

14

Biomolecules

14.1 Carbohydrates

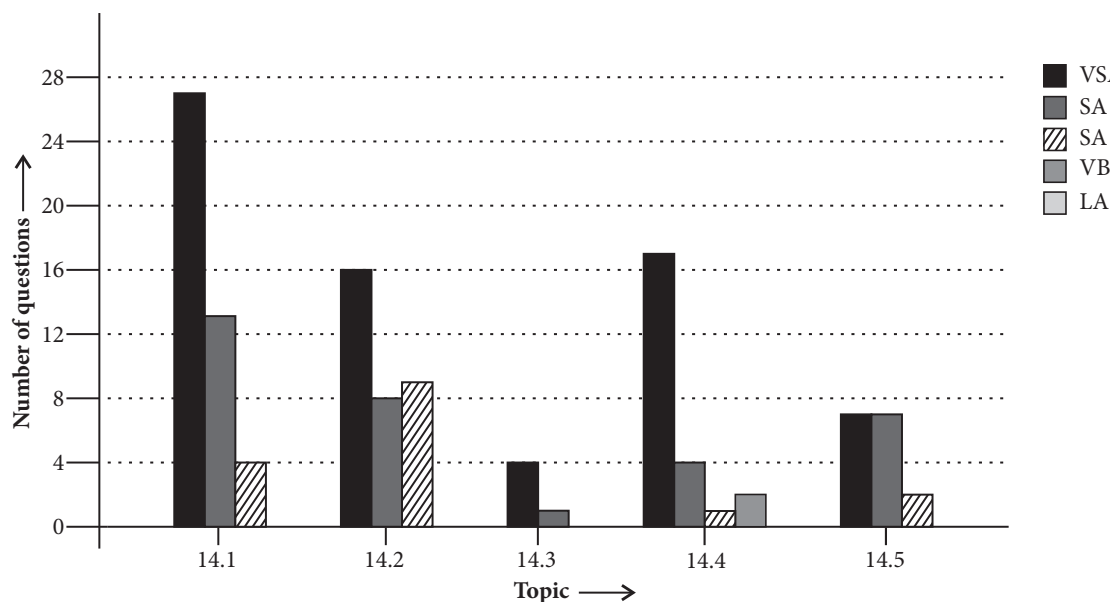
14.4 Vitamins

14.2 Proteins

14.5 Nucleic Acids

14.3 Enzymes

Topicwise Analysis of Last 10 Years' CBSE Board Questions



▶▶ Maximum total weightage is of *Carbohydrates*.

▶▶ Maximum SA I and SA II type questions were asked from *Carbohydrates and Vitamins* respectively.

▶▶ Maximum VSA type questions were asked from *Carbohydrates*.

QUICK RECAP

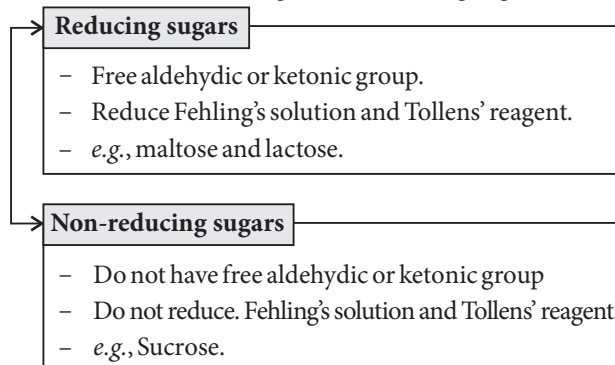
CARBOHYDRATES

▶▶ **General formula** : $C_x(H_2O)_y$

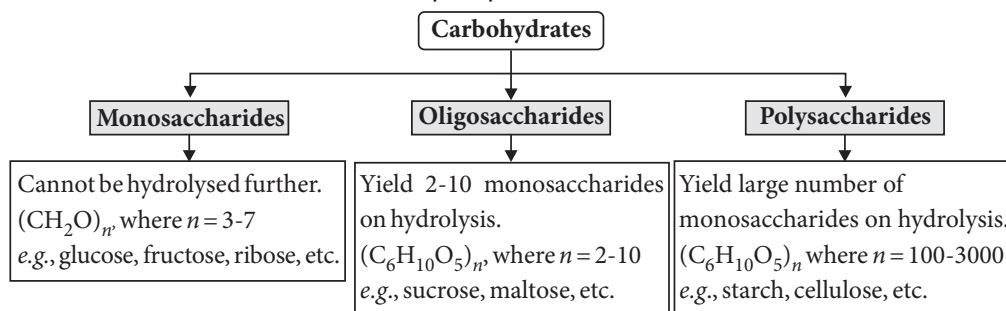
▶▶ **Sugars or Saccharides** : They are optically active polyhydroxyaldehydes or ketones.

►► **Classification :**

Carbohydrates are classified as either reducing or non-reducing sugars :



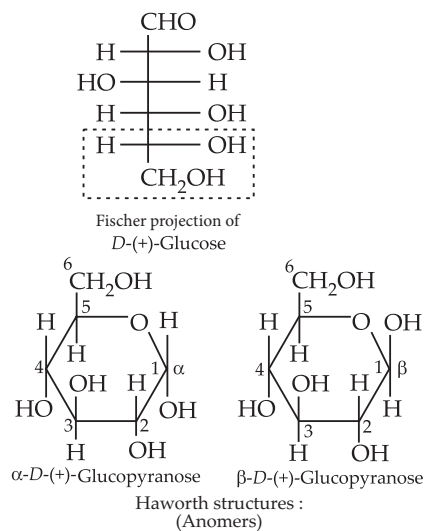
► On the basis of their behaviour towards hydrolysis :



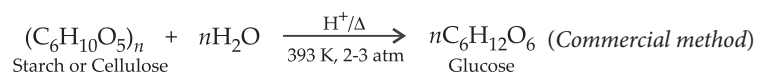
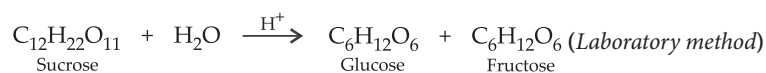
►► **Monosaccharides :**

► **Glucose (C₆H₁₂O₆) :** An aldohexose as it contains six carbon atoms and aldehydic group.

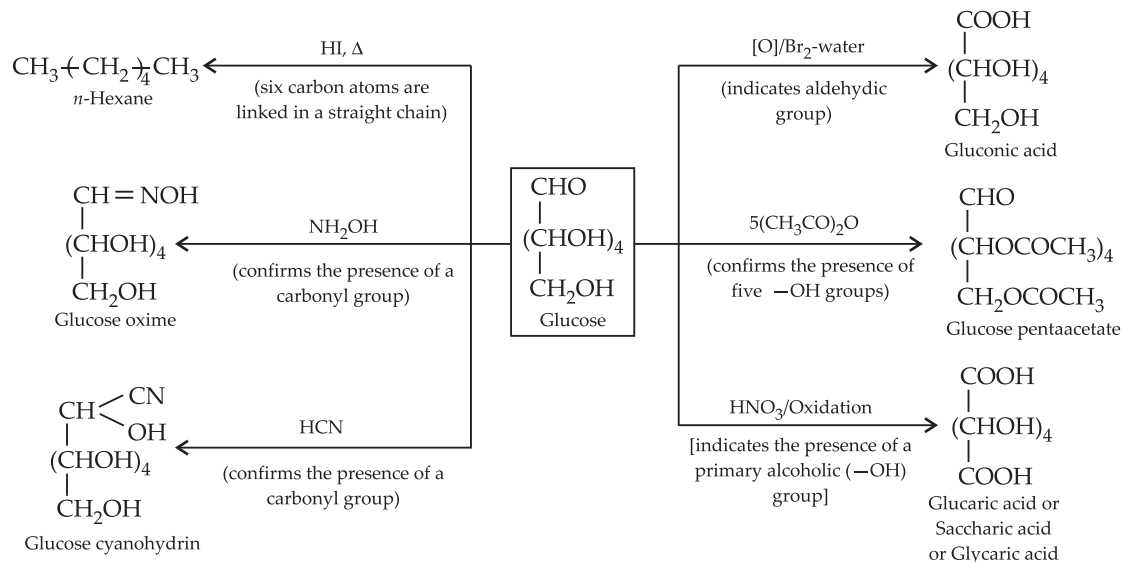
- **Structure :**



- **Preparation :**

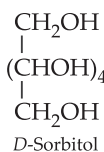


- Glucose was assigned open chain structure on the basis of following evidences :

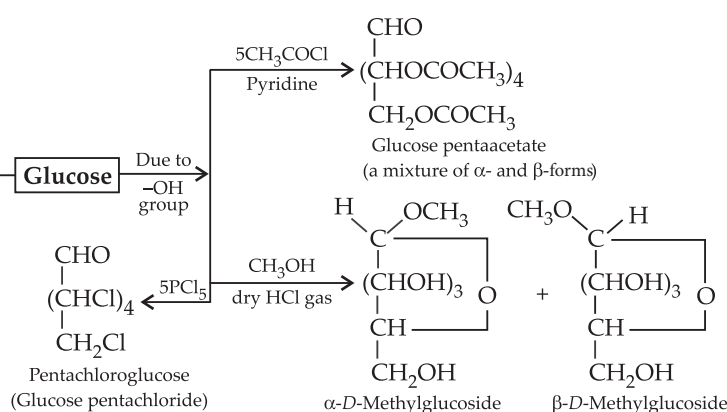
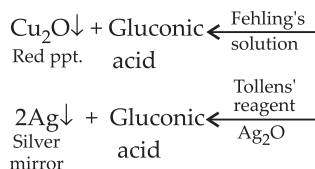


- **Chemical reactions :**

Reduction:

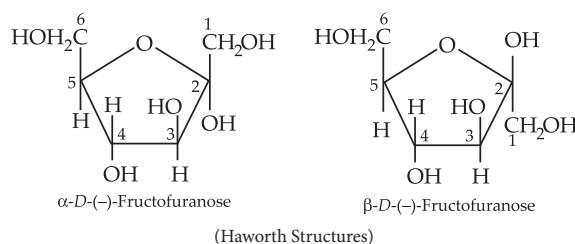
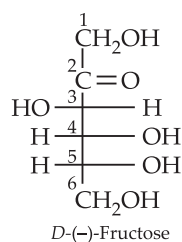


Oxidation:

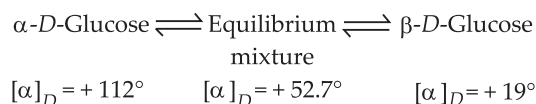


- **Fructose ($\text{C}_6\text{H}_{12}\text{O}_6$)** : A ketohexose as it contains six carbon atoms and ketonic group.

- **Structure :**



- **Mutarotation** : The change in specific rotation of an optically active compound with time to an equilibrium value is called *mutarotation*.

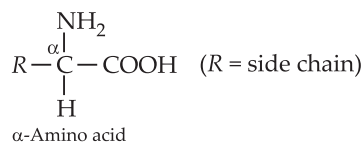


Disaccharides and Polysaccharides

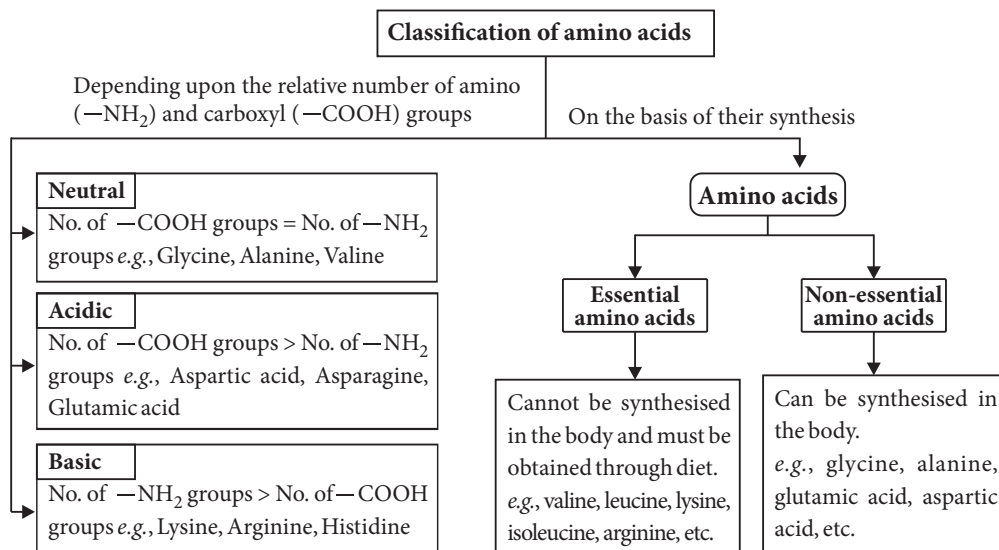
Carbohydrate	Hydrolysis products	Linkage	Reducing property
Sucrose (Disaccharide)	$\alpha\text{-D-Glucose}$ and $\beta\text{-D-Fructose}$	C-1 (Glucose) and C-2(Fructose)	Non-reducing
Maltose (Disaccharide)	$\alpha\text{-D-Glucose}$	C-1 (Glucose) and C-4 (glucose)	Reducing
Lactose (Disaccharide)	$\beta\text{-D-Galactose}$ and $\beta\text{-D-Glucose}$	C-1 (Galactose) and C-4 (Glucose)	Reducing
Starch (Polysaccharide)	Amylose and amylopectin	Amylose (C-1 and C-4 glycosidic linkage between $\alpha\text{-D-Glucose}$) Amylopectin (C-1 and C-4 linkage between $\alpha\text{-D-Glucose}$ and branching occurs by C-1 and C-6 linkage)	Non-reducing
Cellulose (Polysaccharide)	$\beta\text{-D-Glucose}$	C-1(glucose) and C-4(glucose)	Non-reducing
Glycogen (Polysaccharide)	$\alpha\text{-D-Glucose}$	C-1 (glucose) and C-4(glucose)	Non-reducing

PROTEINS

- **Proteins** : They are the biomolecules of the living system made up of nitrogenous organic compounds by condensation polymerisation of α -amino acids.

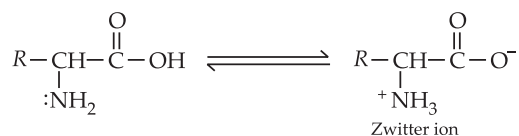


Classification of Amino Acids :

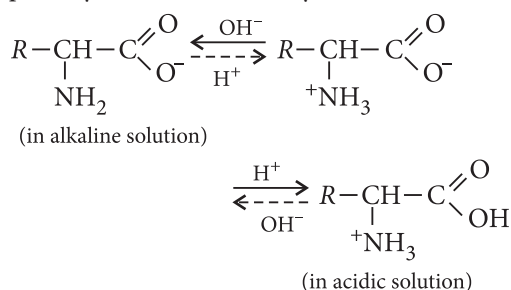


▶▶ Properties :

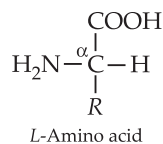
- ▶ In aqueous solution, the carboxylic group can lose a proton and amino group can accept a proton giving rise to a dipolar ion known as *zwitter ion*. This is neutral but contains both positive and negative charges.



- ▶ Since these form salts with acids as well as with bases, their chemical reactions are similar to primary amines and carboxylic acids.

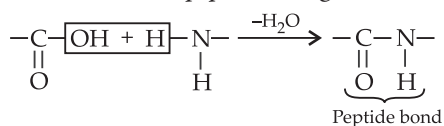


- ▶ **Isoelectric point** : The pH at which dipolar ion (zwitter ion) exists as neutral ion, *i.e.*, +ve and -ve charge is equal and it does not migrate to either electrode, is called *isoelectric point*. The amino acids have least solubility in water at isoelectric point which helps in their separation.
- ▶ Except glycine, all other naturally occurring α -amino acids are optically active because they contain chiral, asymmetric carbon atom.
- ▶ They exist in both *D*- and *L*-forms. Most naturally occurring α -amino acids have *L*-configuration.

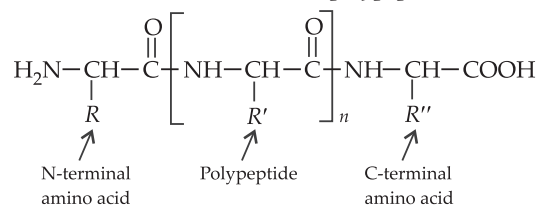


▶▶ Peptides and their classification :

- ▶ **Peptide bond** : The bond formed between two amino acids by the elimination of a water molecule is called a *peptide linkage or bond*.



- ▶ The products formed by the linking of amino acids by peptide linkage are known as *peptides*.
- ▶ Peptides are further divided into *di*, *tri*, *tetra* depending upon the number of amino acids combined.
- ▶ **Oligopeptide** : It contains anywhere between 2-10 amino acids.
- ▶ **Polypeptides** : Structures with more than ten amino acids are known as *polypeptides*.



where *R*, *R'*, *R''* may be same or different.

- ▶ A polypeptide with more than hundred amino acid residues, having molecular mass higher than 10,000 u is called a *protein*.

- ▶▶ **Classification of proteins** : On the basis of molecular structure, proteins are classified as :

Fibrous proteins

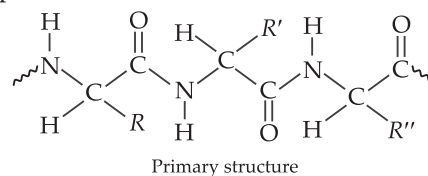
In fibrous proteins, polypeptide chains are parallel and are held together by hydrogen and disulphide bonds. These are insoluble in water, *e.g.*, keratin and myosin.

Globular proteins

Globular proteins results when the polypeptide chains coil around to give three dimensional spherical shape. These are soluble in water, *e.g.*, insulin and albumins.

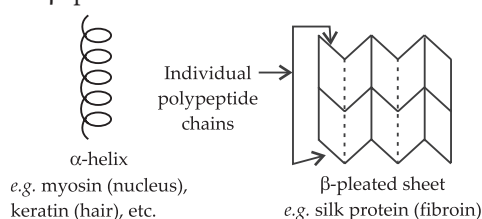
- ▶▶ **Structure** :

- ▶ **Primary structure** : It refers to the number and linear sequence of amino acids held together by peptide bonds.



- ▶ **Secondary structure**: It is due to folding or coiling of the peptide chain. It is mainly of two types :
 - α -**helix** : These coils are stabilized by hydrogen bonds between carbonyl oxygen of first amino acid to amide nitrogen of fourth amino acid.

- **β -pleated sheet structure** : β -pleated sheet structure is formed when hydrogen bonds are formed between the carbonyl oxygens and amide hydrogens of two or more adjacent polypeptide chains. The bonding in β -pleated sheet structure is intermolecular H-bonding. The structure is not planar but is slightly pleated. Silk fibroin is rich in β -pleated sheets.



- ▶ **Tertiary structure** : It represents overall folding of the polypeptide chains, *i.e.*, further folding of the secondary structure and the bonds responsible for such interaction are hydrophobic interactions, hydrogen bonds, ionic interactions, van der Waals' forces and Disulphide bonds.
- ▶ **Quaternary structure** : The spatial arrangement of the subunits (two or more polypeptide chains) with respect to each other.
- ▶ **Denaturation of proteins** :
 - ▶ When a protein in its native form, is subjected to physical changes like change in temperature or chemical changes like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called *denaturation of protein*.
 - ▶ The denaturation causes change in secondary and tertiary structures but primary structure remains intact *e.g.*, coagulation of egg white on boiling, curdling of milk, formation of cheese, when an acid is added to milk.

ENZYMES

- ▶ The enzymes are *biocatalysts* produced by living cells which catalyse biochemical reactions in living organisms. Chemically, enzymes are naturally occurring simple or conjugated proteins. Some enzymes may be non-proteins also.

HORMONES

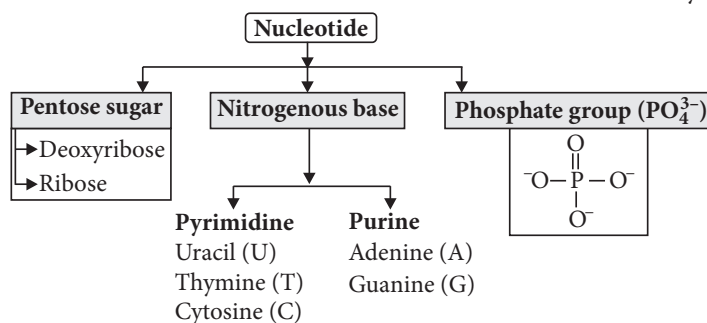
- ▶ **Hormones** : They are the molecules that act as intercellular messengers and are poured directly in the blood stream by endocrine glands.
- ▶ **Types of hormones** :
 - ▶ **Steroids** : Estrogens and androgens
 - ▶ **Polypeptides** : Insulin and endorphins
 - ▶ **Amino acid derivatives** : Epinephrine and norepinephrine.

VITAMINS

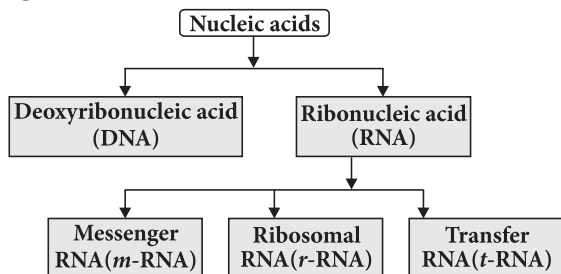
- ▶ **Vitamins**: These are complex organic molecules which cannot be produced by the body and must be supplied in small amounts in diet to carry out essential metabolic reactions which are required for normal growth and maintenance of the body.
- ▶ **Classification** :
 - ▶ **Water soluble vitamins** : Soluble in water. Must be supplied regularly in diet as they are regularly excreted in urine (except vitamin B₁₂) *e.g.*, Vitamin- B₁, B₂, B₆, B₁₂ and C.
 - ▶ **Fatsoluble vitamins**: Soluble in fat and oils. Stored in liver and adipose tissues *e.g.*, Vitamin - A, D, E and K.
- ▶ Deficiency of more than one vitamin in the body causes *avitaminosis* while excess intake of vitamins (A and D) may cause *hypervitaminoses*.

NUCLEIC ACIDS

- ▶ Nucleic acids are the polymers of nucleotides present in nucleus of all living cells and play an important role in transmission of the hereditary characteristics and biosynthesis of proteins.



▶▶ **Types of nucleic acids :**



- ▶▶ **Chargaff's rule:** Amount of purine bases is always equal to that of pyrimidine bases. Purine base of one strand of DNA molecule pairs with pyrimidine base of the other strand. Adenine (A) pairs with thymine (T) through two

H-bonds (A = T) and guanine (G) pairs with cytosine (C) through three H-bonds (G ≡ C).

In case of RNA, adenine (A) pairs with uracil (U), (A = U).

- ▶▶ **Replication :** It is the process by which a single DNA molecule produces two identical copies of itself.

- ▶▶ **Protein synthesis :** It occurs in two steps :

- ▶ **Transcription :** It is the process of synthesis of RNA.

- ▶ **Translation :** The synthesis of proteins occur in the cytoplasm of the cell. The *m*-RNA directs protein synthesis with the help of *r*-RNA and *t*-RNA.

Previous Years' CBSE Board Questions

14.1 Carbohydrates

VSA (1 mark)

1. Write the name of two monosaccharides obtained on hydrolysis of lactose sugar.
(Delhi 2016)
2. Write the structural difference between starch and cellulose.
(AI 2016)
3. Which one of the following is a disaccharide : Starch, Maltose, Fructose, Glucose?
(Delhi 2015)
4. Write the product obtained when *D*-glucose reacts with $\text{H}_2\text{N}-\text{OH}$.
(AI 2015)
5. Which one of the following is a monosaccharide: starch, maltose, fructose, cellulose
(Foreign 2015)
6. Which of the two components of starch is water soluble?
(Delhi 2014)
7. Write the product formed on reaction of *D*-glucose with Br_2 water.
(Delhi 2014)
8. Write the product formed when glucose is treated with HI.
(Delhi 2014)
9. Define the following term :
Anomers (AI 2014, Foreign 2014)
10. Define the following term :
Polysaccharides (Foreign 2014)
11. Define the following term :
Invert sugar (Foreign 2014, Delhi 2010)
12. What is a glycosidic linkage?
(Delhi 2013, 2009)
13. Name two components of starch.
(Delhi 2013C)
14. Write the structure of the product obtained when glucose is oxidised with nitric acid.
(AI 2012)
15. Write a reaction which shows that all the carbon atoms in glucose are linked in a straight chain.
(AI 2012)
16. State two functions of carbohydrates.
(AI 2012C)

17. Explain what is meant by the following: pyranose structure of glucose?
(AI, Foreign 2011)
18. What is meant by 'reducing sugars'?
(AI 2010)
19. What are the products of hydrolysis of sucrose?
(AI 2010)
20. Name of the expected products of hydrolysis of lactose.
(Delhi 2010C, 2009C)
21. What is the structural feature characterising reducing sugar?
(Delhi 2009C)
22. Describe the following, giving an example : Glycosidic linkage
(AI 2008)

SAI (2 marks)

23. Enumerate the reactions of glucose which cannot be explained by its open chain structures.
(Delhi 2014C, AI 2011C, 2010C, 2009C)
24. Write any two reactions of glucose which cannot be explained by the open chain structure of glucose molecule.
(Delhi 2012)
25. Write down the structures and names of the products formed when *D*-glucose is treated with (i) Hydroxylamine (ii) Acetic anhydride.
(AI 2012C)
26. Write down the structures and names of the products formed when *D*-glucose is treated with
(i) Bromine water
(ii) Hydrogen Iodide (Prolonged heating)
(AI 2012C)
27. What is essentially the difference between α -form and β -form of glucose? Explain.
(Delhi 2011)
28. Write such reactions and facts about glucose which can not be explained by open chain structure.
(AI 2011)
29. Name the products of hydrolysis of (i) sucrose and (ii) lactose.
(AI 2010, 2009)
30. Name the products of hydrolysis of sucrose. Why is sucrose not a reducing sugar?
(Delhi 2010)

31. What happens (write chemical equations) when *D*-glucose is treated with the following :
 (i) HI
 (ii) Bromine water (AI 2010C)
32. Answer the following question briefly :
 How are carbohydrates classified? (AI 2007)

SA II (3 marks)

33. Define the following terms :
 (i) Glycosidic linkage
 (ii) Invert sugar
 (iii) Oligosaccharides (AI 2014)
34. What is essentially the difference between α -glucose and β -glucose? What is meant by pyranose structure of glucose?
35. Mention the structural feature characterising reducing sugar. (Delhi 2011C)
36. What happens when *D*-glucose is treated with the following reagents :
 (i) HI
 (ii) Bromine water
 (iii) HNO_3 (AI 2008)
37. Name the three major classes of carbohydrates & give an example of each of these classes. (Delhi 2007)

14.2 Proteins**VSA (1 mark)**

38. Give one example each for fibrous protein and globular protein. (AI 2016, Delhi 2014, AI 2013C)
39. What is the difference between fibrous protein and globular protein? (Delhi 2015)
40. Amino acids show amphoteric behaviour. Why? (AI 2015)
41. What is the difference between acidic amino acids and basic amino acids? (Foreign 2015)
42. What type of linkage is responsible for the formation of proteins? (Delhi, Foreign 2014)
43. Define the following term :
 Essential amino acids (AI 2014)
44. Define the following term :
 Denaturation of proteins (Foreign 2014)

45. Define the following term :
 Amino acids (Foreign 2014)
46. Define a 'Peptide linkage'. (AI 2014C, 2011, Foreign 2011)
47. Where does the water present in the egg go after boiling the egg? (Delhi 2012C)
48. Explain the following term :
 Polypeptides (Delhi 2010)

SA I (2 marks)

49. Describe what you understand by primary structure and secondary structure of proteins? (Delhi 2011)
50. Explain what is meant by a peptide linkage. (Delhi 2011)
51. State what you understand by primary and secondary structure of proteins. (Foreign 2011)
52. Define the following terms in relation to proteins:
 (i) Peptide bond
 (ii) Denaturation of proteins (Delhi 2008)
53. Describe the following terms in reference of proteins :
 (i) Primary structure
 (ii) Denaturation (AI 2008)
54. What are essential and non-essential amino acids? Give one example of each type. (AI 2008C)
55. Mention the type of linkage responsible for the formation of the following:
 (i) Primary structure of proteins
 (ii) Cross-linkage of polypeptide chains
 (iii) α -helix formation
 (iv) β -sheet structure (AI 2008C)
56. Answer the following :
 (i) What type of linkage is responsible for the primary structure of proteins?
 (ii) Name the location where protein synthesis occurs in our body. (Delhi 2007)

SA II (3 marks)

57. Define the following terms as related to proteins:
 (i) Peptide linkage
 (ii) Primary structure
 (iii) Denaturation (AI 2015, 2014)

58. What are essential and nonessential amino acids? Give two examples of each.
(AI 2014C, Delhi 2012C)
59. (a) Give two differences between globular and fibrous proteins.
(b) What change occurs in the nature of egg protein on boiling? (Delhi 2013C)
60. Amino acids may be acidic, alkaline or neutral, How does this happen? What are essential and non-essential amino acids? Name one of each type. (AI 2010)
61. Differentiate between fibrous proteins and globular proteins. What is meant by the denaturation of a protein? (AI 2010)
62. (a) What type of bonding helps in stabilising of α -helix structure of proteins?
(b) Differentiate between globular and fibrous proteins. (Delhi 2010C)
63. What are proteins? State a difference between globular and fibrous proteins. (AI 2007)
72. Deficiency of which vitamin causes rickets? (Delhi 2014)
73. Deficiency of which vitamin causes scurvy? (Delhi 2014)
74. Define the following term :
Vitamins (Foreign 2014)
75. Why are vitamin A and vitamin C essential for us? (Delhi 2014C)
76. Name the deficiency diseases resulting from lack of Vitamins A and E in the diet. (Delhi 2013C)
77. Name one of the water soluble vitamin which is powerful antioxidant. Give its one natural source. (Delhi 2013C, AI 2012C)
78. How are hormones and vitamins different in respect of their source and functions? (AI 2013C)
79. Name the only vitamin which can be synthesized in our body. Name the disease caused due to the deficiency of this vitamin. (Delhi 2013C)
80. Name the deficiency disease resulting from lack of vitamin A in the diet. (Delhi 2011C)
81. The deficiency of which vitamin causes the disease, 'pernicious anaemia'? (AI 2011C)
82. What are vitamins? Deficiency of which vitamin causes
(i) Pernicious anaemia?
(ii) Convulsions? (AI 2010C)
83. Name two water soluble vitamins, their sources and diseases caused due to their deficiency in diet. (Delhi 2009)

14.3 Enzymes

VSA (1 mark)

64. Define the following term :
Enzymes (Foreign 2014, AI 2007)
65. What are enzymes? (AI 2014C)
66. What is meant by biocatalysts? (Delhi 2012)

SAI (2 marks)

67. List two characteristic features of enzymes. (AI 2007)

14.4 Vitamins

VSA (1 mark)

68. Why Vitamin C cannot be stored in our body? (Delhi 2016)
69. Write the name of vitamin whose deficiency causes bone deformities in children. (Delhi 2015)
70. Write the name of the vitamin whose deficiency causes bleeding of gums. (Foreign 2015)
71. Deficiency of which vitamin causes night-blindness? (Delhi 2014)

SAI (2 marks)

84. Name two fat soluble vitamins, their sources and the diseases caused due to their deficiency in diet. (AI 2009)
85. How are the vitamins classified? Mention the chief sources of vitamins A and C. (AI 2008)
86. B-complex is an often prescribed vitamin. What is complex about it and what is its usefulness? (AI 2007)
87. Answer the following questions briefly :
(i) What are the two good sources of vitamin A?
(ii) Why is vitamin C essential to us? Give its important sources. (AI 2007)

SA II (3 marks)

88. How are vitamins classified? Name the vitamin responsible for the coagulation of blood.
(Delhi 2015C)

VBQ (3 marks)

89. After watching a programme on TV about the adverse effects of junk food and soft drinks on the health of school children, Sonali, a student of Class XII, discussed the issue with the school principal. Principal immediately instructed the canteen contractor to replace the fast food with the fibre and vitamins rich food like sprouts, salad, fruits etc. This decision was welcomed by the parents and the students.

After reading the above passage, answer the following questions:

- (a) What values are expressed by Sonali and the Principal of the school?
(b) Give two examples of water-soluble vitamins.
(Delhi 2013)
90. Shanti, a domestic helper of Mrs. Anuradha, fainted while mopping the floor. Mrs. Anuradha immediately took her to the nearby hospital where she was diagnosed to be severely 'anaemic'. The doctor prescribed an iron rich diet and multivitamins supplement to her. Mrs. Anuradha supported her financially to get the medicines. After a month, Shanti was diagnosed to be normal.
- After reading the above passage, answer the following questions:
- (i) What values are displayed by Mrs. Anuradha?
(ii) Name the vitamin whose deficiency causes 'pernicious anaemia'.
(iii) Give an example of a water soluble vitamin.
(AI 2013)

14.5 Nucleic Acids**VSA (1 mark)**

91. What is difference between a nucleoside and nucleotide?
(Delhi 2016, 2014C)

92. What type of linkage is present in nucleic acids?
(AI 2016)
93. Name of the base that is found in nucleotide of RNA only.
(Delhi 2014)
94. Define the following term:
Nucleoside
(Foregin 2014)
95. Mention one important function of nucleic acids in our body.
(AI 2013C)
96. Name of the purines present in DNA.(AI 2007)

SA I (2 marks)

97. Write the structural and functional difference between DNA and RNA.
(Delhi 2013C)
98. Write the main structural difference between DNA and RNA. Of the two bases, thymine and uracil, which one is present in DNA?
(Delhi 2012)
99. Name the bases present in RNA. Which one of these is not present in DNA?
(Delhi 2011)
100. Write the main structural difference between DNA and RNA. Of the four bases, name those which are common to both DNA and RNA.
(AI 2011)
101. Name the four bases present in DNA. Which one of these is not present in RNA?
(AI 2009)
102. (a) What is the structural difference between a nucleoside and a nucleotide?
(b) The two strands in DNA are not identical but are complementary. Explain.
(Delhi 2009C)
103. When RNA is hydrolysed, there is no relationship among the quantities of different bases formed. What does this fact suggest about the structure of RNA?
(AI 2008C)

SA II (3 marks)

104. What are the different types of RNA found in cells of organisms? State the functions of each type.
(Delhi 2012C)
105. (a) Write the important structural difference between DNA and RNA.
(b) Mention the names of the bases produced on hydrolysis of DNA.
(AI 2009C)

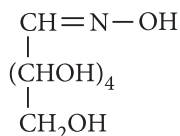
Detailed Solutions

1. Lactose on hydrolysis gives β -D-glucose and β -D-galactose.

2. The basic structural difference between starch and cellulose is of linkage between the glucose units. In starch, there is α -D-glycosidic linkage. Both the components of starch-amylose and amylopectin are polymer of α -D-glucose. On the other hand, cellulose is a linear polymer of β -D-glucose in which C_1 of one glucose unit is connected to C_4 of the other through β -D-glycosidic linkage.

3. Maltose is a disaccharide as it consists of two α -D-glucose units.

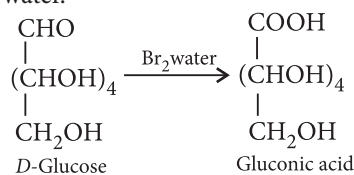
4. D-Glucose reacts with H_2N-OH to give glucose oxime.



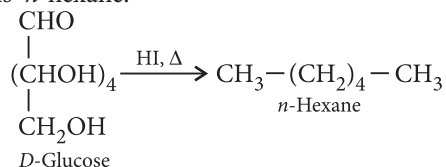
5. Fructose is a monosaccharide because it cannot be hydrolysed to simpler polyhydroxy aldehydes or ketones.

6. Amylose is water soluble and amylopectin is insoluble in water.

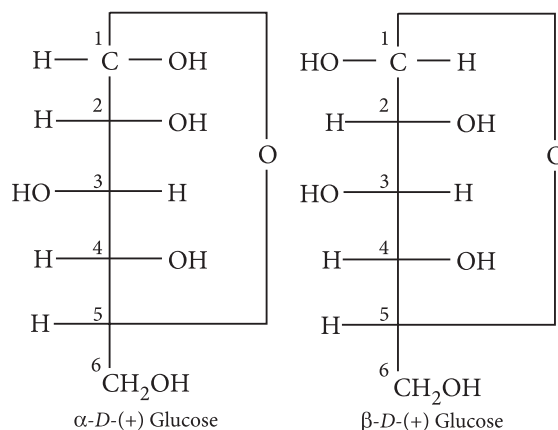
7. D - Glucose gets oxidised to six carbon carboxylic acid (gluconic acid) on reaction with bromine water.



8. On prolonged heating with HI, D-Glucose forms n-hexane.



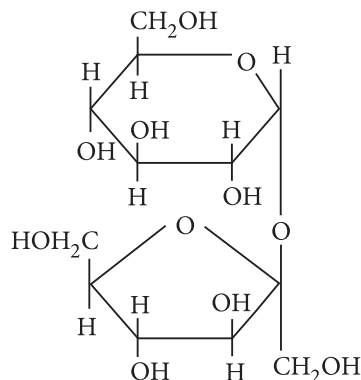
9. The pair of stereoisomers which differ only in the configuration of the hydroxyl group at C_1 are called anomers.



10. Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides.

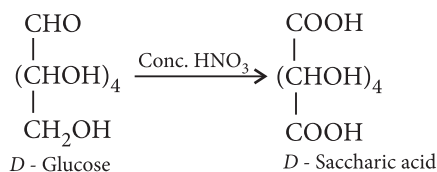
11. An equimolar mixture of glucose and fructose, obtained by hydrolysis of sucrose in presence of an acid or the enzyme invertase is called invert sugar.

12. The two monosaccharides are joined together by an oxide linkage formed by the loss of water molecule. Such linkage is called glycosidic linkage.



13. Amylose and amylopectin are the two components of starch.

14. On oxidation with nitric acid, D - glucose yields saccharic acid.



33. (i) Refer to answer 12.
 (ii) Refer to answer 11
 (iii) Refer to answer 32 (ii)

34. Refer to answers 27 and 17.

35. Reducing sugar : The sugars which reduce Fehling's solution and Tollen's reagent are called reducing sugars. For example, all monosaccharides containing free $-\text{CHO}$ or $-\overset{\text{O}}{\parallel}{\text{C}}$ group are reducing sugars.

36. (i) Refer to answer 8.
 (ii) Refer to answer 7.
 (iii) Refer to answer 14.

37. Refer to answer 32.

38. Globular protein – Insulin
 Fibrous protein – Keratin

39. Characteristic differences between globular and fibrous proteins can be given as :

S. No.	Globular proteins	Fibrous proteins
1.	These are cross-linked proteins and are condensation product of acidic and basic amino acids.	These are linear condensation polymer.
2.	These are soluble in water, mineral acids and bases.	These are insoluble in water but soluble in strong acids and bases.
3.	These proteins have three dimensional folded structure. These are stabilised by internal hydrogen bonding. e.g., egg albumin, enzymes.	These are linear polymers held together by intermolecular hydrogen bonds. e.g., hair, silk.

40. As amino acids have both acidic (carboxy group) and basic groups (amino group) in the same molecule, they react with both acids and bases. Hence, they show amphoteric behaviour.

41. Acidic amino acids are those which contain more number of carboxyl groups as compared to amino groups whereas basic amino acids are those which contains more number of amino groups than carboxyl groups.

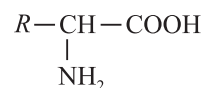
42. Peptide linkage.

43. **Essential amino acids** : Amino acids which cannot be synthesized in the body and must be obtained through diet are known as essential amino acids. e.g., valine, leucine, etc.

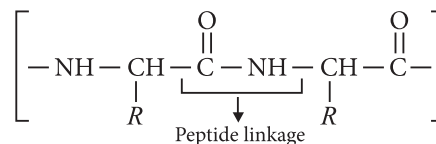
44. **Denaturation** : The loss of biological activity of a protein by changing the pH, temperature or by adding some salt due to disruption of the native structure of protein is called denaturation.

During denaturation secondary and tertiary structure of protein is destroyed but primary structure remains intact.

45. Organic compounds containing both amino ($-\text{NH}_2$) and carboxy ($-\text{COOH}$) functional groups are called amino acids.



46. Proteins are the polymers of α -amino acids linked by amide formation between carboxyl and amino group. This is called peptide linkage or peptide bond e.g.,



47. An egg contains a soluble globular protein called albumin which is present in the white part. On boiling, denaturation (loss of biological activity) of this protein takes place which results in the formation of insoluble fibrous proteins. The water molecules are utilized in this process.

48. Polypeptides are the macromolecules formed by combination of 10 or more amino acids.

49. **Primary structure** : 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 primary structure creates a different protein.

Secondary structure : The conformation of the polypeptide chain is known as secondary structure. The two types of secondary structure are α -helix and β -pleated sheet structure.

In α -helix structure, the polypeptide chain forms all the possible hydrogen bonds by twisting into a right

handed screw (helix) with the —NH groups of each amino acid residue hydrogen bonded to the $\begin{array}{c} \diagup \\ \text{C}=\text{O} \\ \diagdown \end{array}$ group of an adjacent turn of the helix. In β -pleated sheet structure, all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by intermolecular hydrogen bonds.

50. (i) Refer to answer 46.
51. Refer to answer 49.
52. (i) Refer to answer 46.
(ii) Refer to answer 44.
53. (i) Refer to answer 49.
(i) Refer to answer 44.
54. Amino acids which cannot be synthesised in the body and must be obtained through diet are known as essential amino acids, e.g., valine and leucine. There are ten essential amino acids. Amino acids which can be synthesised in the body are known as non-essential amino acids, e.g., alanine and glutamic acids.
55. (i) Primary structure – Peptide bond of protein (linkage)
(ii) Cross linkage of polypeptide chain – Hydrogen bonds, disulphide linkage, electrostatic force of attraction
(iii) α -helix formation – Hydrogen bond
(iv) β -sheet structure – Intermolecular hydrogen bonds
56. (i) Refer to answer 42.
(ii) Protein synthesis takes place in cytoplasm.
57. (i) Refer to answer 46.
(ii) Refer to answer 49.
(iii) Refer to answer 44.
58. Refer to answer 54.
59. (a) Refer to answer 39.
(b) Protein is denatured and its biological activity is lost.
60. Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecules.
(a) Equal number of amino and carboxyl groups makes it neutral (b) more number of amino groups

than carboxyl groups make it basic and (c) more carboxyl groups as compared to amino groups make it acidic.

Refer to answer 54.

61. Refer to answers 39 and 44.
62. (a) Hydrogen bonding
(b) Refer to answer 39.
63. Macromolecules formed by the combination of 100-1000 amino acid groups in a proper conformation are called proteins.
Refer to answer 39.
64. **Enzymes:** Most of the chemical reactions which occur in living systems process at very slow rates under mild condition of temperature and pH. These reactions are catalysed by a group of biomolecules called enzymes.
65. Refer to answer 64.
66. Substances which catalyse chemical reactions taking place in living organisms are called biocatalysts. e.g., enzymes
67. (i) Enzymes are highly specific for a particular reaction and for a particular substrate.
(ii) Very small amount of enzyme is required for the process of a reaction.
68. Vitamin C is soluble in water and regularly excreted in urine and hence cannot be stored in body.
69. Vitamin D
70. Vitamin C
71. Vitamin A
72. Vitamin D
73. Vitamin C
74. 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 are called vitamins.
75. The deficiency of vitamin A leads to xerophthalmia and night blindness. The deficiency of vitamin C leads to scurvy.
76. Vitamin – A : Night blindness
Vitamin E : Muscular weakness.
77. Vitamin C is water soluble and powerful antioxidant. Natural source of vitamin C is amla.

78.

	Hormones	Vitamins
(i)	The biomolecules which transfer information from one group of cell to distant tissue or organ.	These are essential dietary factors required by an organism in minute quantities.
(ii)	They are produced in the body in ductless glands.	They are supplied to the body from the food eaten.

79. Vitamin D

Disease caused due to deficiency of Vitamin D is rickets.

80. Refer to answer 76.

81. Vitamin B₁₂

82. Refer to answer 74.

(i) Refer to answer 81.

(ii) Vitamin B₆83. Examples of water soluble vitamins :
Vitamin B and vitamin C.

Name of vitamins	Source	Deficiency diseases
Vitamin B ₁	Yeast, milk, green vegetables, cereals etc.	Beri beri
Vitamin C	Citrus fruits, amla, and leafy vegetables.	Scurvy (bleeding gums)

84. Examples of fat soluble vitamins are vitamin A and D.

Name of vitamins	Source	Deficiency diseases
Vitamin A	Fish liver oil, carrots, butter, milk	Night blindness
Vitamin D	Fish and egg yolk	Rickets and osteomalacia

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

(i) Fat soluble vitamins.

(ii) Water soluble vitamins.

Sources of vitamin A : Fish, liver oil, carrots, butter and milk.

Sources of vitamin C : Citrus fruits, amla and green leafy vegetables.

86. B-complex is a group of vitamins which contains vitamins B₁, B₂, B₆, B₁₂, biotin, folic acid, pantothenic acid and nicotinic acid. It is required to release energy from food and to promote healthy skin and muscles. Its deficiency causes beri beri and pernicious anaemia.

87. (i) Milk and butter are two good sources of vitamin A.

(ii) Refer to answer 84.

88. Refer to answer 85.

Vitamin K is responsible for the coagulation of blood.

89. (a) Awareness and social thinking

(b) Vitamin B complex and vitamin C.

90. (i) Humanitarian (kindness and caring)

(ii) Refer to answer 81.

(iii) Refer to answer 83.

91. Nucleoside contains pentose sugar, and base whereas nucleotide contains pentose sugar, base as well as phosphate group.

Nucleoside = Base + Sugar

Nucleotide = Base + Sugar + Phosphate.

92. Ester linkage

93. Uracil

94. Refer to answer 91.

95. DNA is reserve of genetic information and responsible for heredity transmission.

96. Adenine and guanine

97. **Structural differences between DNA and RNA**

(i) The sugar in DNA is deoxyribose while that in RNA is ribose.

(ii) DNA has a double-stranded helical structure, while RNA has a single-stranded helical structure.

Functional differences between DNA and RNA

(i) DNA is the chemical basis of heredity and is responsible for maintaining the identity of different species.

(ii) RNA molecules are responsible for protein synthesis but the message for the synthesis of a particular protein is present in DNA.

98. Refer to answer 97.

In DNA, thymine is present.

99. The bases present in RNA are adenine (A), guanine (G) cytosine (C) and Uracil (U).

Uracil is not present in DNA

100. Refer to answer 97 (Structural difference).

Common bases in DNA and RNA are adenine, guanine and cytosine.

101. DNA contains four bases viz adenine (A) guanine (G), cytosine (C), and thymine (T). RNA also contains four bases but thymine is not present in RNA.

102. (a) Refer to answer 91.

(b) DNA is a double helix in which the two strands of DNA are held by the hydrogen bonds between the bases on the two strands. Thymine (T) pairs with adenine through two hydrogen bonds and cytosine (C) pairs with guanine (G) through three H-bonds. Hence, the two strands of DNA are complementary to each other.

103. When a RNA molecule is hydrolysed then there is no relationship between the quantities of

four bases viz. adenine (A), guanine (G), cytosine (C), and uracil (U). This fact suggests that RNA has single stranded structure.

104. RNA are of three types :

(i) **Messenger RNA (*m*-RNA)** : Function as messenger carrying the information in a gene to the protein synthesizing machinery.

Transfer RNA (*t*-RNA) : They transfer the amino acids from cytoplasm to the protein synthesizing machinery.

(ii) **Ribosomal RNA (*r*RNA)** : They associates with a set of proteins to form ribosomes. These complex structures, which physically move among an *m*RNA molecule, catalyze the assembly of amino acids into protein chains. They also bind *t*-RNAs and various molecules necessary for protein synthesis.

105. (a) Refer to answer 97 (Structural difference).

(b) DNA an hydrolysis gives pentose sugar, Phosphoric acid and nitrogen containing heterocyclic bases viz. adenine, guanine, cytosine and thymine.

