Biomolecules

10.1 Carbohydrates

MCQ

1. Which of the following is a non-reducing sugar?
   (a) Sucrose (b) Maltose
   (c) Glucose (d) Lactose *(2023)*

2. The glycosidic linkage involved in linking the glucose units in amylose part of starch is
   (a) $C_1 - C_6$ α linkage (b) $C_1 - C_6$ β linkage
   (c) $C_1 - C_4$ α linkage (d) $C_1 - C_4$ β linkage
   (2023)

3. Which of the following sugar is known as dextrose?
   (a) Glucose (b) Fructose
   (c) Ribose (d) Sucrose
   (Term I, 2021-22)

4. α-*D*(+) glucose and β-*D*(+) glucose are
   (a) geometrical isomers (b) enantiomers
   (c) anomers (d) optical isomers.
   (2020) Ap

5. **Assertion (A) :** Sucrose is a non-reducing sugar.
   Reason (R) : Sucrose has glycosidic linkage.
   (a) Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).
   (b) Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).
   (c) Assertion (A) is correct, but Reason (R) is incorrect statement.
   (d) Assertion (A) is incorrect, but Reason (R) is correct statement. *(2020)* An

VSA (1 mark)

6. Name the disaccharide which on hydrolysis gives two molecules of glucose. *(One word, 2020)*
7. Write the name of linkage joining two monosaccharides. *(One word, 2020)*
8. What is the basic structural difference between glucose and fructose? *(Delhi 2019)* R
9. Write the structural difference between starch and cellulose. *(AI 2019, 2016)*
10. Write the products obtained after hydrolysis of lactose. *(Delhi 2019)*

    OR

    Write the name of two monosaccharides obtained on hydrolysis of lactose sugar. *(Delhi 2016)*
11. Name a carbohydrate present in liver, muscles and brain. *(2019C)*
12. What are the hydrolysis products of sucrose ? *(2019C)*
13. Define the following with an example : Polysaccharides *(1/3, 2018)*

    OR

    Define the following term : Polysaccharides *(Foreign 2014)*
14. Write the product when *D*-glucose reacts with conc. HNO_3. *(1/3, 2018)*
15. Which one of the following is a disaccharide : Starch, Maltose, Fructose, Glucose? *(Delhi 2015)* Ev
16. Write the product obtained when *D*-glucose reacts with H_2N-OH. *(AI 2015)*
17. Which one of the following is a monosaccharide : starch, maltose, fructose, cellulose *(Foreign 2015)* U
18. Which of the two components of starch is water soluble? *(Delhi 2014)*
19. Write the product formed on reaction of *D*-glucose with Br_2 water. *(Delhi 2014)*
20. Write the product formed when glucose is treated with HI. *(Delhi 2014)* Ap
21. Define the following term : Anomers *(AI 2014, Foreign 2014)*
22. Define the following term : Invert sugar *(Foreign 2014)*

SA I (2 marks)

23. Give the reaction of heating glucose with hydroxylamine. Presence of which group is confirmed by this reaction? *(2023)*
24. Define the following terms :
    (i) Oligosaccharides
    (ii) Invert sugar *(2020)* R
25. Write the reactions showing the presence of following in the open structure of glucose :
    (i) an aldehyde group
    (ii) a primary alcohol. *(2020)*
26. Enumerate the reactions of glucose which cannot be explained by its open chain structures. *(Delhi 2014C)*

SA II (3 marks)

27. (a) What are the hydrolysis products of (i) Lactose, (ii) Maltose?
    (b) Give the basic structural difference between starch and cellulose. *(2023)*
28. Write the reaction of glucose with
    (i) HCN (ii) Br_2 (iii) HI *(2021 C)*
29. Write chemical reactions to show that open structure of *D*-glucose contains the following :
    (i) Straight chain
    (ii) Five alcohol groups
    (iii) Aldehyde as carbonyl group. *(Delhi 2019)* U
30. What happens when *D*-glucose is treated with the following reagents?
    (a) Br_2 water (b) HCN
    (c) $(CH_3CO)_2O$ *(AI 2019)*

31. Define the following terms :
(i) Glycosidic linkage (ii) Invert sugar
(iii) Oligosaccharides *(AI 2014)*

10.2 Proteins

MCQ

32. β-pleated sheet structure in proteins refers to
(a) primary structure (b) secondary structure
(c) tertiary structure (d) quaternary structure. *(2023)*

33. An α-helix is a structural feature of
(a) sucrose (b) starch
(c) polypeptides (d) nucleotides. *(2023)*

34. Complete the following analogy :
Curdling of milk : A :: α-helix : B
(a) A : Primary structure , B : Secondary structure
(b) A : Denatured protein, B : Primary structure
(c) A : Secondary structure, B : Denatured protein
(d) A : Denatured protein, B : Secondary structure
(Term I, 2021-22) An

35. Amino acids which cannot be synthesized in the body and must be obtained through diet are known as
(a) acidic amino acids
(b) essential amino acids
(c) basic amino acids
(d) non-essential amino acids. *(Term I, 2021-22)*

36. The helix structure of proteins is stabilised by:
(a) peptide bond (b) hydrogen bond
(c) disulphide bond (d) van der Waals' forces *(2021C)*

37. Peptide linkage is present in
(a) carbohydrates (b) vitamins
(c) protein (d) rubber. *(2020)* U

38. Amino acids are
(a) acidic (b) basic
(c) amphoteric (d) neutral. *(2020)* R

39. **Assertion (A) :** Albumin is a globular protein.
Reason (R) : Polypeptide chain coils around to give a straight chain.
(a) Both assertion (A) and reason (R) are correct statements, and reason (R) is the correct explanation of the assertion (A).
(b) Both assertion (A) and reason (R) are correct statements, but reason (R) is not the correct explanation of the assertion (A).
(c) Assertion (A) is correct, but reason (R) is incorrect statement.
(d) Assertion (A) is incorrect, but reason (R) is correct statement. *(2020)*

40. An α-helix is a structural feature of
(a) sucrose (b) polypeptides
(c) nucleotides (d) starch. *(2020)*

VSA (1 mark)

41. What is the difference between a glycosidic linkage and a peptide linkage ? *(2019)* U

42. Define the following terms with a suitable example of each :
(a) Anomers (b) Essential amino acids
(c) Denaturation of protein *(2019)*

43. What is the difference between fibrous protein and globular protein? *(1/3, AI 2017C, Delhi 2015)*

44. Give one example each for fibrous protein and globular protein. *(AI 2016, Delhi 2014)*

45. Amino acids show amphoteric behaviour. Why? *(AI 2015)* An

46. What is the difference between acidic amino acids and basic amino acids? *(Foreign 2015)*

47. What type of linkage is responsible for the formation of proteins? *(Delhi, Foreign 2014)*

48. Define the following term :
Essential amino acids *(AI 2014)*

49. Define the following term:
Denaturation of proteins *(Foreign 2014)*

50. Define the following term :
Amino acids *(Foreign 2014)* R

SA I (2 marks)

51. Define denaturation of protein. What is the effect of denaturation on the structure of protein? *(2023)*

52. (a) Write chemical reaction to show that open structure of *D*-glucose contains the straight chain.
(b) What type of linkage is responsible for the formation of protein? *(2023)*

53. Define the following with an example of each :
(i) Denatured protein
(ii) Essential amino acids *(2/3, 2018)*

54. (a) Amino acids show amphoteric behaviour. Why?
(b) Write one difference between α-helix and β-pleated structures of proteins. *(2/3, 2018)*

SA II (3 marks)

55. (a) Write the product when *D*-glucose reacts with conc. HNO_3.
(b) Amino acids show amphoteric behaviour. Why?
(c) Write one difference between α-helix and β-pleated structure of protein. *(2023)*

56. Define proteins and classify them on the basis of their molecular shape. *(2020C)*

57. Differentiate between the following :
(i) Amylose and Amylopectin
(ii) Peptide linkage and Glycosidic linkage
(iii) Fibrous proteins and Globular proteins.
(Delhi 2019) Ev

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

59. What are essential and non-essential amino acids? Give two examples of each. *(AI 2014C)*

Case Based (5 marks)

60. **Read the given passage and answer the questions number (i) to (v) that follow :** 1×5=5
Organic compounds containing amine as functional group are present in a vivid variety of compounds, namely amino acids, hormones, neurotransmitters, DNA, alkaloids, dyes, etc. Drugs including nicotine, morphine, codeine and heroin, etc. which have physiological effects on humans also contain amino group in one form or another. Amines are basic because of the presence of lone pair of electrons on nitrogen. Addition of nitrogen into an organic framework leads to the formation of two families of molecules, namely amines and amides. As chemistry students, we must appreciate the versatility of nitrogen.
(i) What are amino acids ?
(ii) Why are amino acids amphoteric ?
(iii) Give one point of difference between acidic and basic amino acid.
(iv) What are essential amino acids ?
(v) Name the linkage formed when carboxyl end of one amino acid condenses with amino end of other amino acid. *(2020)*

10.3 Enzymes

VSA (1 mark)

61. Define the following term :
Enzymes *(Foreign 2014, AI 2014 C)*

10.4 Vitamins

VSA (1 mark)

62. Why vitamin C cannot be stored in our body? *(Delhi 2016)*
63. Write the name of vitamin whose deficiency causes bone deformities in children. *(Delhi 2015)*
64. Write the name of the vitamin whose deficiency causes bleeding of gums. *(Foreign 2015)*
65. Deficiency of which vitamin causes night-blindness? *(Delhi 2014)* R
66. Deficiency of which vitamin causes rickets? *(Delhi 2014)*
67. Deficiency of which vitamin causes scurvy? *(Delhi 2014)*
68. Define the following term : Vitamins *(Foreign 2014)* R
69. Why are vitamin *A* and vitamin *C* essential for us? *(Delhi 2014C)*

SA I (2 marks)

70. Define vitamins and classify them on the basis of their solubility. *(2020C)* R

SA II (3 marks)

71. (a) What are the products of hydrolysis of maltose ?
(b) What type of bonding provides stability to α-helix structure of protein ?
(c) Name the vitamin whose deficiency causes pernicious anaemia. *(2019)*
72. How are vitamins classified? Name the vitamin responsible for the coagulation of blood. *(Delhi 2015C)*

10.5 Nucleic Acids

MCQ

73. **Assertion :** The backbone of DNA and RNA molecules is a chain consisting of heterocyclic base, pentose sugar and phosphate group.
Reason : Nucleotides and nucleosides mainly differ from each other in presence of phosphate group.
(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true. *(2023)*
74. The base which is present in DNA but not in RNA, is
(a) cytosine (b) guanine (c) adenine (d) thymine. *(Term I, 2021-22)* R
75. Nucleic acids are polymer of
(a) amino acids (b) nucleosides
(c) nucleotides (d) glucose. *(Term I, 2021-22, 2021C)*
76. Nucleosides are composed of
(a) a pentose sugar and phosphoric acid
(b) a nitrogenous base and phosphoric acid
(c) a nitrogenous base and a pentose sugar
(d) a nitrogenous base, a pentose sugar and phosphoric acid. *(Term I, 2021-22)* R

VSA (1 mark)

77. Name the unit formed by the attachment of a base to 1′ position of sugar. *(2020C)*
78. Write the products obtained after hydrolysis of DNA. *(2019)*
79. What is difference between a nucleoside and nucleotide? *(2019, Delhi 2016, 2014C)*
80. What type of linkage is present in nucleic acids? *(AI 2016)* U
81. Name of the base that is found in nucleotide of RNA only. *(Delhi 2014)*
82. Define the following term :
Nucleoside *(Foreign 2014)* R

SA I (2 marks)

83. Write two differences between DNA and RNA. *(2019)*

SA II (3 marks)

84. Give reasons for any 3 of the following observations:
(a) Penta-acetate of glucose does not react with hydroxylamine.
(b) Amino acids behave like salts.
(c) Water soluble vitamins must be taken regularly in diet.
(d) The two strands in DNA are complimentary to each other. *(2023)*

85. Differentiate the following
(i) Fibrous protein and Globular protein
(ii) Essential amino acids and Non-essential amino acids
(iii) DNA and RNA *(2021C)* U

86. Define the following terms :
(a) Invert sugar (b) Native protein
(c) Nucleotide *(2019)*

87. Give the plausible explanation for the following :
(a) Glucose doesn't give 2,4-DNP test.
(b) The two strands in DNA are not identical but are complementary.
(c) Starch and cellulose both contain glucose unit as monomers yet they are structurally different. *(2020)*

88. Differentiate between following :
(i) Amylose and Amylopectin
(ii) Globular protein and Fibrous protein
(iii) Nucleotide and Nucleoside *(2020)* Ap

CBSE Sample Questions

10.1 Carbohydrates

MCQ

1. Which one of the following reactions is not explained by the open chain structure of glucose?
(a) Formation of pentaacetate of glucose with acetic anhydride
(b) Formation of addition product with 2,4 DNP reagent
(c) Silver mirror formation with Tollen's reagent
(d) Existence of alpha and beta forms of glucose
(Term I, 2021-22) U

2. Which of the following is a polysaccharide?
(a) Glucose (b) Maltose
(c) Glycogen (d) Lactose
(Term I, 2021-22)

3. Which one of the following statements is correct about sucrose?
(a) It can reduce Tollen's reagent, however cannot reduce Fehling's reagent.
(b) It undergoes mutarotation like glucose and fructose.
(c) It undergoes inversion in the configuration on hydrolysis.
(d) It is laevorotatory in nature.
(Term I, 2021-22) R

4. In the following reaction,identify *A* and *B*.

$$C_6H_{12}O_6 \xrightarrow{\text{Acetic anhydride}} A$$
$$\downarrow \text{Conc. nitric acid}$$
$$B$$

(a) $A = COOH-(CH_2)_4-COOH$,
$B = OHC-(CHOCOCH_3)_4-CH_2OCOCH_3$
(b) $A = COOH-(CH_2)_4-CHO$,
$B = OHC-(CHOCOCH_3)_4-CH_2OCOCH_3$
(c) $A = OHC-(CHOCOCH_3)_3-CH_2OCOCH_3$,
$B = COOH-(CH_2)_4-CHO$
(d) $A = OHC-(CHOCOCH_3)_4-CH_2OCOCH_3$,
$B = COOH-(CHOH)_4-COOH$ *(Term I, 2021-22)*

5. Dissacharides that are reducing in nature are
(a) sucrose and lactose
(b) sucrose and maltose
(c) lactose and maltose
(d) sucrose, lactose and maltose. *(2020-21)*

SA I (2 marks)

6. Account for the following:
(a) There are 5 -OH groups in glucose.
(b) Glucose is a reducing sugar.

OR

What happens when *D*-glucose is treated with the following reagents?
(a) Bromine water
(b) HNO_3 *(2022-23)*

10.2 Proteins

MCQ

7. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : Proteins are found to have two different types of secondary structures *viz* alpha-helix and beta-pleated sheet structure.
Reason (R) : The secondary structure of proteins is stabilized by hydrogen bonding.
Select the most appropriate answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true. *(2022-23)*

8. Which of the following statements is correct?
(a) Fibrous proteins are generally soluble in water.
(b) Albumin is an example of fibrous protein.
(c) In fibrous proteins, the structure is stabilised by hydrogen bonds and disulphide bonds.
(d) pH does not affect the primary structure of protein. *(Term I, 2021-22)* An

9. Curdling of milk is an example of
(a) breaking of peptide linkage
(b) hydrolysis of lactose
(c) breaking of protein into amino acids
(d) denaturation of protein. *(2020-21)*

SA II (3 marks)

10. Three amino acids are given below :
Alanine : $CH_3CH(COOH)(NH_2)$,

Aspartic acid : $HOOC - CH_2CH(COOH)(NH_2)$ and Lysine : $H_2N - (CH_2)_4 - CH(COOH)(NH_2)$

(i) Make two tripeptides using these amino acids and mark the peptide linkage in both cases.

(ii) Represent alanine in the zwitter ionic form.

(2020-21) Cr

10.5 Nucleic Acids

MCQ

11. Match the following:

I		II	
(i)	Amino acids	(A)	Protein
(ii)	Thymine	(B)	Nucleic acid
(iii)	Insulin	(C)	DNA
(iv)	Phosphodiester linkage	(D)	Zwitter ion
(v)	Uracil		

Which of the following is the best matched options?

(a) (i)-A, (v)-D, (iii)-C, (iv)-B (b) (i)-D, (ii)-C, (iii)-A, (iv)-B

(c) (i)-D, (v)- D, (iii)-A, (iv)-B (d) (i)-A, (ii)-C, (iii)-D, (iv)-B

(Term I, 2021-22) An

12. **Assertion :** The two strands are complementary to each other.

Reason : The hydrogen bonds are formed between specific pairs of bases.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement. *(2020-21)*

Case Based (5 marks)

13. **Strengthening the Foundation: Chargaff Formulates His "Rules"**

Many people believe that James Watson and Francis Crick discovered DNA in the 1950s. In reality, this is not the case. Rather, DNA was first identified in the late 1860s by Swiss chemist Friedrich Miescher. Then, in the decades following Miescher's discovery, other scientists-notably, Phoebus Levene and Erwin Chargaff carried out a series of research efforts that revealed additional details about the DNA molecule, including its primary chemical components and the ways in which they joined with one another. Without the scientific foundation provided by these pioneers, Watson and Crick may never have reached their groundbreaking conclusion of 1953: that the DNA molecule exists in the form of a three-dimensional double helix.

Chargaff, an Austrian biochemist, as his first step in this DNA research, set out to see whether there were any differences in DNA among different species. After developing a new paper chromatography method for separating and identifying small amounts of organic material, Chargaff reached two major conclusions:

(i) the nucleotide composition of DNA varies among species.

(ii) Almost all DNA, no matter what organism or tissue type it comes from maintains certain properties, even as its composition varies. In particular, the amount of adenine (A) is similar to the amount of thymine (T), and the amount of guanine (G) approximates the amount of cytosine (C). In other words, the total amount of purines (A + G) and the total amount of pyrimidines (C + T) are usually nearly equal. This conclusion is now known as "Chargaff's rule." Chargaff's rule is not obeyed in some viruses. These either have single- stranded DNA or RNA as their genetic material.

Answer the following questions:

(a) A segment of DNA has 100 adenine and 150 cytosine bases. What is the total number of nucleotides present in this segment of DNA?

(b) A sample of hair and blood was found at two sites. Scientists claim that the samples belong to same species. How did the scientists arrive at this conclusion?

(c) The sample of a virus was tested and it was found to contain 20% adenine, 20% thymine, 20 % guanine and the rest cytosine. Is the genetic material of this virus (a) DNA- double helix (b) DNA-single helix (c) RNA? What do you infer from this data?

OR

How can Chargaff's rule be used to infer that the genetic material of an organism is double- helix or single- helix? *(2022-23)*

Detailed SOLUTIONS

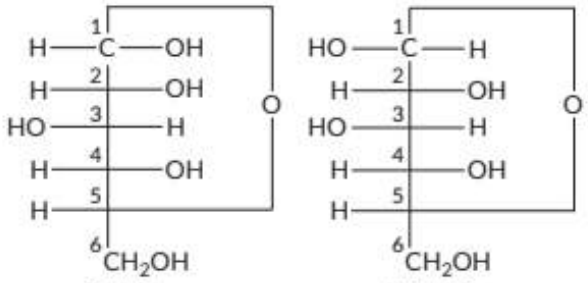
Previous Years' CBSE Board Questions

1. (a): Sucrose is a non-reducing sugar which on hydrolysis gives equimolar mixture of α-*D*(+)-glucose and β-*D*(−)-fructose. Since, the reducing groups of glucose and fructose are involved in a glycosidic bond formation (C1 of α-glucose and C2 of β-fructose), hence sucrose is a non-reducing sugar.

2. (c): Starch is main storage polysaccharide of plants. It is a polymer of α-*D*-glucose and consists of two components – Amylose and Amylopectin. Amylose is held by $C_1 - C_4$ α-glycosidic linkage while amylopectin is formed by $\alpha - C_1 - C_4$ and $\alpha - C_1 - C_6$ glycosidic linkage.

3. (a): Glucose is known as dextrose.

4. (c): The pair of stereoisomers which differ only in the configuration of the hydroxyl group at C_1 are called anomers.



Concept Applied

➲ Anomers differ in configuration at C-1 only.

5. (a): Sucrose is disaccharide and its two monosaccharides are held together by a glycosidic linkage. Since, the reducing groups of glucose and fructose are involved in glycosidic bond formation, therefore, sucrose is a non-reducing sugar.

6. Maltose

7. Glycosidic linkage

8. Glucose contains an aldehydic group while fructose contains a ketonic group.

9. 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.

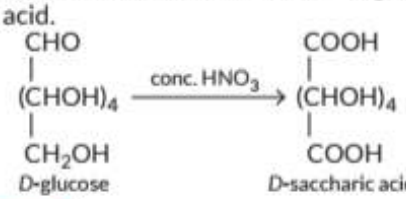
10. Lactose on hydrolysis gives β-*D*-glucose and β-*D*-galactose.

11. Carbohydrate is present in the form of glycogen in liver, muscles and brain.

12. Hydrolysis products of sucrose are glucose and fructose.

13. Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides, *e.g.*, cellulose.

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

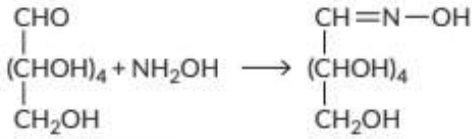


Answer Tips

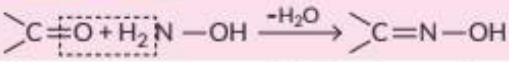
➲ Oxidation of *D*-glucose takes place in presence of nitric acid.

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

16. *D*-Glucose reacts with $H_2N—OH$ to give glucose oxime.



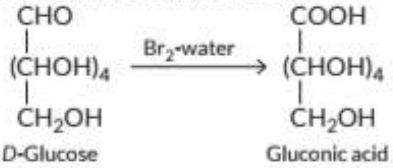
Concept Applied

➲ 

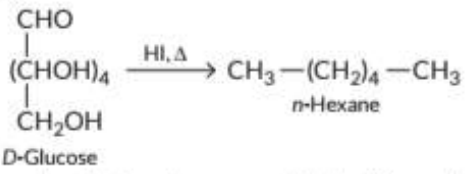
17. Fructose is a monosaccharide because it cannot be hydrolysed to simpler polyhydroxy aldehydes or ketones.

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

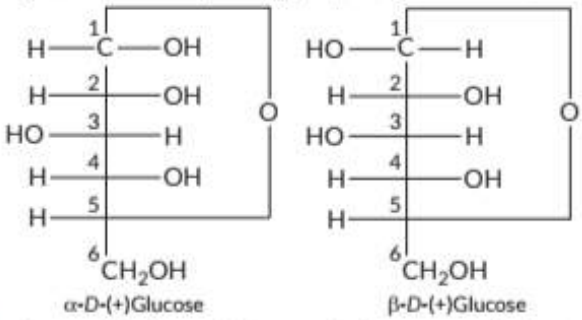
19. *D*-Glucose gets oxidised to carboxylic acid (gluconic acid) on reaction with bromine water.



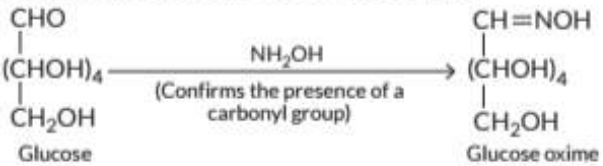
20. On prolonged heating with HI, *D*-glucose forms *n*-hexane.



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



22. 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.

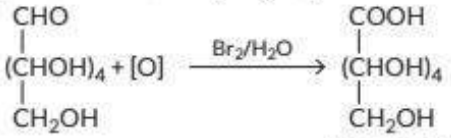
23. 

24. (i) These are the carbohydrates which on hydrolysis give 2-10 monosaccharides. For example, sucrose, lactose, maltose, etc.

(ii) 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.

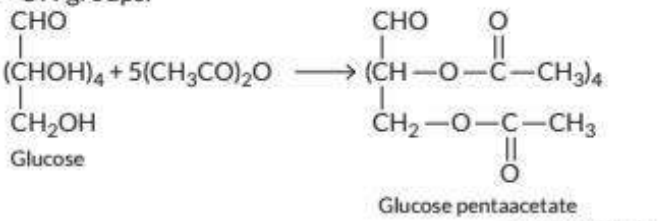
25. (i) Glucose on oxidation with a mild oxidising agent like bromine water gives gluconic acid containing

the same six carbon atoms as present in glucose. This indicates presence of aldehyde group.



Gluconic acid

(ii) On acetylation with acetic anhydride, glucose gives a pentaacetate. This confirms that glucose contains five –OH groups.

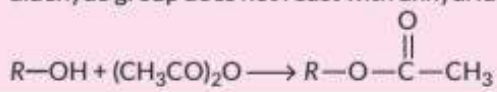


Glucose pentaacetate

$+ 5CH_3COOH$

Concept Applied

➲ —OH group reacts with acetic anhydride while aldehyde group does not react with anhydrides.



26. The following reactions of *D*-glucose cannot be explained on the basis of its open chain structure :

(i) *D*-Glucose does not react with sodium bisulphite ($NaHSO_3$).

(ii) It does not give 2, 4-DNP test and Schiff's test.

(iii) The pentaacetate of *D*-glucose does not react with hydroxylamine.

(iv) *D*-Glucose shows the phenomenon of mutarotation *i.e.*, when its aqueous solution is kept for sometime its optical activity changes.

(v) On reaction with 1 mole of methanol, it yields two monomethyl derivatives which are known as methyl α-*D*-glucoside and methyl-β-*D*-glucoside.

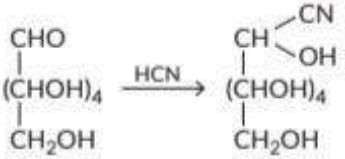
27. (a) (i) On hydrolysis lactose gives, β-*D*-glucose and β-*D*-galactose.

(ii) On hydrolysis maltose gives, α-*D*-glucose units only.

(b) The basic structural difference between starch and cellulose is of linkage between the glucose units.

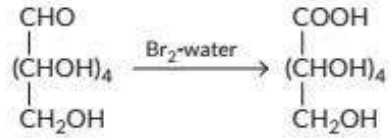
In starch, there is α-*D*-glycosidic linkage. Both the components of starch-amylose and amylopectin are polymer of α-*D*-glucose. On the other hand, cellulose is a linear polymer of β-*D*-glucose in which C_1 of one glucose unit is connected to C_4 of the other through β-*D*-glycosidic linkage.

28. (i)



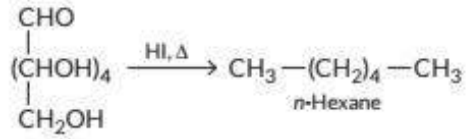
Glucose cyanohydrin

(ii) *D*-Glucose gets oxidised to carboxylic acid (gluconic acid) on reaction with bromine water.



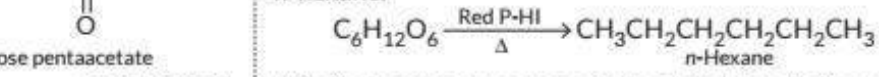
D-Glucose Gluconic acid

(iii) On prolonged heating with HI, *D*-glucose forms *n*-hexane.



D-Glucose *n*-Hexane

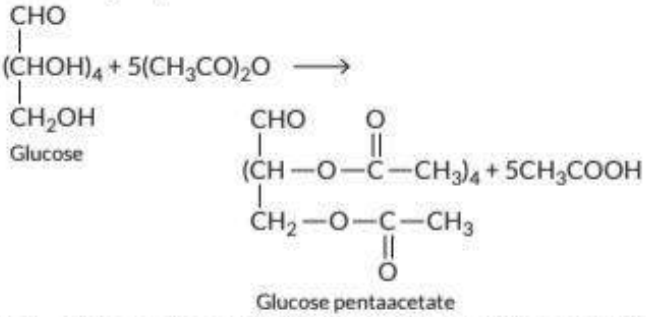
29. (i) Glucose when heated with red P and HI gives *n*-hexane.



n-Hexane

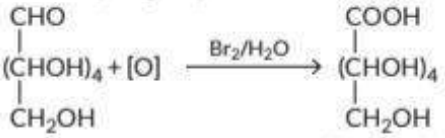
It indicates the presence of straight chain of six carbon atoms in glucose.

(ii) On acetylation with acetic anhydride, glucose gives a pentaacetate. This confirms that glucose contains five –OH groups.



Glucose pentaacetate

(iii) Glucose on oxidation with a mild oxidising agent like bromine water gives gluconic acid containing the same six carbon atoms as present in glucose. This indicates presence of aldehyde group.

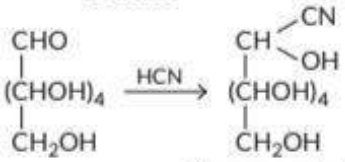


Gluconic acid

30. (a) *D*-Glucose gets oxidised to carboxylic acid (gluconic acid) on reaction with bromine water.

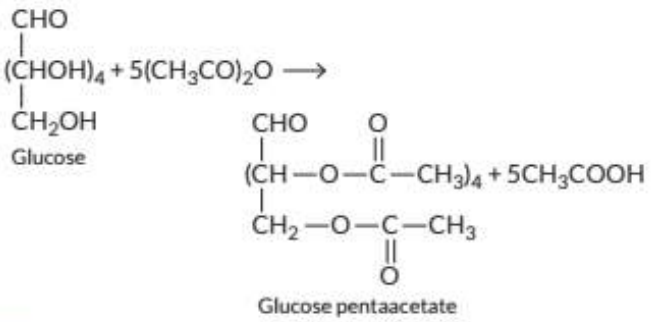
D-Glucose Gluconic acid

(b)

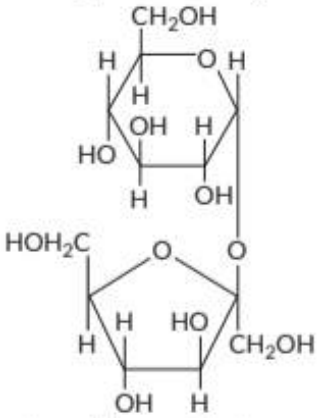


Glucose cyanohydrin

(c) On acetylation with acetic anhydride, glucose gives a pentaacetate. This confirms that glucose contains five –OH groups.



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



(ii) 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.
(iii) These are the carbohydrates which on hydrolysis give 2-10 monosaccharides. For example, sucrose, lactose, maltose, etc.

32. (b): β-pleated sheet structure in proteins refers to secondary structure.

33. (c): α-Helix is one of the most common ways in which a polypeptide chain forms all possible hydrogen bonds by twisting into right-handed screw (helix) with $-NH_2$ group of each amino acid residue hydrogen bonded >C = O of adjacent turn of helix.

34. (d): Curdling of milk is an example of denatured protein and α-helix represents secondary structure of protein.

35. (b): Essential amino acids must be taken through diet as these cannot be synthesised in the body.

36. (b): Helix structure of proteins is stabilised by hydrogen bonds.

37. (c): Peptide linkage is present in proteins.

Key Points

➲ $\left[\begin{matrix}O\\ \|\\ -C-NH-\end{matrix}\right]$ is called peptide linkage.

38. (c): Amino acid contains both basic ($-NH_2$) and acidic group (−COOH) hence, there are amphoteric in nature.

39. (c): Albumin is a globular protein. The chains of polypeptides coil around to give a spherical shape.

40. (b): α-Helix is a secondary structure of protein.

41. Peptide linkage is an amide linkage formed between —COOH group of one α-amino acid and $—NH_2$ group of the other amino acid by loss of a molecule of water whereas a linkage between two monosaccharides units through oxygen atom is called glycosidic linkage.

42. (a) The pair of stereoisomers which differ only in the configuration of the hydroxyl group at C_1 are called anomers.
(b) **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.
(c) **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.

43. 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.

44. Globular protein – Insulin
Fibrous protein – Keratin

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

Answer Tips

➲ Amphoteric compounds react both with acids and bases.

46. 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.

47. Peptide linkage

48. **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.

49. **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.

50. Organic compounds containing both amino ($-NH_2$) and carboxyl ($-COOH$) functional groups are called amino acids.

$$R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$$

51. Disruption of native conformation of protein by changing its environment resulting in loss of biological activity is known as denaturation of protein.
Proteins are very sensitive to the action of heat, change of pH, presence of electrolytes and radiation (particularly short wavelengths).
Whenever proteins are subjected to such changes in the surroundings, they undergo some structural changes leading to the disruption of three dimensional structure. Thus, causes permanent loss of activity of proteins.
During denaturation, 2° and 3° structures are destroyed but 1° structure remains intact.

52. (a) Glucose when heated with red P and HI gives *n*-hexane.

$$C_6H_{12}O_6 \xrightarrow[\Delta]{\text{Red P-HI}} \underset{\text{n-Hexane}}{CH_3CH_2CH_2CH_2CH_2CH_3}$$

The above chemical reaction indicates the presence of straight chain of six carbon atoms in glucose.
(b) Peptide linkage

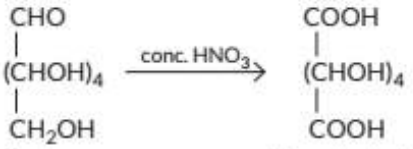
53. (i) The loss of biological activity of a protein by changing the pH, temperature or by adding some salt due to disruption of the native structure of protein is called denaturation.
During denaturation, secondary and tertiary structure of protein is destroyed but primary structure remains intact. The normal shape of protein gets deformed because some of hydrogen bonds are broken and is referred as denatured proteins. *e.g.*, curdling of milk, coagulation of egg white on boiling etc.
(ii) **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.

54. (a) As amino acids have both acidic (carboxyl group) and basic groups (amino group) in the same molecule, they react with both acids and bases. Hence, they show amphoteric behaviour.
(b) In α-helix structure, intramolecular H-bonding takes place whereas in β-pleated structure, intermolecular H-bonding takes place.

Alternative Method

➲ α-Helix is having coiled structure while β-pleated is not planar but slightly pleated, *e.g.*, fibroin.

55. (a) On oxidation with nitric acid, *D*-glucose yields saccharic acid.



D-glucose *D*-saccharic acid

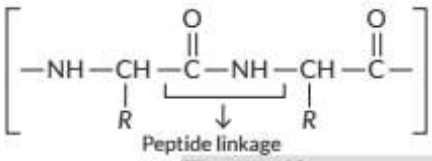
(b) As amino acids have both acidic (carboxy group) and basic groups (amino group) in the same molecule, they react with both acids and bases. Hence, they show amphoteric behaviour.
(c) In α-helix structure, intramolecular H-bonding takes place whereas in β-pleated structure, intermolecular H-bonding takes place.

56. Proteins are the biomolecules of the living system made up of nitrogenous organic compounds by condensation polymerisation of α-amino acids.
On the basis of molecular structure, proteins are classified as :
(a) 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.
(b) Globular proteins : Globular proteins result when the polypeptide chains coil around to give three dimensional spherical shape. These are soluble in water, *e.g.*, insulin and albumins.

57. (i) Amylose is a linear condensation polymer of α-*D*-glucose in which C_1 of one glucose unit is attached to C_4 of the other through α-glycosidic linkage while amylopectin is a highly branched polymer in which α-*D*-glucose is linked with C_1-C_4 linkage and C_1-C_6 linkage is present between two linear chains.
(ii) Peptide linkage is an amide linkage formed between $-COOH$ group of one α-amino acid and $-NH_2$ group of the other amino acid by loss of a molecule of water whereas a linkage between two monosaccharides units through oxygen atom is called glycosidic linkage.
(iii) 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.

58. (i) 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.*,



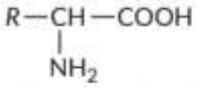
(ii) **Primary structure :** The specific sequence in which the various amino acids present in a protein are linked to one another is called its primary structure. Any change in the primary structure creates a different protein.

(iii) **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.

59. 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.

60. (i) Organic compounds containing both amino ($-NH_2$) and carboxyl (—COOH) functional groups are called amino acids.

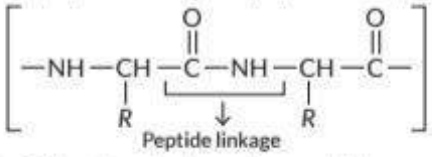


(ii) As amino acids have both acidic (carboxyl group) and basic groups (amino group) in the same molecule, they react with both acids and bases. Hence, they show amphoteric behaviour.

(iii) 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.

(iv) 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.

(v) 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.*,



61. 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.

62. Vitamin C is soluble in water and regularly excreted in urine and hence cannot be stored in body.

63. Vitamin D 64. Vitamin C

65. Vitamin A 66. Vitamin D

67. Vitamin C

68. 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.

69. The deficiency of vitamin A leads to xerophthalmia and night blindness. The deficiency of vitamin C leads to scurvy.

70. 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.

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

(i) Fat soluble vitamins, (*e.g.*, vitamin A and D)

(ii) Water soluble vitamins, (*e.g.*, vitamin B and C)

71. (a) Maltose $\xrightarrow{\text{Hydrolysis}}$ Glucose + Glucose

(b) α-helix structure of protein stabilised by hydrogen bonding

(c) Vitamin B_{12}

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

(i) Fat soluble vitamins, (*e.g.*, vitamin A and D)

(ii) Water soluble vitamins, (*e.g.*, vitamin B and C)

Vitamin K is responsible for the coagulation of blood.

73. (b): Nucleoside contains pentose sugar and base whereas nucleotide contains pentose sugar, base as well as phosphate group.

Nucleoside = Base + Sugar

Nucleotide = Base + Sugar + Phosphate.

74. (d): Thymine is present in DNA but not in RNA.

75. (c): Nucleic acids are polymer of nucleotides.

76. (c): Nucleosides are composed of a pentose sugar and a nitrogenous base.

Key Points

- Nucleotide = Nucleoside + Phosphoric acid

77. A unit formed by attachment of base to 1′ position of sugar is known as nucleoside.

78. Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds as bases.

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

Nucleoside = Base + Sugar

Nucleotide = Base + Sugar + Phosphate

Answer Tips

- Nucleoside + Phosphate = Nucleotide

80. Phosphodiester linkage 81. Uracil

82. A nucleoside is consist of a purine or a pyrimidine base and a ribose or deoxyribose sugar connected via a β-glycosidic linkage.

83. 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.

Answer Tips

- RNA is having one extra —OH in its sugar unit. Also bases present in RNA are adenine, cytosine, uracil and guanine, while in DNA these are thyamine, cytosine, adenine and guanine.

84. (a) As glucose forms a six-membered ring in which —CHO group combines with —OH group at C-5, penta-acetate of glucose does not react with hydroxylamine due to the absence of free —CHO group.
(b) Amino acids behave like salts rather than simple amines or carboxylic acids. This behaviour is due to the presence of both acidic (carboxyl group) and basic (amino groups) group in the same molecule.
(c) Water soluble vitamins must be taken regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B_{12}) in our body.
(d) The two strands in DNA are complementary to each other because the hydrogen bonds are formed between specific pairs of bases. Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine.

85. (i) 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.

(ii) 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. The amino acids, which can be synthesised in the body, are known as non-essential amino acids.
(iii) The sugar in DNA is deoxyribose while that in RNA is ribose. DNA has a double-stranded helical structure, while RNA has a single-stranded helical structure.

86. (a) 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.
(b) Native proteins : Protein purified from natural source which includes blood, plasma from animal etc.
(c) When nucleoside is linked to phosphoric acid at 5′-position of sugar moiety, we get a nucleotide.

87. (a) Actually, glucose exists in the cyclic hemiacetal form with only a small amount (< 0.05%) of the open chain form. Since, the concentration of the open chain form is low and its reaction with 2,4-DNP is reversible, therefore, formation of 2,4-DNP derivative cannot disturb the equilibrium to regenerate more of the open chain form from the cyclic hemiacetal form and hence, does not give this test.

Answer Tips

- 99.95% glucose exists in cyclic hemiacetal form.

(b) The two strands in DNA molecule are held together by the 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 (thymine) through two H-bonds (*i.e.*, A = T). Due to this base-pairing principle, the sequence of bases in one strand automatically fixes the sequence of bases in the other strand. Thus, the two strands are complementary and not identical.
(c) 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 polymers of α-*D*-glucose. On the other hand, cellulose is a linear polymer of β-*D*-glucose in which C1 of one glucose unit is connected to C4 of the other through β-*D*-glycosidic linkage.

88. (i)

S.No.	Amylose	Amylopectin
1.	15-20% part of starch	80-85% part of starch
2.	Made up of linear chain polymers of α-*D* glucose with C1-C4 linkage.	Made up of branched polymers of α-*D* glucose with C1-C4 and C1-C6 linkage between two chains
3.	Water soluble	Water insoluble

(ii) 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.

(iii) Nucleoside contains pentose sugar, and base whereas nucleotide contains pentose sugar, base as well as phosphate group.
Nucleoside = Base + Sugar
Nucleotide = Base + Sugar + Phosphate

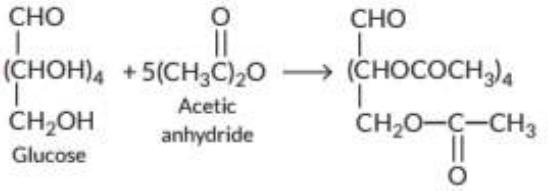
CBSE Sample Questions

1. (d): Open chain structure of glucose cannot explain existence of alpha and beta forms of glucose. **(0.77)**

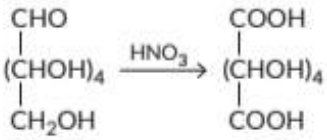
2. (c): Glycogen is a polymer of glucose. Hence, it is a polysaccharide. Glucose and maltose are monosaccharide whereas lactose is a disaccharide. **(0.77)**

3. (c): It undergoes inversion in the configuration on hydrolysis. Initially sucrose is *dextro*-rotatory but the mixture obtained after hydrolysis is *laevo*-rotatory. **(0.77)**

4. (d):



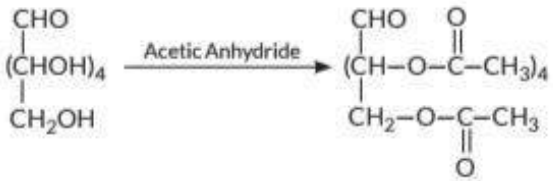
$+ 5CH_3COOH$



(0.77)

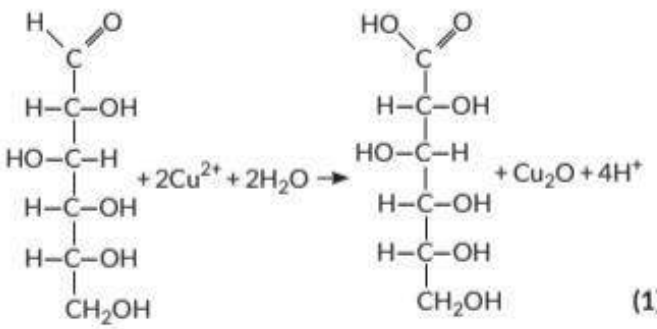
5. (a): Lactose and maltose are reducing sugars. **(1)**

6. (a) Acetylation of glucose with acetic anhydride gives glucose pentaacetate which confirms the presence of five –OH groups. Since, it exists as a stable compound, five –OH groups should be attached to different carbon atoms



(1)

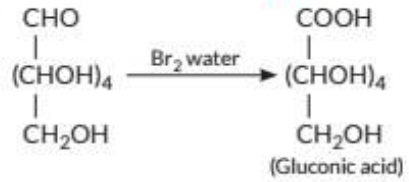
(b) Glucose reduces Fehling's reagent.



(1)

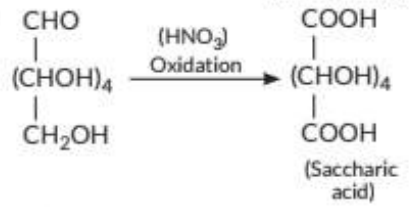
OR

(a)



(1)

(b)



(1)

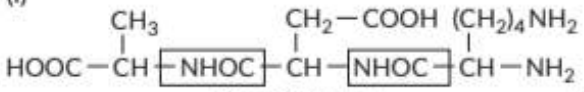
7. (b) **(1)**

8. (d): pH does not affect the primary structure of protein. pH changes affect the weak inter and intra molecular secondary linkage and hydrogen bonding. **(0.77)**

9. (d) **(1)**

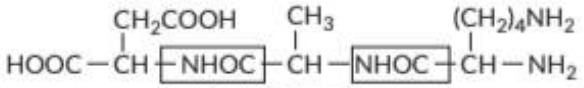
10. (i)

(a)



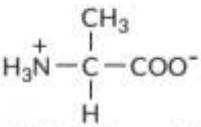
(1)

(b)



(1)

(ii)



(1)

11. (b): Amino acids form proteins and exist as zwitter ion. Thymine is a nitrogenous base in DNA, Insulin is a protein, a phosphodiester linkage is found in nucleic acids so also in DNA and uracil is nitrogenous base found in RNA which is a nucleic acid. **(0.77)**

12. (a) **(1)**

13. (a) Adenine bonds with thymine while cytosine bonds with guanine.
100 Adenine make bond with 100 Thymine
150 Cytosine make bond with 150 Guanine.
Total nucleotides = 100 + 100 + 150 + 150 = 500 **(1)**
(b) They studied the nucleotide composition of DNA. It was the same, so they concluded that the samples belong to same species. **(1)**
(c) A = T = 20% **(1)**
But G is not equal to C. So, virus is not a double helix.
The bases pairs are ATGC and not AUGC so it is not a RNA.
The virus is a single helix DNA virus. **(1)**

OR

According to Chargaff rule, all double helix DNA will have the same amount of A and T as well as C will be same amount as G. If the ratio of A or G and C is not maintained then, helix is single stranded.