14 Biomolecules

Facts that Matter

Key Point	Explanations
Monosaccharides	Cannot be hydrolysed further, *e.g.* glucose, fructose, ribose.
Disaccharides	Sucrose (α-D-glucose + β-D-fructose), Maltose (α-D-glucose + α-D-glucose), Lactose (β-D-galactose + β-D-glucose).
Polysaccharides	*Starch* (two components—Amylose and Amylopectin): a polymer of α-D-glucose.
Amylose	Water soluble, 15-20% of starch, unbranched chain, C_1–C_4 glycosidic linkage.
Amylopectin	Water insoluble, 80–85% of starch, branched chain polymer, C_1–C_4 and C_1–C_6 glycosidic linkage.
Cellulose	Straight chain polysaccharide of β-D-glucose units/joined by C_1–C_4 glycosidic linkage (β-link), not digestible by human/constituent of cell wall of plant cells.
Glycogen	Highly branched polymer of α-D-glucose, found in liver, muscles and brain.
Reducing Sugars	Aldehydic/ketonic groups are free so they can reduce Fehling's/Tollens' solution, *e.g.* maltose and lactose.
Non–reducing Sugars	Aldehydic/ketonic groups are bonded, so it cannot reduce Fehling's solution and Tollens' reagent. *E.g.* Sucrose.
Anomers	The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C-1, called *anomeric carbon*. Such isomers, *i.e.* α–form and β–form are called anomers.
Invert Sugar	Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose (–92.4°) is more than dextrorotation of glucose (+52.5°), the mixture on the whole is laevorotatory. Thus, hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as invert sugar.
Glycosidic linkage	Linkage between two monosaccharides.
Importance of Carbohydrates	—Major portion of our food/used as storage molecules as starch in plants and glycogen in animals. —Cell wall of bacteria and plants is made up of cellulose/wood and cloth made of cotton or jute are made up of cellulose. —Provide raw materials for many important industries like textiles, paper, lacquers and breweries.

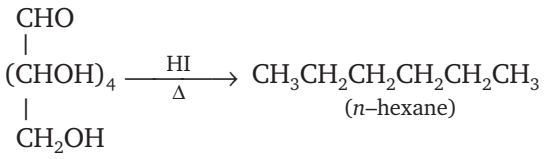
Essential amino acids	Which cannot be synthesised in the body and must be obtained through diet, *e.g.,* Valine, Leucine.
Non essential amino acids	Which can be synthesised in the body, *e.g.* Glycine, Alanine.
Zwitter ion	In aqueous solution, amino acids exist as a dipolar ions known as *zwitter ion.*
Peptide linkage	Peptide linkage is an amide formed between —COOH group and $—NH_2$ group of two successive amino acids in a peptide chain.
1°-structure of	Sequence of amino acids that the protein is made up of is said to be the primary structure of protein.
2°-structure of proteins	Secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two types of structures viz α-helix and β-pleated sheet structure.
3°–structure of proteins	Further folding of the secondary structure. It gives rise to two major molecular shapes viz fibrous and globular.
Fibrous proteins	Polypeptide chains run parallel, held together by hydrogen and disulphide bonds, fibre–like structure. Water insoluble *e.g.,* are keratin (in hair, wool, silk) and myosin (present in muscles).
Globular proteins	Chain of polypeptides coils around to give a spherical shape. Water soluble. *e.g.* insulin and albumin.
Forces which stabilise 2° & 3°	Hydrogen bonds, disulphide linkage, van der Waals and electrostatic forces of attraction.
Denaturation of proteins	When a protein is subjected to a physical change like change in temperature or chemical change like change in pH, then hydrogen bonds are disturbed. Due to this, globules will unfold and helix gets uncoiled and protein loses its biological activity. This is called **denaturation** of proteins. (During denaturation, 2° and 3° structures are destroyed but 1° structure remains intact). *e.g.,* The coagulation of egg white on boiling, curdling of milk.
Fat soluble vitamins	These are vitamins A, D, E and K. They are stored in liver and adipose (fat storing) tissues.
Water soluble vitamins	Vitamins B & C. These vitamins must be supplied regularly in diet because they are readily excreted in urine.
Vitamins sources and Deficiency diseases	Vitamin. A (Fish liver oil, carrots)–Night blindness; Vitamin B_1 (Yeast, milk)–Beriberi Vitamin. B_2 (Milk, eggwhite)–Cheilosis; Vitamin. B_6 (Yeast, milk)–Convulsions; Vitamin. B_{12} (Meat, fish)–Pernicious anaemia; Vitamin. C (Citrus fruits)–Scurvy; Vitamin. D (Exposure to sunlight, fish and egg yolk)–Rickets, osteomalacia; Vitamin. E (wheat oil, sunflower oil)–fragility of RBCs; Vitamin. K (leafy vegetables) increased blood clotting time.
DNA	Pentose sugar (D-2-deoxyribose) + phosphoric acid + nitrogenous bases (A, G, C, T)

RNA	Pentose sugar (ribose) + Phosphoric acid + Nitrogenous bases (A, G, C, U)
Nucleoside/tides	Nucleoside → sugar + base Nucleotides → sugar + base + phosphate
Phosphodiester link	Linkage between two nucleotides in polynucleotides
Functions of Nucleic Acids	DNA reserve genetic information, maintain the identity of different species that is capable of self duplication during cell division, synthesises protein in the cell.

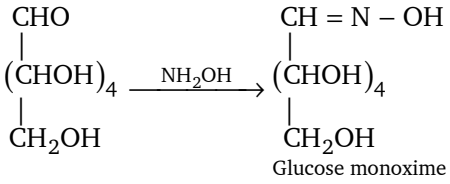
Properties of Glucose

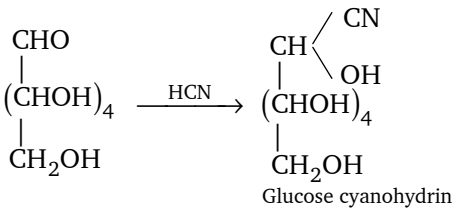
Glucose is an aldohexose and is also known as dextrose. It is the monomer of many of the large carbohydrates, namely starch, cellulose. Its molecular formula was found to be $C_6H_{12}O_6$.

(*i*) **On prolonged heating with HI** it forms *n*-hexane in which all the six carbon atoms are linked in a straight chain:

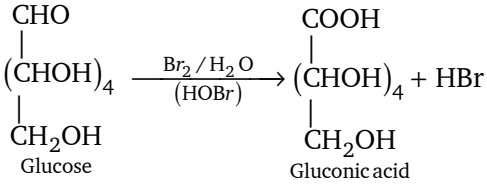


(*ii*) Glucose reacts with hydroxylamine to form oxime and adds a molecule of hydrogen cyanide to give cyanohydrin. These reaction confirms the presence of a carbonyl group ($>C = 0$) in glucose:

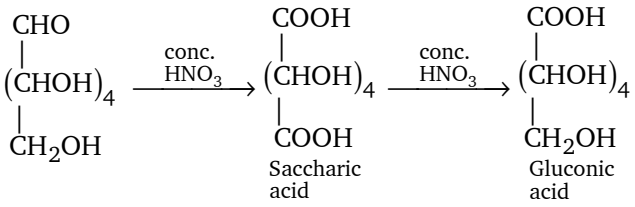




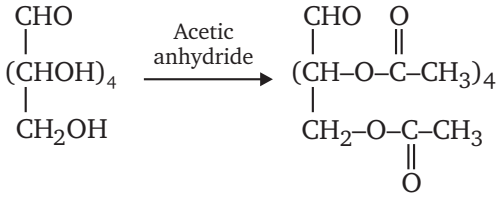
(*iii*) On oxidation with bromine water glucose forms gluconic acid:



(*iv*) On oxidation with nitric acid, glucose as well as gluconic acid both yield a dicarboxylic acid, saccharic acid. This indicates the presence of a primary alcoholic (–OH) group in glucose.



(*v*) **Acetylation of Glucose:** Acetylation of glucose with acetic anhydride gives glucose pentaacetate with confirms the presence of five –OH groups.



NCERT IN-TEXT QUESTIONS SOLVED

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

Ans. Glucose and sucrose molecules contain many –OH groups and hence are capable of forming H–bond with water molecules. On the other hand, cyclohexane and benzene are hydrocarbon and hence they cannot form H–bond with water. Therefore, glucose and sucrose are soluble in water whereas cyclohexane and benzene are insoluble in water.

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

Ans. Since lactose is a disaccharide, therefore on hydrolysis it give two molecules of monosaccharides, *i.e.* one molecule each of D – (+) – glucose and D – (+) – galactose.

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

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

Ans. Since pentaacetate of D-glucose are not oxidised either by Tollen's reagent or Fehling's solution. This indicates the absence of aldehyde group.

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

Ans. The amino acids exists as a Zwitter ions as:

$$H_3N^+ - CHR - COO^-$$

Due to this dipolar salt like structure they have strong dipole-dipole attraction or electrostatic forces of attraction. Therefore, their melting points are higher than that of corresponding halo acids.

Due to salt like structure of amino acids their solubility is also higher than the corresponding halo acids.

14.5. Where does the water present in the egg go after boiling the egg?

Ans. When the egg is boiled, the proteins first undergo denaturation and then coagulation and the water present in the egg get absorbed.

14.6. Why cannot Vitamin C be stored in our body?

Ans. Vitamin C is water soluble, therefore it is readily excreted in urine and hence cannot be stored in the body.

14.7. What products would be formed when a nucleotide from DNA containing thymine is hydrolysed?

Ans. Besides thymine, the two other products are—2 deoxy–D–ribose sugar and phosphoric acid.

14.8. 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. Since in RNA after complete hydrolysis there is no relationship between the quantities of four bases (C, G, A and U) obtained. Therefore, as per the base—pairing principle, *i.e*. A pairs with U and C pairs with G is not followed. Therefore, unlike DNA, RNA has a single strand.

NCERT TEXTBOOK QUESTIONS SOLVED

14.1. What are monosaccharides?

Ans. Monosaccharides are simple carbohydrates that cannot be hydrolysed, *e.g.,* glucose, fructose, galactose, ribose, deoxyribose, etc.

14.2. What are reducing sugars?

Ans. Those sugars which can reduce Tollens' reagent, Fehling's solution and Benedict's reagent are called reducing sugars. For example, glucose and fructose.

14.3. Write two main functions of carbohydrates in plants.

Ans. (*i*) Cell wall of plants is made up of cellulose.
(*ii*) Carbohydrates are used as storage molecules as starch in plants.

14.4. Classify the following into monosaccharides and disaccharides.
Ribose, 2–deoxyribose, maltose, galactose, fructose and lactose.

Ans. Monosaccharides — Ribose, 2-deoxyribose, galactose, fructose.
Disaccharides — Maltose, lactose.

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

Ans. In disaccharides or polysaccharides, monosaccharides are joined together by an oxide linkage formed by loss of a water molecule. Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.

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

Ans. Glycogen is a polysaccharide stored in animal body.
Its structure is similar to amylopectin and is rather highly branched. Whereas starch consists of both amylose and amylopectin.

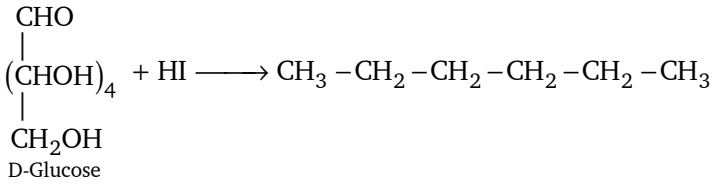
14.7. What are the hydrolysis product of (i) Sucrose and (ii) Lactose?

Ans. (*i*) Sucrose on hydrolysis gives glucose and fructose in the presence of invertase enzyme.
(*ii*) Lactose on hydrolysis gives glucose and galactose in the presence of lactase enzyme.

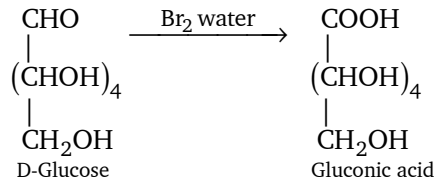
14.8. What is the basic structural difference between starch and cellulose?

Ans. Starch is a branched chain polymer of α-glucose whereas cellulose is a linear polymer of β-glucose.

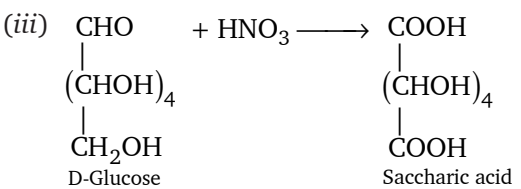
14.9. What happens when D-glucose is treated with the following reagents?
(*i*) HI (*ii*) Bromine water (*iii*) HNO_3

Ans. (*i*) 

D-Glucose

(*ii*) 

D-Glucose Gluconic acid

(*iii*) 

D-Glucose Saccharic acid

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

Ans. Unlike simple aldehydes, glucose did not form the crystalline bisulphite compound and failed to give the Schiff's test.

The pentaacetate and pentamethyl and other derivatives of glucose are not oxidised by Tollens' reagent or Fehling's solution thus indicating the absence of free — CHO group.

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

Ans. Essential amino acids: Amino acids which cannot be synthesised in the body and must be obtained through regular diet are known as essential amino acids. For example, Valine, Leucine.

Non-essential amino acids. The amino acids which can be synthesised in the body by itself are known as non-essential amino acids. For example, glycine, alanine.

14.12. Define the following as related to proteins.

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

Ans. (*i*) **Peptide linkage:** Amino acids are bifunctional molecules with NH_2 group at its one end and COOH at the other. Therefore, the COOH of one molecule and NH_2 of another molecule can interact with elimination of a H_2O molecule to form an amide like linkage called peptide bond or peptide linkage.

(*ii*) **Primary structure:** The sequence in which amino acids are linked together in a polypeptide chain forms the primary structure.

(*iii*) **Denaturation:** The process by which secondary and tertiary structure of proteins get disturbed by change of pH or temperature, so that they are not able to perform their functions, is called denaturation of proteins.

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

Ans. (*i*) α-helix (*ii*) β-pleated sheet structure

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

Ans. Hydrogen bonding stabilises the α-helix structure of proteins.

14.15. Differentiate between globular and fibrous proteins.

Ans.

Globular proteins	Fibrous Proteins
(*i*) They form α-helix structure.	(*i*) They have β-pleated structure.
(*ii*) They are soluble in water.	(*ii*) They are insoluble in water.
(*iii*) They are cross linked condensation polymers of acidic and basic amino acids.	(*iii*) They are linear condensation polymeric proteins.

(*iv*) They are folded to give rise to a three dimensional spherical shape. **Examples:** Albumin, enzymes, hormones.	(*iv*) They are long linear protein chains that forms fibre-like structure. **Examples:** Fibroin, collagen, myosin, etc.

14.16. How do you explain the amphoteric behaviour of amino acids?

Ans. Amino acids contains an acidic (carbonyl) group and a basic (amino) group within the same molecule. In zwitter ionic form, α-amino acids show amphoteric behaviour as they react with both acids and bases.

14.17. What are enzymes?

Ans. Enzymes are biological catalysts which speeds up the chemical reactions in a biosystem. They are very specific and selective in their action chemically. All enzymes are essentially proteins.

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

Ans. During the denaturation process, 2° and 3° structure of proteins are destroyed but 1° structure remains intact. For example, curdling of milk.

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

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

(*i*) **Water soluble vitamins—**These include vitamins of 'B' group (except B_{12}) and vitamin 'C'.

(*ii*) **Fat soluble vitamin—**These include vitamins A, D, E and K. They are stored in liver and adipose tissues.

Vitamin 'K' is responsible for the coagulation of blood.

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

Ans. Vitamin 'A' — Deficiency leads to Xerophthalamia and night-blindness.

Sources of vitamin A — Carrot, fish liver oil, milk, butter, etc.

Vitamin 'C' — Deficiency leads to scurvy and bleeding gums.

Sources of vitamin 'C' — Citrus fruits, *amla*, green leafy vegetables.

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

Ans. Nucleic acids are polymers of nucleotides containing a pentose sugar, heterocyclic base and a phosphate group.

They help in synthesis of proteins.

They are also responsible for the transfer of genetic characters from one generation to the next generation.

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

Ans. Nucleoside is formed by the condensation of a purine or pyrimidine base with pentose sugar at position 1. When nucleoside is linked to phosphoric acid at 5 position of sugar moiety, we get a nucleotide. Hence, a nucleotide has three units—phosphate group, pentose sugar and a base, whereas nucleoside has two units—pentose sugar and a base.

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

Ans. The two strands in DNA are complementary to each other because the hydrogen bonds are formed between specific pair of bases. Adenine always form hydrogen bond with thymine whereas cytosine always form hydrogen bond with guanine.

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

Ans.

DNA	RNA
1. The sugar present in DNA is 2-deoxy-D– (–) – ribose.	1. The sugar present in RNA is D – (–) – ribose.
2. DNA has a double stranded α-helix structure.	2. RNA has single stranded α-helix structure.
3. DNA contains cytosine and thymine as pyrimidine bases.	3. RNA contains cytosine and uracil as pyrimidine bases.
4. DNA has a unique property to replicate. by itself	4. RNA usually does not replicate.
5. DNA is responsible for heredity characters.	5. RNA controls protein synthesis.

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

Ans. There are three types of RNA:

(*i*) Ribosomal RNA (*r*-RNA)

(*ii*) Messenger RNA (*m*-RNA)

(*iii*) Transfer RNA (*t*-RNA)

ADDITIONAL QUESTIONS SOLVED

I. Very Short Answer Type Questions

(1 Mark)

Q1. What type of linkage hold together the monomers of DNA? [*CBSE* 2009]

Ans. Phosphodiester linkage.

Q2. Except for vitamin B_{12}, all other vitamins of group B, should be supplied regularly in diet. Why? [*CBSE* 2009]

Ans. Except for B_{12} which can be stored in liver for years, no other vitamin of group B can be stored in the body and is readily excreted through urine.

Q3. Write two main functions of carbohydrates in plants. [*AI* 2008]

Ans. Main functions of carbohydrates in plants:

(*i*) Carbohydrates are used as storage molecules as starch in plants.

(*ii*) Cell wall of bacteria and plants is made up of cellulose.

Q4. B-Complex are often prescribed vitamins. What is complex about them and what are their usefulness? [*AI* 2007]

Ans. B-complex is a group of vitamins. It is required to release energy from food and to promote healthy skin and muscles. Its deficiency causes pernicious anaemia.

Q5. Name the purine bases present in DNA. [*AI* 2007]

Ans. Adenine and Guanine

Q6. Give one example each for reducing and non-reducing sugars. [*AI* 2006 *C*]

Ans. Reducing sugar: D–fructose
Non-reducing sugar: Sucrose

Q7. Why are carbohydrates generally optically active? [*AI* 2005]

Ans. Because one or more carbon atoms is present in view contains an asymmetric carbon atom.

Q8. Why is cellulose in our diet not nourishing? [*AI* 2003]

Ans. This is because our body does not have the required enzymes for the digestion of cellulose.

Q9. Under what conditions does each protein take a shape that is energetically most stable? [*AI* 2003 *C*]

Ans. In normal physiological state it takes the shape which is energetically most stable.

Q10. What is the difference between amylose and amylopectin?

Ans. Amylose is a water soluble, linear polymer of α-glucose whereas amylopectin is water insoluble, branched chain polymer of α-glucose.

Q11. What are the constituents of starch?

Ans. Starch is made up of amylose and amylopectin. Amylose is a soluble fraction and a linear polymer of α-D-glucose. Amylopectin is the water soluble fraction and consists of linear as well as branched chain polymer of α-D-glucose.

Q12. What type of bonding occurs in β-pleated sheet structure of proteins?

Ans. Peptide chains are arranged side by side and these are held by a large number of intermolecular H-bonds between $-\overset{\overset{O}{\|}}{C}-$ and $-NH_2$ groups of peptide bond.

Q13. Deficiency of which vitamin causes rickets?

Ans. Deficiency of vitamin 'D' causes Rickets.

Q14. What type of bonding is present in Globular proteins?

Ans. Globular protein involve hydrogen bonds, disulphide linkages, van der Waals' forces of attraction, etc.

Q15. What is the structural formula of zwitter ion formed from alamine?

Ans. $CH_3-\overset{\overset{\oplus}{NH_3}}{\underset{|}{C}}H-COO^{\ominus}$ is the zwitter ion of alamine.

Q16. Name the vitamins whose deficiency are responsible for

(*i*) night blindness,

(*ii*) poor coagulation of blood.

Ans. (*i*) Vitamin 'A' (*ii*) Vitamin 'K'

Q17. What are the constituent units of cellulose?

Ans. Cellulose is a linear polymer made up of D(+) – glucose molecules linked by β-glycosidic bonds (linkages).

Q18. Which vitamin is linked with anti-sterility?

Ans. Vitamin E

Q19. Write the products of hydrolysis of lactose. [*CBSE* 2014]

Ans. β-D-Glucose and β-D-Galactose

II. Short Answer Type Questions

(2 or 3 Marks)

Q1. Name two components of starch. How do they differ from each other structurally? [*CBSE* 2009]

Ans. The two components of starch are:

(*a*) Amylose (*b*) Amylopectin

Amylose is a straight chain polymer of α–D–(+) glucose, while amylopectin is a branched chain polymer of α-D-glucose.

Q2. (*a*) What changes occur in the nature of egg proteins on boiling?

(*b*) Name the type of bonding which stabilises the α-helix structure in proteins. [*CBSE* 2009]

Ans. (*a*) On boiling, protein of egg gets denatured. Thus, due to coagulation water get absorbed.

(*b*) Hydrogen bonding between $-\overset{\overset{O}{\|}}{C}-$ and $-NH_2-$ groups of peptide bond.

Q3. Name the four bases present in DNA. Which one of the these is not present in RNA? [*AI* 2009]

Ans. DNA contains four bases, viz.

adenine (A) guanine (G),

cytosine (C) thymine (T)

RNA also contain four bases, first three bases are same as in DNA but the fourth one is uracil (U).

Q4. Name two fat soluble vitamins, their sources and the diseases caused due to their deficiency in diet. [*AI* 2009]

Ans.

Vitamins	Sources	Deficiency Diseases
Vitamin A	Fish, liver oil, carrot	Night blindness
Vitamin D	Sunlight, milk, egg yolk	Rickets and Osteomalacia

Q5. Explain what is meant by

(*i*) a peptide linkage

(*ii*) a glycosidic linkage.

[*AI* 2009, *Delhi* 2012]

Ans. (*i*) **Peptide linkage:** Polymers of α-amino acids are connected to each other by peptide bond or peptide linkage.

Chemically peptide linkage is an amide formed between—COOH group and—NH_2 group.

(*ii*) **Glycosidic linkage:** The two monosaccharide units are joined together by an oxide linkage formed by the loss of a water mol ecule. Such a linkage between two mono saccharide units through oxygen atom is called glycosidic linkage.

Q6. Name two water soluble vitamins, their sources and the diseases caused due to their deficiency in diet. [*AI* 2009]

Ans.

Vitamins	Sources	Deficiency Diseases
Vitamin B_1	Yeast, milk, vegetables	Beri-beri
Vitamin C	Citrus fruits, *amla* and green leafy vegetables	Scurvy (bleeding gums)

Q7. What are essential and non-essential amino acids? Give one example of each type. [*AI* 2008]

Ans. Essential amino acids: Amino acids which are not synthesised by the human body are called essential amino acids.

Example: Valine, Leucine.

Non-essential amino acids: Amino acids which are synthesised by human body are called non-essential amino acids.

Example: Glycine, Aspartic acid, etc.

Q8. Mention the type of linkage responsible for the formation of the following:

(*i*) Primary structure of proteins.

(*ii*) Cross linking of polypeptide chains.

(*iii*) α-helix formation.

(*iv*) β-sheet structure. [*AI* 2008]

Ans.

Type of structure	Types of linkages
1. primary structure of proteins.	peptide bond or peptide linkage
2. cross-linking of polypeptide chains.	polypeptide linkage
3. α-helix formation.	Hydrogen bond
4. β-sheet structure	intermolecular-hydrogen bond

Q9. Write the major classes in which the carbohydrates are divided depending upon whether these undergo hydrolysis, and if so, the number of products formed. [*AI* 2004]

Ans. On the basis of hydrolysis, carbohydrates are divided into three major classes:

(*i*) **Monosaccharides.** These cannot be hydrolysed into simpler molecules. These are further classified as aldoses, and ketoses.

(*ii*) **Oligosaccharides.** These carbohydrates on hydrolysis give 2–10 units of mono-saccharides. For example, sucrose.

(*iii*) **Polysaccharides.** These are high molecular mass carbohydrates which give many molecules of monosaccharides on hydrolysis. For example, cellulose, starch.

Q10. Explain the term mutarotation giving an example. [*AI* 2006 *C*]

Ans. The spontaneous change in specific rotation when an optically active substance is dissolved in water is called mutarotation. For example, when α-glucose is dissolved in water its specific rotation changes because it gets converted into β-glucose.

Q11. Name the chemical components which constitute nucleotides. Write any two functions of nucleotides in a cell. [*CBSE* 2003]

Ans. Nucleotides are made up of a heterocyclic base containing nitrogen, a five carbon atom-moeity and a phosphate group, e.g.

AMP (adenosine monophosphate),
ADP (adenosine diphosphate) and
ATP (adenosine triphosphate)

Functions:

(*i*) Act as energy carriers

(*ii*) They synthesise proteins.

Q12. An optically active compound having molecular formula $C_6H_{12}O_6$ is found in two isomeric forms (A) and (B) in nature. When (A) and (B) are dissolved in water they show the following equilibrium: [*AI CBSE* 2009]

$$(A) \rightleftharpoons \underset{\text{mixture}}{\text{Equilibrium}} \rightleftharpoons (B)$$

$[\alpha]_D = 111°$ 52.5° 19.2°

(*i*) What are such isomers called?

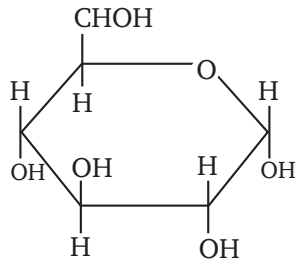
(*ii*) Can these be called enantiomers? Justify your answer.

(*iii*) Draw the cyclic structure of isomer (A).

Ans. (*i*) Anomers

(*ii*) No, these are not enantiomers because stereoisomers are related to each other and non superimposable mirror images are enantiomers. Anomers differ only at C_1 configuration.

(*iii*)



Q13. An optically active amino acid (A) can exist in three forms depending on the pH of the medium. If the molecular formula of (A) is $C_3H_7NO_2$. Write:

(*i*) An ion of compound (A) exists in aqueous medium. What are such ions called?

(*ii*) In which medium will the cationic form of compound (A) will exist?

(*iii*) In alkaline medium, towards which electrode will the compound (A) will migrate in the electric field? [*CBSE* 2009]

Ans. (*i*) $R-\underset{\underset{{}^{+}NH_3}{|}}{CH}-\overset{\overset{O}{||}}{C}-O^-$ (Zwitter ion)

(*ii*) acidic

(*iii*) anode

Q14. Despite having an aldehyde group:

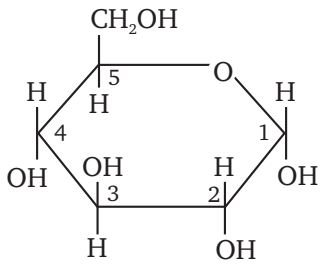
(*a*) Glucose does not give 2, 4-DNP test. What does this indicate?

(*b*) Draw the Haworth structure of α-D-(+)–Glucopyranose.

(*c*) What is the significance of D and (+) here? [*CBSE* 2009]

Ans. (*a*) This indicates that the aldehyde group in glucose is not free.

(*b*)



α – D – (+) – Glucopyranose

(*c*) 'D' gives the configuration, *i.e*. the –OH group at carbon 5 is on the right hand side and+ sign indicates that the isomer is dextrorotatory.

Q15. Explain the following terms:

(*i*) Mutarotation [*Foreign* 2007]

(*ii*) Avitaminosis [*CBSE* 2007]

Ans. (*i*) **Mutarotation:** The spontaneous change in specific rotation of an optically active compound is called mutarotation, when it is dissolved in water.

When glucose is crystallised from a concentrated solution at 30°C, it gives glucose having $[\alpha] = +111°$. Its specific rotation changes to 52.5° when it is dissolved in water. It is because α-glucose changes into β-glucose. The change in optical rotation is called mutarotation.

(*ii*) **Avitaminosis:** Multiple deficiencies caused by lack of more than one vitamin in human beings is called avitaminosis.

Q16. Answer the following questions briefly:

(*i*) What are reducing sugars?

(*ii*) What is meant by denaturation of a protein?

(*iii*) How is oxygen replenished in our atmosphere? [*AI* 2007]

Ans. (*i*) **Reducing sugar:** All those carbohydrates which reduce Fehling's solution and Tollens' reagent are referred to as reducing sugars. All monosaccharides whether aldose or ketose are reducing sugars.

(*ii*) **Denaturation of a protein:** When 2° and 3° structure of a protein is destroyed due to the physical changes like temperature, change in pH, it is called denaturation of a protein.

Example: Coagulation of egg white on boiling.

(*iii*) We take oxygen from atmosphere and release CO_2. Plants take up CO_2 and H_2O from the atmosphere to prepare their food in the presence of sunlight and release O_2, thus O_2 is replenished in atmosphere.

Q17. Name the main disease caused due to lack of vitamin and its source in each of the following: A, B_6 and E. [*CBSE* 2006]

Ans.

Vitamin	Deficiency	Sources
Vitamin A	Night blindness	Carrot, fish liver oil
Vitamin B_6	Convulsions	Cereals, grams, yeast, etc
Vitamin E	Loss of reproduction power	Germ oil, cotton seed oil.

Q18. Answer the following queries about proteins.

(*i*) How are proteins related to amino acids?

(*ii*) How are oligopeptides different from polypeptides?

(*iii*) When is a protein said to be denatured? [*AI* 2006]

Ans. (*i*) Proteins are the polymers of about twenty different α-amino acids which are linked by peptide bonds.

(*ii*) Oligopeptides on hydrolysis give 3 to 12 α-amino acids whereas polypeptides give large number of α-amino acids on hydrolysis.

(*iii*) When 2° and 3° structure of a protein is destroyed by change in pH or in temperature, protein is said to be denatured.

Q19. Define the following and give one example of each:

(*a*) Isoelectric point (*b*) Mutarotation

(*c*) Enzymes [*Foreign* 2006]

Ans. (*a*) **Isoelectric point:** It is the pH at which +ve and –ve charges on zwitter ion are equal, e.g. amino

acid exists as zwitter ion at pH = 5.5 to 6.3.

(*b*) **Mutarotation:** It is a spontaneous change in optical rotation when an optically active substance is dissolved in water, e.g. α-glucose, when dissolved in water, then its optical rotation changes from 111° to 52.5°.

(*c*) **Enzymes:** Enzymes are biocatalysts which speeds up the reactions in biosystems. They are highly specific and selective in their action. Chemically all enzymes are proteins.

Q20. (*a*) What is denaturation and renaturation of proteins?

(*b*) Give reason: Amylose present in the saliva becomes inactive in the stomach. [*AI* 2006 C, 05 C]

Ans. (*a*) The process of disruption of 2° and 3° structure of proteins without changing its primary structure is called denaturation. If the disruptive agent is removed and protein recovers its original structure, it is called renaturation.

(*b*) In stomach the pH is acidic, therefore amylose becomes inactive. That is why digestion of carbohydrates does not take place in stomach.

Q21. Write four characteristic features of enzymes. Name a disease which is caused by the deficiency of a particular enzyme. [*AI* 2003 C]

Ans. Characteristic features:

(*i*) They are specific in their action.

(*ii*) They work at specific pH.

(*iii*) Chemically all enzymes are proteins.

(*iv*) They are generally named after the compound or the class of compounds upon which they work.

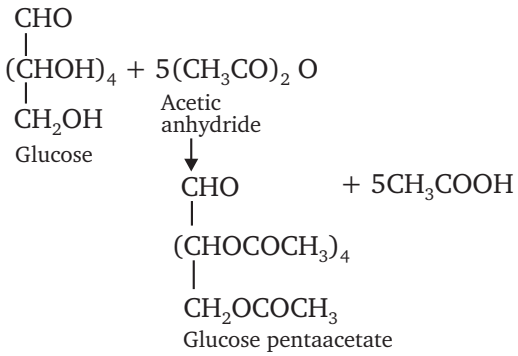
Deficiency of enzymes leads to specific diseases, *e.g.,* phenylketone urea is caused by the deficiency of phenyl alanine hydroxylase.

Q22. Write the chemical reaction equations for the reaction of glucose with;

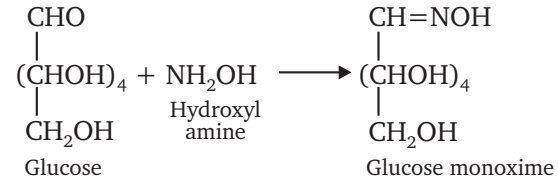
(*i*) acetic anhydride (*ii*) NH_2OH

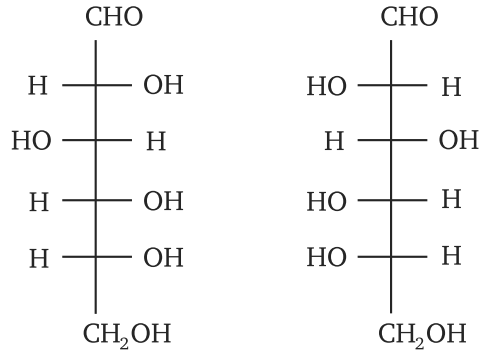
Also draw Fischer projections of D-glucose and L-glucose. [*Foreign* 2005]

Ans. (*i*)



(*ii*)





D (+) – Glucose L (–) – Glucose

Q23. Define the following terms: [*CBSE* 2014]

(*i*) Nucleotide (*ii*) Anomers

(*iii*) Essential amino acids

Ans. (*i*) **Nucleotide:** It is the monomer unit of DNA which is formed by a nitrogenous base, deoxyribose sugar and Phosphoric acid.

(*ii*) **Anomers:** Anomers are cyclic monosaccharides which are differing from each other in the configuration of C-l if it is an aldose or in the configuration at C-2 if it is a ketose.

(*iii*) **Essential amino acids:** The amino acids cannot be synthesised by the body and are essential for the body.

Q24. (*a*) Which one of the following is disaccharide: Starch, Maltose, Fructose, Glucose?

(*b*) What is the difference between fibrous protein and globular protein?

(*c*) Write the name of vitamin whose deficiency causes bone deformities in children.

Ans. (*a*) Maltose

(*i*) In **fibrous proteins,** the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds.

In **globular proteins,** the polypeptide chain is folded, looped and twisted, so that the molecules are spherical.

(*ii*) They are insoluble in water. For example, keratin (present in hair, wool, silk) and myosin (present in muscles), etc. They are soluble in water.

For example, egg albumin, haemoglobin, enzymes and some hormones like insulin.

(*c*) Vitamin D

Q25. (*i*) Write one reaction of D-Glucose which cannot be explained by its open chain structure.

(*ii*) What type of linkage is present in Nucleic acids ?

(*iii*) Give one example each for water-soluble vitamins and fat-soluble vitamins?

Ans. (*i*) The open chain structure fails to explain the following reactions:

(*a*) Despite having an aldehyde (–CHO) group, glucose does not react with sodium bisulphite ($NaHSO_3$).

(*b*) Glucose does not give 2, 4–DNP test and Schiff test.

(*c*) The pentaacetate of glucose does not react with hydroxylamine. This indicates the absence of free –CHO group.

(*ii*) Phosphodiester linkage is present in Nucleic acids.

(*iii*) Examples of fat soluble vitamins ⇒ Vitamine A,D,E,K.

Examples of water soluble vitamins ⇒ Vitamins B and C.

III. Long Answer Type Questions

(5 Marks)

Q1. (*a*) Answer the following questions briefly:

(*i*) Write any two good sources of vitamin A.

(*ii*) What are nucleotides?

(*b*) How are carbohydrates classified? [*AI* 2007]

Ans. (*a*) (*i*) Milk, carrot

(*ii*) Nucleotides are monomer units of nucleic acid. They are made up of a heterocyclic base containing nitrogen, a five carbon sugar and a phosphate group, *e.g*. AMP (Adenosine monophosphate).

(*b*) On the basis of hydrolysis, carbohydrates are classified into three classes:

(*i*) **Monosaccharides:** For example —glucose, fructose.

(*ii*) **Disaccharides:** For example —maltose, sucrose.

(*iii*) **Polysaccharides:** For example—starch, glycogen.

Q2. (*a*) Name the three major classes of carbohydrates and give the distinctive characteristic of each class.

(*b*) What are nucleotides? Name two classes of nitrogen containing bases found amongst nucleotides. [*Foreign* 2007]

Ans. (*a*) On the basis of hydrolysis, carbohydrates are classified into three classes:

(*i*) **Monosaccharides:** Carbohydrates that cannot be hydrolysed further to give simpler unit. Example—Glucose, fructose, ribose, etc.

(*ii*) **Oligosaccharides:** Carbohydrates that yield two to ten monosaccharides units on hydrolysis are called oligosaccharides. Example—sucrose.

(*iii*) **Polysaccharides:** Carbohydrates which yields a large number of monosaccharide units on hydrolysis are called polysaccharides. Example—Cellulose, glycogen.

(*b*) Nucleotides are the monomer units of a nucleic acid. They are made up of heterocyclic base containing nitrogen, a five carbon sugar and a phosphate group, etc. e.g. AMP, ADP. They consists of heterocyclic bases; namely Adenine (A), Guanine (G), Cytosine (C), Thymine (T) and Uracil (U).

Q3. (*a*) Define the following terms:

(*i*) Co-enzymes

(*ii*) Mutation in biomolecules

(*iii*) Nucleotides

(*b*) List four main functions of carbohydrates in organism. [*AI* 2006]

Ans. (*a*)

(*i*) **Co-enzymes:** The prosthetic groups which get attached to enzymes at the time of reaction are called co-enzymes. They increases the activity of enzymes.

(*ii*) **Mutation in biomolecules:** A difference in the basic structural unit, eg. difference of a single base in DNA molecule can change sequence of amino acids of a protein which leads to mutation.

(*iii*) Nucleotides are monomers of nucleic acid. They consist of a heterocyclic base, pentose sugar and phosphoric acid residue.

(*b*) **Functions of carbohydrates**

(*i*) Cellulose form the cell wall of plant cells.

(*ii*) Store energy in the form of starch in plant cells and in the form of glycogen in animal cells.

(*iii*) They are found in combination with proteins and lipids.

(*iv*) They are essential for plants and animals as a source of energy.

Q4. Write down the structures and name of products formed when D-glucose is treated with;

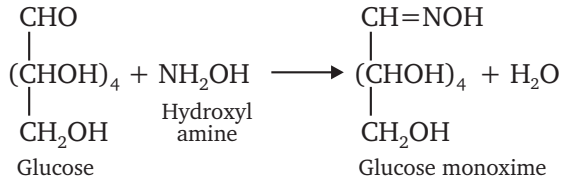
(*a*) (*i*) Hydroxylamine (*ii*) HI

(*iii*) Ammonical silver nitrate solution.

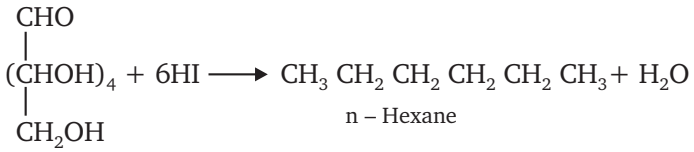
(*b*) How are hormones and vitamins different in respect of their sources and functions?

[*Foreign* 2006]

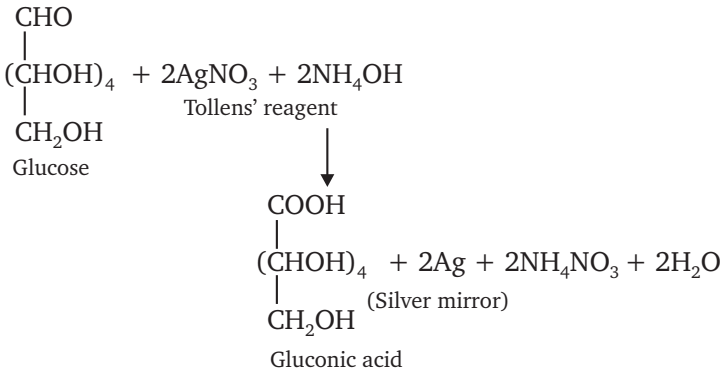
Ans. (*a*) (*i*)



(*ii*)



(*iii*)



(*b*) Hormones are secreted by endocrine glands. They have specific biological functions. They are responsible for growth and development and various metabolic activities. Vitamins are complex compounds obtained from fruits and vegetables.

Q5. (*a*) What are reducing and non-reducing sugars? What is the structural feature characterising reducing sugars? What is an invert sugar?

(*b*) Define enzymes. What is the most important reason for their specificity in action.

[*CBSE* 2006 *C*]

Ans. (*a*) **Reducing sugars:** Those carbohydrates which contain free aldehydic or ketonic group and reduces Fehling's solution and Tollens' reagent are called reducing sugars. All monosaccharides whether aldose or ketose are reducing sugars.

Non-reducing sugars: Carbohydrates which do not reduce Tollens' reagent and Fehling's solution are called non-reducing sugars, *e.g.* sucrose. They do not have free aldehyde group.

Invert sugar: The mixture of *d*(+) – glucose and *l*(–) – fructose obtained on hydrolysis of sucrose is called invert sugar.

(*b*) **Enzymes:** They are biological catalysts which catalyse specific biochemical reactions. They have active sites due to which they can bind to specific substrate, that is why they are specific in their action.

Q6. (*a*) Give reasons for the following statements:

(*i*) Amino acids are amphoteric in nature.

(*ii*) Amino acids have comparatively higher melting points than the corresponding halo acids.

(*b*) What deficiency diseases are caused due to lack of vitamin A, B_1, B_6 and K in human diet?

[*CBSE* 2005]

Ans. (*a*) (*i*) This behaviour is due to the presence of both acidic (carboxyl group) and basic (amino) groups in the same molecule. They react with both acid as well as a base.

(*ii*) Amino acids are more polar than halo acids due to the presence of both acidic (—COOH) group and basic ($-NH_2$) group, i.e., they behave like salts. That is why they have high melting point due to the strong electrostatic forces between them.

(*b*)

Vitamins	**Deficiency diseases**
Vitamin A	Night blindness
Vitamin B_1	Beri-beri
Vitamin B_6	Convulsions
Vitamin K	Haemophillia

Q7. (*a*) State the constitutional difference between DNA and RNA. Write down the names of bases produced on hydrolysis of DNA.

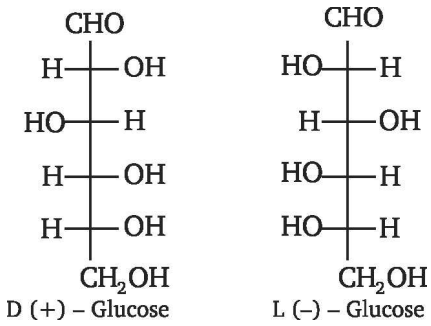
(*b*) Draw simple Fischer projections of D-glucose and L-glucose. Can these be called enantiomers

[*CBSE* 2005]

Ans. (*a*)

DNA	**RNA**
1. The sugar present in DNA is 2-deoxy D-(–) ribose.	1. The sugar present in RNA is D-(–) ribose.
2. DNA has double stranded α-helix structure.	2. RNA has single stranded α-helix structure.
3. DNA contains cytosine and thymine as pyrimidine bases, and guanine and adenine as purine bases.	3. RNA contains cytosine and uracil as pyrimidine bases, and guanine and adenine as purine bases.

(*b*)



These are enantiomers.

Q8. (*a*) Define vitamins and state their classification. List two vitamins of each class.

(*b*) What are enzymes? State the activity of an enzyme. [*CBSE* 2005]

Ans. (*a*) **Vitamins:** Vitamins are the organic compounds required in regular diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of an organism. Vitamins are classified into two groups depending upon their solubility in water or fat:

(*i*) *Fat soluble vitamins:* Vitamin A, Vitamin D.

(*ii*) *Water soluble vitamins:* Vitamin B and C.

(*b*) **Enzymes:** Enzymes are biocatalysts which speeds up the reactions in biosystems. They are very specific and selective in their action.

IV. Value-Based Questions

Q1. Pradeep had very high fever. He was given strong antibiotics. But after recovering from fever he was not able to digest food and was feeling too weak. The grandmother who lived in his neighborhood suggested him to take lots of fruits and vegetables.

(*a*) Why?

(*b*) What is the remedy for this?

(*c*) What was the value that Pradeep had by taking fruits and vegetables?

Ans. (*a*) Rise in temperature denatures the proteins in our body. The enzymes which are also proteins gets denatured. The body has to regenerate these enzymes. Till then Pradeep will continue to feel weak as the enzymes which has to digest food and used for respiration are destroyed due to high temperature and change in pH. Even after the enzymes are regenerated, vitamins which act as prosthetic groups in enzyme action are to be taken from an external source.

(*b*) By taking fruits and vegetables Pradeep is actually taking in vitamins.

(*c*) He obeyed an elderly person's advice.

Q2. Mrs Renuka was worried about her daughter not eating properly even though her favourite dishes are made, and shows very small growth in last six months.

(*a*) Which vitamin deficiency may be there in the girl child?

(*b*) Give chemical name of the vitamin deficient in the girl child.

(*c*) What are the values associated with this observation?

Ans. (*a*) Vitamin B_1

(*b*) Thiamine

(*c*) Critical thinking

Q3. Nita's mother fell ill and the doctor diagnosed her with pernicious anaemia. She felt lethargic and did not have the energy to do work. Nita helped her mother in household work till she recovered.

(*i*) Name the vitamin whose deficiency caused pernicious anaemia.

(*ii*) Name the sources which will provide this vitamin.

(*iii*) Mention the values shown by Nita.

Ans. (*i*) Vitamin B_{12}

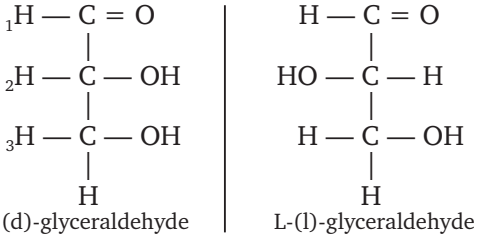
(*ii*) Fish, curd, egg and meat

(*iii*) Caring and Helping attitude

V. Hots Questions

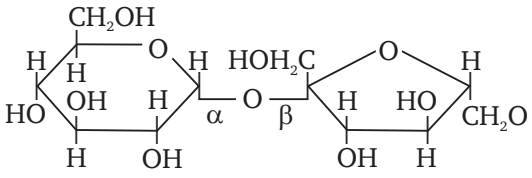
Q1. Give the D and L configurations of Glyceraldehyde?

Ans.



Q2. Give the chemical structure of sucrose and explain why sucrose is non-reducing sugar.

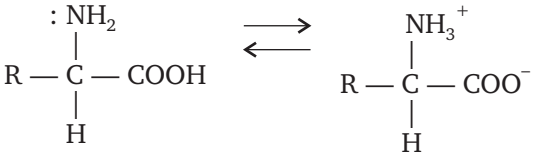
Ans.



Sucrose is a non-reducing sugar because its ketonic and aldehydic group are bonded and so it cannot reduce Fehling's solution and Tollens reagent.

Q3. Give a short note on Zwitter ion?

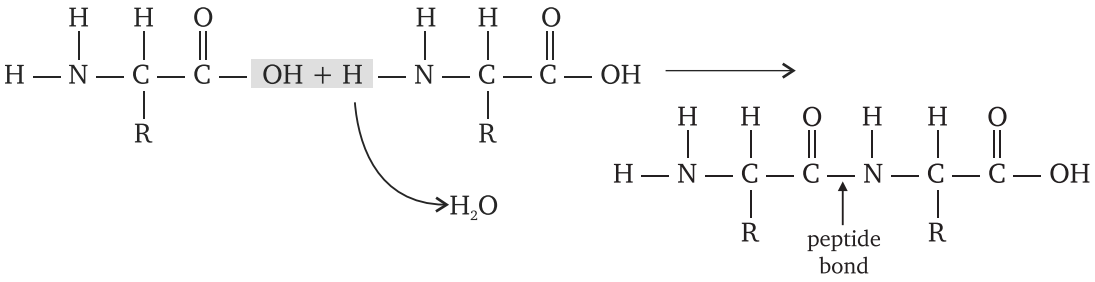
Ans. Amino acids are usually colourless, crystalline solids. These are water soluble, high melting solids and behave like salts rather than simple amines or carboxylic acids. This behaviour is due to the presence of both acidic (carboxylic group) and basic (amino group) groups in the same molecule. In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, thus giving rise to a dipolar ion known as zwitter ion.



R is the functional group of the amino acid

Q4. How are peptides formed? Show the formation of peptide bond with diagram.

Ans. Peptides are amides formed by the condensation of amino group of one α-amino acid with the carboxyl group of another molecule of the same or different α-amino acid with the elimination of a water molecule. They are classified as *di-*, *tri-*, *tetra-*, etc.



❑❑