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

Sol. The α-helix structure of proteins is stabilised by intramolecular H-bonding between C = O of one amino acid residue and the N–H of the fourth amino acid residue in the chain.

15. Differentiate between globular and fibrous proteins.

Sol. (i) **Fibrous proteins:** These proteins consist of linear thread like molecules which tend to lie side by side to form fibres. The polypeptide chains in them are held together usually at many points by hydrogen bonds and some disulphide bonds. As a result, intermolecular forces of attraction are very strong and hence fibrous proteins are in soluble in water. Further, these proteins are stable to moderate changes in temperature and pH. Fibrous proteins serve as the chief structural material of animal tissues. For example, keratin in skin, hair, nails and wool, collagen in tendons, fibrosis in silk and myosin in muscles.

(ii) **Globular proteins:** The polypeptide chain in these proteins is folded around itself in such a way so as to give the entire protein molecule an almost spheroidal shape. The folding takes place in such a manner that lipophilic (non-polar) parts are pushed inwards and hydrophilic (polar) parts are pushed outwards. As a result, water molecules interact strongly with the polar groups and hence globular protein are water soluble. As compared to fibrous proteins, these are very sensitive to small changes in temperature and pH. This class of protein includes all enzymes, many hormones such as insulin from pancreas, thyroglobulin from thyroid gland, etc.

16. How do you explain the amphoteric nature of amino acids?

Sol. Amino acids contain an acidic (carboxyl group) and basic (amino group) group in the same molecule. In neutralise aqueous solution, they each other. The carboxyl group loses a proton while the amino group accepts it. As a result, a dipolar or zwitter ion is formed.

$$H_2N-\underset{\underset{R}{|}}{CH}-COOH \longrightarrow \underset{\text{Zwitter ion}}{H_3\overset{+}{N}-\underset{\underset{R}{|}}{CH}-COO^-}$$

In Zwitter ionic form, a-amino acid show amphoteric behaviour as they react with both acids and bases.

$$\underset{\text{(I)}}{H_3\overset{+}{N}-\underset{\underset{(R)}{|}}{CH}-COOH} \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} \underset{\text{Zwitter ion}}{H_3\overset{+}{N}-\underset{\underset{R}{|}}{CH}-COO^-} \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} \underset{\text{(II)}}{H_2N-\underset{\underset{R}{|}}{CH}-COO^-}$$

17. What are enzymes?

Sol. Enzymes are biological catalyst. Each biological system requires a different enzymes. Thus, as compared to conventional catalyst enzymes are very specific and efficient in their action. They are required in only small quantity and work at optimum temperature (310 K) and pH (7·4), under one atmospheric pressure.

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

Sol. During denaturation, 2° and 3° structures of proteins are destroyed but 1° structure remains intact. As a result of denaturation, the globular proteins (soluble in H_2O) are converted into fibrous proteins (insoluble in H_2O) and their biological activity is lost. For example, boiled egg which contains coagulated proteins cannot be hatched.

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

Sol. Vitamins are classified into two groups depending upon their solubility in water or fat:

(i) **Water soluble vitamins:** These include vitamin B-complex (B_1, B_2, B_5, i.e. nicotinic acid), (B_1, B_{12}, panthothenic acid biotin, i.e. vitamin H and folic acid) and vitamin C.

(ii) **Fat soluble vitamins:** These include vitamins A, D, E and K. They are stored in liver and adipose (fat storing tissues). Vitamin K is responsible for coagulation of blood.

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

Sol. **Vitamin A** is essential for us because its deficiency causes xerophthalmia (hardening of cornea of eye) and night blindness.

Sources: Fish liver oil, carrots, butter and milk.

Vitamin C is essential for us because its deficiency causes scurvy (bleeding of gums) and pyorrhea (loosening and bleeding of teeth).

Sources: Citrus fruits, amla and green leafy vegetables.

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

Sol. Nucleic acids are biomolecules which are found in the nuclei of all living cell in form of nucleoproteins or chromosomes (proteins containing nucleic acids as the prosthetic group). Nucleic acids are of two types: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

The two main functions of nucleic acids are:

(a) DNA is responsible for transmission of hereditary effects from one generation to another. This is due to the unique property of replication, during cell division and two identical DNA strands are transferred to the daughter cells.

(b) DNA and RNA are responsible for synthesis of all proteins needed for the growth and maintenance of our body. Actually the proteins are synthesised by various RNA molecules (r-RNA, m-RNA) and t-RNA) in the cell but the message for the synthesis of a particular protein is present in DNA.

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

Sol. A nucleoside is formed when 1-position of pyrimidine (cytosine, thiamine or uracil) or 9-position of purine (guanine or adenine) base is attached to C-1 of sugar (ribose or deoxyribose) by a β-linkage. Thus, in general nucleosides may be represented as sugar base. A nucleotide contains all the three basic components of nucleic acids (i.e. a phosphoric acid group, a pentoses sugar and a nitrogenous base). These are obtained by esterification of C_5, –OH group of the pentose sugar by phosphoric acid.

23. The two stands in DNA are not identical but are complementary. Explain.

Sol. The two strands in DNA molecule are held together by hydrogen bonds between purine base of one strand and pyrimidine base of the other and vice versa. Because of different sizes and geometries of the bases, the only possible pairing in DNA are G (guanine) and C (cytosine) through three H-bonds (i.e. C≡G) and between A (adenine) and T (thiamine) through two H-bonds (i.e. A=T). Due to this base -pairing principle, the sequence of bases in one stand automatically fixes the sequence of bases in the other stand. Thus, the two strands are complimentary and not identical.

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

Sol.

DNA	***RNA***
Structural Difference	
(a) The sugar present in DNA is 2-deoxy-D-(–)-ribose.	(a) The sugar present in RNA is D-(–)-ribose.
(b) DNA contains cytosine and thymine as pyrimidine bases.	(b) RNA contains cytosine and uracil as pyrimidine bases.
(c) DNA has double stranded μ-helix structure.	(c) RNA has a single stranded μ-helix structure
(d) DNA molecule are very large, their molecular mass may vary from $6 \times 10^6 – 16 \times 10^6$ μ.	(d) RNA molecules are much smaller with molecular mass ranging from 20,000 – 40,000 μ.
Functional Difference	

(a) DNA has unique property of replication. (b) DNA controls the transmission of hereditary effects.	(a) RNA usually does not replicates. (b) RNA controls the synthesis of proteins.

25. What are different types of RNA formed in the cell?

Sol. There are three types of RNA:

(a) Ribosomal RNA (r-RNA) (b) Messenger RNA (m-RNA)

(c) Transfer RNA (t-RNA).