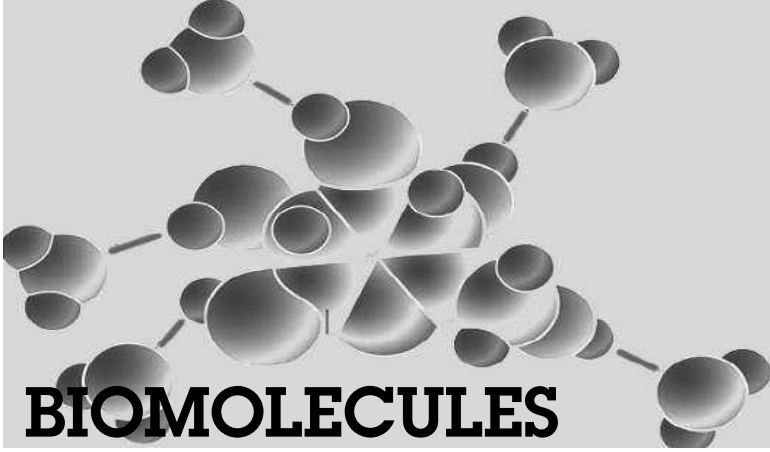
CHAPTER

14 BIOMOLECULES



Chapter Objectives

This chapter will help you to understand :

- ***Biomolecules :*** *Carbohydrates; Proteins; Enzymes; Vitamins and Nucleic acids.*

TOPIC-1
Carbohydrates

Quick Review

- Carbohydrates are optically active polyhydroxy aldehydes or ketones or molecules which provide such units on hydrolysis.
- They are broadly classified into three groups : monosaccharides, disaccharides and polysaccharides. Glucose, the most important source of energy for mammals, is obtained by the digestion of starch.
- Monosaccharides are held together by glycosidic linkages to form disaccharides or polysaccharides.

TIPS...

- *Learn the concept of different types of carbohydrates with the help of Flow chart.*
- *Always relate the different types of carbohydrates with daily life examples.*
- *For explanation use diagrams, flow charts and examples.*
- *Learn the concept of carbohydrates and their types with the help of Flow chart.*

TRICKS...

- *Make a flow chart for quick revision.*
- *Learn the concept through examples and diagrams.*
- *Always make a flow chart to learn any classification.*

Multiple Choice Questions **(1 mark each)**

Tick One Option

Q. 1. Glycogen is a branched chain polymer of α-D-glucose units in which chain is formed by C_1–C_4 glycosidic linkage whereas branching occurs by the formation of C_1–C_6 glycosidic linkage. Structure of glycogen is similar to :

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

(c) Cellulose **(d) Glucose**

[NCERT Exemp. Q. 1, Page 202]

Ans. Correct option : (b)

Explanation : Structure of glycogen is similar to amylopectin. It is a branched chain polymer of α-D-glucose units in which chain is formed by C_1–C_4 glycosidic linkage and branching occurs by the formation of C_1–C_6 glycosidic linkage.

Q. 2. Which of the following polymer is stored in the liver of animals?

(a) Amylose **(b) Cellulose**

(c) Amylopectin **(d) Glycogen**

[NCERT Exemp. Q. 2, Page 202]

Ans. Correct option : (d)

Explanation : Glycogen is stored in the liver of animals.

Q. 3. Sucrose (cane sugar) is a disaccharide. One molecule of sucrose on hydrolysis gives

(a) 2 molecules of glucose

(b) 2 molecules of glucose + 1 molecule of fructose

(c) 1 molecule of glucose + 1 molecule of fructose

(d) 2 molecules of fructose

[NCERT Exemp. Q. 3, Page 202]

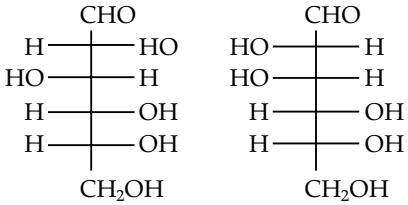
Ans. Correct option : (c)

Explanation : Sucrose (cane sugar) is a disaccharide. One molecule of sucrose on hydrolysis gives 1 molecule of glucose +1 molecule of fructose.

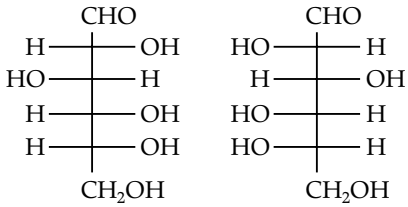
$$C_{12}H_{22}O_{11}(\text{Cane sugar}) \xrightarrow[H^+]{H_2O} C_6H_{12}O_6 (\text{D} - \text{Glucose}) + C_6H_{12}O_6(\text{D-Fructose})$$

Q. 4. Which of the following pairs represents anomers?

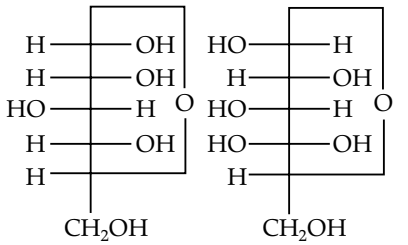
(a)



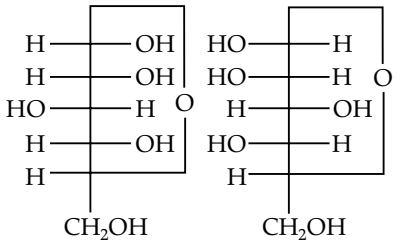
(b)



(c)



(d)



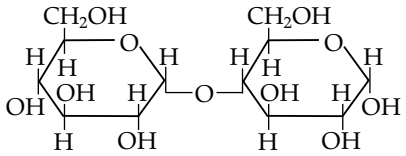
[NCERT Exemp. Q. 4, Page 202]

Ans. Correct option : (c)

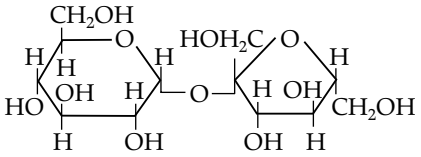
Explanation : The isomers, which differ only in the configuration of the hydroxyl group at C-1, are called anomers and are referred to as α and β-forms.

Q. 5. In disaccharides, if the reducing groups of monosaccharides, that is, aldehydic or ketonic groups are bonded, these are non-reducing sugars. Which of the following disaccharide is a non-reducing sugar?

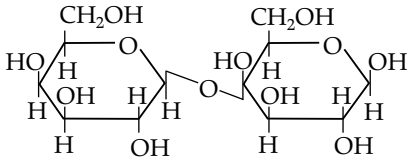
(a)



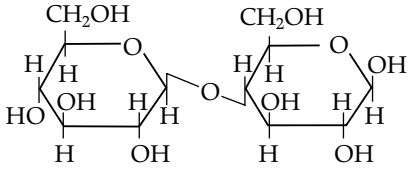
(b)



(c)



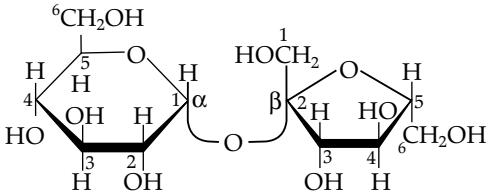
(d)



[NCERT Exemp. Q. 6, Page 203]

Ans. Correct option : (b)

Explanation : This structure represents sucrose in which α-D glucose and β-D fructose is attached to each other by C_1–C_2 glycosidic linkage. Since reducing groups of glucose and fructose are involved in glycosidic bond formation, this is considered as non-reducing sugar.



Sucrose

α-D-glucopyranosyl β-D-fructofuranoside

Glc (α 1 ↔ 2 β) Fru

Q. 6. Which of the following statements is not true about glucose?

(a) It is an aldohexose.

(b) On heating with HI it forms *n*-hexane.

(c) It is present in furanose form.

(d) It does not give 2,4-DNP test.

[NCERT Exemp. Q. 10, Page 204]

Ans. Correct option : (c)

Explanation : It is not present in furanose form instead present in pyranose form.

Q. 7. Which of the following reactions of glucose can be explained only by its cyclic structure?

(a) Glucose forms pentaacetate.

(b) Glucose reacts with hydroxylamine to form an oxime.

(c) Pentaacetate of glucose does not react with hydroxylamine.

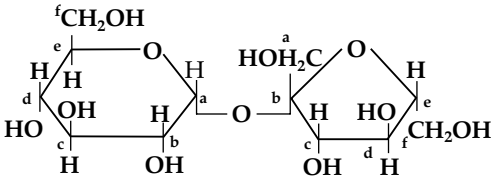
(d) Glucose is oxidised by nitric acid to gluconic acid.

[NCERT Exemp. Q. 16, Page 206]

Ans. Correct option : (c)

Explanation : The pentaacetate of glucose does not react with hydroxylamine indicating the absence of free-CHO group. This reaction of glucose can be explained only by its cyclic structure.

Q. 8. Structure of a disaccharide formed by glucose and fructose is given below. Identify anomeric carbon atoms in monosaccharide units.



(a) 'a' carbon of glucose and 'a' carbon of fructose.

(b) 'a' carbon of glucose and e' carbon of fructose.

(c) 'a' carbon of glucose and 'b' carbon of fructose.

(d) 'f' carbon of glucose and 'f' carbon of fructose.

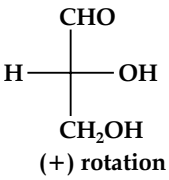
[NCERT Exemp. Q. 18, Page 206]

Ans. Correct option : (c)

Explanation : C-adjacent to oxygen atom in the cyclic structure of glucose or fructose is known as anomericcarbon. In above structure 'a' and 'b' are present at adjacent to oxygen atom. Both carbons differ in configurations of the hydroxyl group.

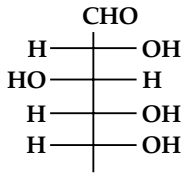
Q. 9. Optical rotations of some compounds along with their structures are given below which of them have D-configuration.

(i)



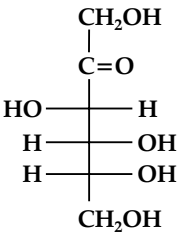
(+) rotation

(ii)



(+) rotation

(iii)



(–) rotation

(a) I, II, III **(b) II, III**

(c) I, II **(d) III**

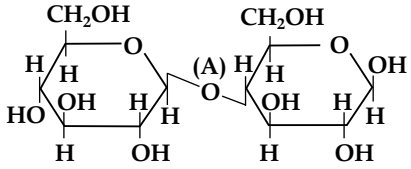
[NCERT Exemp. Q. 17, Page 206]

Ans. Correct option : (a)

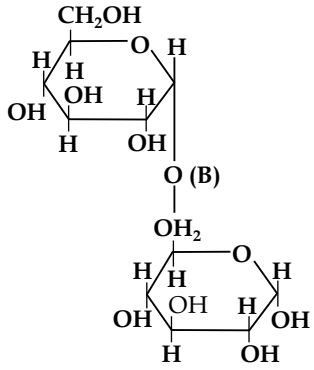
Explanation : I, II and III structures have D configuration with –OH group on the lowest asymmetric carbon is on the right side which is comparable to (+) glyceraldehydes.

Q. 10. Three structures are given below in which two glucose units are linked. Which of these linkages between glucose units are between C_1 and C_4 and which linkages are between C_1 and C_6?

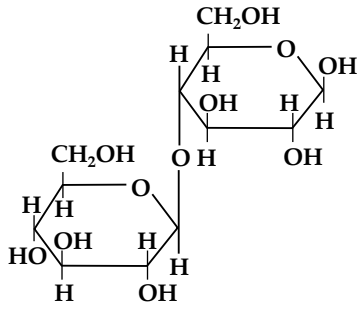
(i)



(ii)



(iii)



(i) (A) is between C_1 and C_4, (B) and (C) are between C_1 and C_6

(ii) (A) and (B) are between C_1 and C_4, (C) is between C_1 and C_6

(iii) (A) and (C) are between C_1 and C_4, (B) is between C_1 and C_6

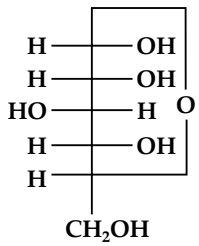
(iv) (A) and (C) are between C_1 and C_6, (B) is between C_1 and C_4 **[NCERT Exemp. Q. 19, Page 206]**

Ans. Correct option : (iii)

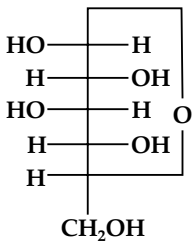
Explanation : (A) and (C) are between C_1 and C_4, (B) is between C_1 and C_6.

Q. 11. Three cyclic structures of monosaccharides are given below which of these are anomers

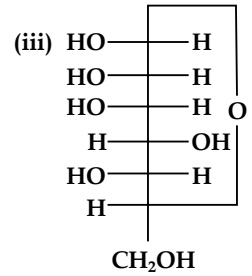
(i)



(ii)



(iii)



(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i) and (iii)
(d) (iii) is anomer of (i) and (ii)

[NCERT Exemp. Q. 15, Page 205]

Ans. Correct option : (a)

Explanation : Cyclic structures of monosaccharides which differ in structure at carbon-1 are known as anomers. Here, (a) and (b) are anomer because they differ from each other at carbon-1 only.

Tick Two or More Options

Q. 1. Carbohydrates are classified on the basis of their behaviour on hydrolysis and also as reducing or non-reducing sugar. Sucrose is a _____.

(a) monosaccharide. **(b) disaccharide.**
(c) reducing sugar. **(d) non-reducing sugar.**

[NCERT Exemp. Q. 20, Page 207]

Ans. Correct options : (b) and (d).

Explanation : Sucrose is adisaccharide and non-reducing sugar.

Q. 2. Which of the following carbohydrates are branched polymers of glucose?

(a) Amylose **(b) Amylopectin**
(c) Cellulose **(d) Glycogen**

[NCERT Exemp. Q. 22, Page 208]

Ans. Correct options : (b) and (d).

Explanation : Amylopectin and glycogen are branched polymers of glucose.

Q. 3. Which of the following monosaccharides are present as five membered cyclic structure (furanose structure)?

(a) Ribose **(b) Glucose**
(c) Fructose **(d) Galactose**

[NCERT Exemp. Q. 25, Page 208]

Ans. Correct option : (a) and (c).

Explanation : Ribose and fructose are presented as five membered cyclic structures (furanose structure). They have five membered ring with analogy to the compound furan.

Assertion and Reason

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct and reason explains the assertion.
(b) Both assertion and reason are wrong statement.
(c) Assertion is correct statement reason is wrong statement.
(d) Assertion is wrong statement and reason is correct statement.
(e) Assertion and reason both are correct statements but reason does not explain assertion.

Q. 1. Assertion : D (+) – glucose is dextrorotatory in nature.

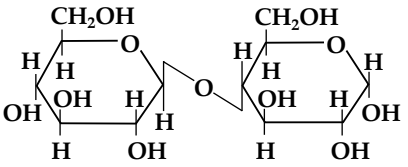
Reason : 'D' represents its dextrorotatory nature.

[NCERT Exemp. Q. 60, Page 212]

Ans. Correct option : (c)

Explanation : D corresponds to the position of –OH group on the right side on the farthest asymmetric C-atom.

Q. 2. Assertion : β-glycosidic linkage is present in maltose.



Reason : Maltose is composed of two glucose units in which C–1 of one glucose unit is linked to C–4 of another glucose unit.

[NCERT Exemp. Q. 62, Page 212]

Ans. Correct option : (d)

Explanation : α-glycosidic linkage is present in maltose

Q. 3. Assertion : Deoxyribose, $C_5H_{10}O_4$ is not a carbohydrate.

Reason : Carbohydrates are hydrates of carbon so compounds which follow $C_x(H_2O)_y$ formula are carbohydrates. **[NCERT Exemp. Q. 64, Page 213]**

Ans. Correct option : (b)

Explanation : Deoxyribose, $C_5H_{10}O_4$ is a carbohydrate and is the sugar moiety of DNA. Carbohydrates are optically active polyhydroxy aldehyde or polyhydroxy ketone or substances which give these on hydrolysis.

Very Short Answer Type Questions (1 or 2 marks each)

Q. 1. Name the sugar present in milk. How many monosaccharide units are present in it? What are such oligosaccharides called?

[NCERT Exemp. Q. 29, Page 209]

Ans. Lactose sugar present in milk. **[1]**

Two monosaccharide units is present in it. Such oligosaccharides are called disaccharides. **[1]**

Q. 2. Name the linkage connecting monosaccharide units in polysaccharides.

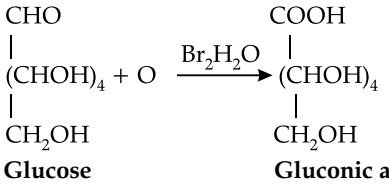
[NCERT Exemp. Q. 32, Page 209]

Ans. Glycosidic linkage is connecting monosaccharide units in polysaccharides. **[1]**

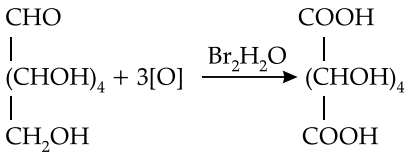
Q. 3. Under what conditions glucose is converted to gluconic and saccharic acid?

[NCERT Exemp. Q. 33, Page 209]

Ans. Glucose is converted to gluconic acid by bromine water and to saccharic acid by conc. HNO_3.



Glucose **Gluconic acid**

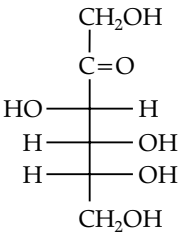


Glucose acid **Saccharic acid**

[2]

Q. 4. Monosaccharides contain carbonyl group hence are classified, as aldose or ketose. The number of carbon atoms present in the monosaccharide molecule are also considered for classification. In which class of monosaccharide will you place fructose? [NCERT Exemp. Q. 34, Page 209]

Ans. Monosaccharides contain carbonyl group hence are classified, as aldose or ketose. When aldehyde group is present, the monosaccharides are known as ketose. Fructose has molecular formula $C_6H_{12}O_6$ containing six carbon and keto group and is classified as ketohexose. **[1]**



[1]

Q. 5. How do you explain the presence of all the six carbon atoms in glucose in a straight chain?

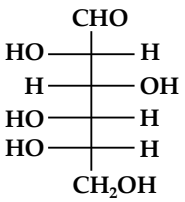
[NCERT Exemp. Q. 30, Page 209]

Ans. On prolonged heating with HI, glucose gives n-hexane. **[1]**

$$C_6H_{12}O_6 \text{ (Glucose)} \xrightarrow[V]{\text{H1 (excess)}} CH_3CH_2CH_2CH_2CH_2CH_3$$ **[1]**

Q. 6. The letters 'D' or 'L' before the name of a stereoisomer of a compound indicate the correlation of configuration of that particular stereoisomer. This refers to their relation with one of the isomers of glyceraldehyde. Predict whether the following compound has 'D' or 'L' configuration.

[NCERT Exemp. Q. 35, Page 209]



[1]

Ans. Since the OH-group at the penultimate chiral carbon atom (i.e., last but one C_5) is towards left. Therefore, the given compound has 'L' configuration.

Q. 7. During curdling of milk, what happens to sugar present in it? [NCERT Exemp. Q. 41, Page 210]

Ans. The milk sugar lactose is converted into lactic acid during curdling of milk. **[1]**

Q. 8. Which monosaccharide units are present in starch, cellulose and glucose and which linkages link these units? [NCERT Exemp. Q. 53, Page 211]

Ans. In starch and glycogen, glycosidic-α-linkage is present and in cellulose, glycosidic-β-linkage is present between glucose units. **[1]**

Q. 9. What are glycosidic linkages? In which type of biomolecules are they present?

[NCERT Exemp. Q. 52, Page 211]

Ans. Two molecules of monosaccharides are joined together by an oxide linkage formed by the loss of water molecule. Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage. [1]

Glycosidic linkage is present in disaccharides, trisaccharides and polysaccharides, etc. **[1]**

Short Answer Type Questions (3 marks each)

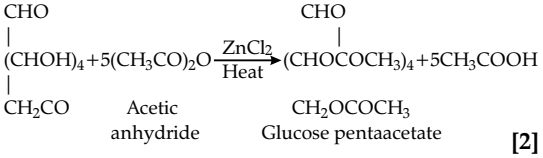
Q. 1. Which sugar is called invert sugar? Why is it called so? [NCERT Exemp. Q. 37, Page 210]

Ans. Sucrose is called invert sugar. The sugar obtained from sugar beet is a colourless, crystalline and sweet substance. It is very soluble in water and its aqueous solution is dextrorotatory having $[\alpha]_D = +66.5^o$. On hydrolysis with dilute acids or enzyme invertase, cane sugar gives equimolar mixture of D-(+) glucose and D-(–)- fructose. So, sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose. D-(–)- fructose has a greater specific rotation than D-(+)- glucose. Therefore, the resultant solution upon hydrolysis is lavorotatory in nature with specific rotation of (–39.9°). Since there is change in the sign of rotation from dextro before hydrolysis to laevo after hydrolysis, the reaction is called inversion reaction and the mixture (glucose and fructose) is called invert sugar. **[3]**

Q. 2. How do you explain the presence of five —OH groups in glucose molecule?

[NCERT Exemp. Q. 42, Page 210]

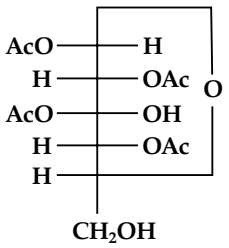
Ans. Glucose gives pentaacetate derivative on acetylation with acetic anhydride. **[1]**



[2]

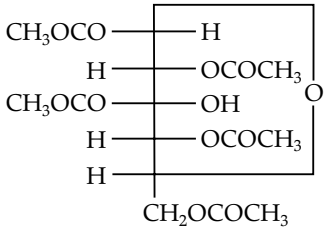
This confirms the presence of five —OH groups

Q. 3. Why does compound (a) given below not form an oxime?



[NCERT Exemp. Q. 43, Page 210]

Ans. Glucose pentaacetate (structure a) doesn't have a free —OH group at C_1 and so can't be converted to the open chain form to give —CHO group and hence doesn't form the oxime. **[2]**



(Structure A) **[1]**

Q. 4. Sucrose is dextrorotatory but the mixture obtained after hydrolysis is laevorotatory. Explain?

[NCERT Exemp. Q. 45, Page 210]

Ans. Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose (–92.4°) is more than dextrorotation of glucose (+ 52.5°), the mixture is laevorotatory. Thus, hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as invert sugar.

Q. 5. Activation energy for the acid catalysed hydrolysis of sucrose is 6.22 kJ mol^{-1}, while the activation energy is only 2.15 kJ mol^{-1} when hydrolysis is catalysed by the enzyme sucrose. Explain.

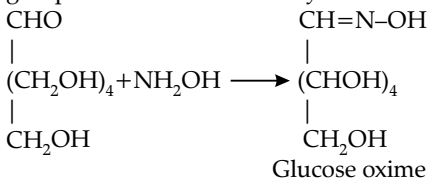
[NCERT Exemp. Q. 49, Page 211]

Ans. Enzymes, the biocatalysts, reduce the magnitude of activation energy by providing alternative path. In the hydrolysis of sucrose the enzyme sucrase reduces the activation energy from 6.22 kJ mol^{-1} to 2.15 kJ mol^{-1}. As a result, enzyme catalysed reactions occur at a match faster rate than the ordinary chemical reactions using conventional catalysts. **[3]**

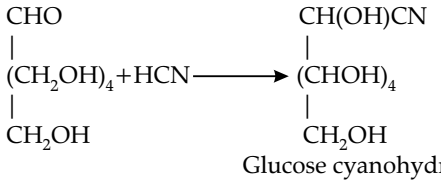
Q. 6. How do you explain the presence of an aldehydic group in a glucose molecule?

[NCERT Exemp. Q. 50, Page 211]

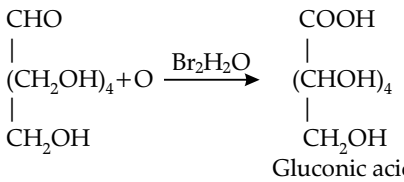
Ans. Glucose reacts with hydroxylamine to form a monoxime and adds one molecule of hydrogen cyanide to give cyanohydrin so it contains a carbonyl group which can be an aldehyde or a ketone.



Glucose oxime



Glucose cyanohydrin



Gluconic acid

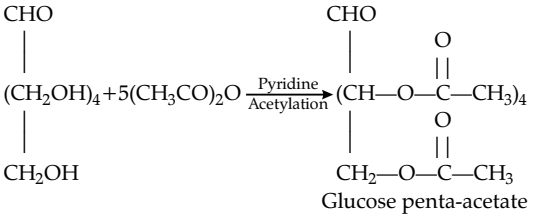
On mild oxidation with bromine water, glucose gives gluconic acid which is a six-carbon carboxylic acid. This indicates that carbonyl group present in glucose is an aldehydic group. **[3]**

Q. 7. How will you distinguish 1° and 2° hydroxyl groups present in glucose? Explain with reaction.

[NCERT Exemp. Q. 56, Page 211]

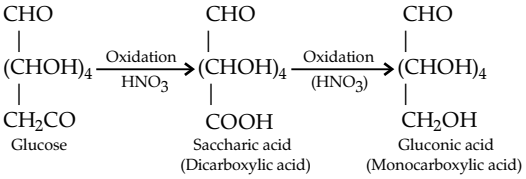
Ans. Glucose on treatment with acetic anhydride in presence of pyridine or a few drops of conc. H_2SO_4. It forms penta-acetyl derivative indicating the presence of 5-OH groups. Out of which one –OH group is

primary (1°) alcoholic and four (C_2, C_3, C_4 and C_5) – OH groups are secondary (2°) alcoholic groups.



[1½]

Glucose (or gluconic acid) on oxidation with HNO_3 gives saccharic acid (a dicarboxylic acid) indicating that one of the primary (1°) alcoholic group is oxidized to –COOH group but secondary (2°) hydroxyl groups undergo oxidation only drastic conditions.



[1½]

Q. 8. Carbohydrates are essential for life in both plants and animals. Name the carbohydrates that are used as storage molecules in plants and animals, also name the carbohydrate which is present in wood or in the fibre of cotton cloth.

[NCERT Exemp. Q. 69, Page 213]

Ans. Carbohydrates that are used as storage molecules in plants and animals are as follows :

(i) Plant contains mainly starch, cellulose, sucrose, etc. **[1]**

(ii) Animal contain glycogen in their body. So, glycogen is also known as animal starch. Glycogen is present in liver, muscles and brain when body needs glucose, enzyme breaks glycogen down to glucose. **[1]**

(iii) Cellulose is present in wood, and fibre of clothes. **[1]**

Long Answer Type Questions **(5 marks each)**

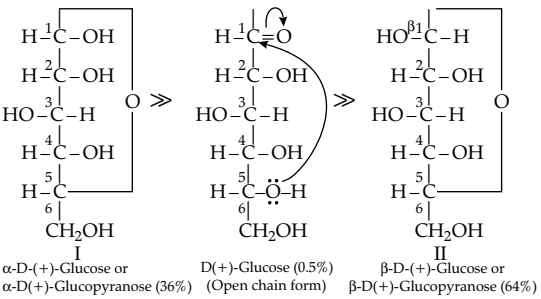
Q. 1. Write the reactions of D-glucose which can't be explained by its open-chain structure. How can cyclic structure of glucose explains these reactions? [NCERT Exemp. Q. 67, Page 213]

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

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

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

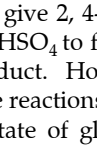
(iv) Glucose forms isomeric methyl glucosides. When glucose is heated with methanol in the presence of dry hydrogen chloride gas, it gives two isomeric mono methyl derivatives known as methyl ∝-D-glucoside (m.p. =438 K or 165°C) and methyl β-D-glucoside(m.p. =380 K or 107°C).



[5]

These results show that glucose does not have open chain structure.

Q. 2. On the basis of which evidences D-glucose was assigned the following structure?



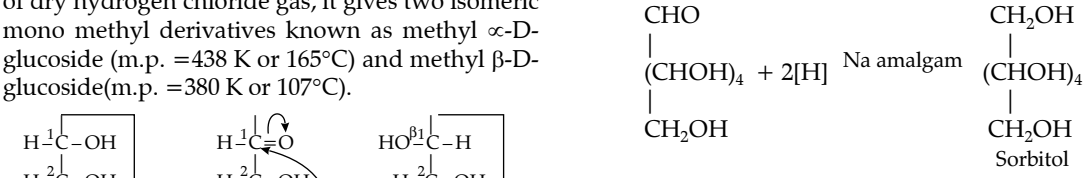
[NCERT Exemp. Q. 68, Page 213]

Ans. This structure was assigned on the basis of the following evidences :

(i) Molecular formula : $C_6H_{12}O_6$ is molecular formula of glucose.

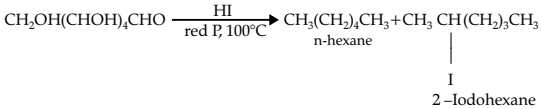
(ii) Straight chain structure :

(a) When aqueous solution of glucose is treated with sodium amalgam (Na/Hg) or sodium borohydride, it is reduced to sorbitol (or glucitol) a hexahydric alcohol.



[1]

(b) Prolonged heating with hydriodic acid and red phosphorous at 100°C gives a mixture of *n*-hexane and 2-iodohexane.



[1]

The formation of *n*-hexane suggests that all the six carbon atoms in glucose are arranged in a straight chain structure.

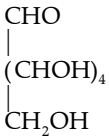
(c) Presence of five –OH groups : On acetylation with acetic anhydride, glucose gives a pentaacetate. This confirms that glucose contains five –OH groups. We know that the presence of two or more –OH groups on the same carbon atom makes the molecules unstable. **[1]**

Now since glucose is a stable compound, therefore, the five –OH groups must present on different carbon atoms.

(d) Presence of one primary alcoholic group : On oxidation with conc. HNO_3, both glucose and gluconic acid give the same dicarboxylic acid, saccharic acid and glucaric acid. The primary alcoholic group (CH_2OH) is always present at the end of the carbon chain. **[1]**

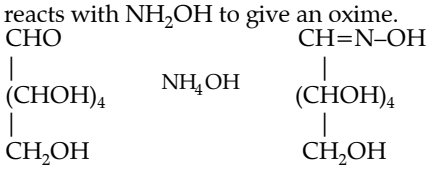
(e) Presence of an aldehyde (–CHO) group : Glucose reacts with hydroxylamine, NH_2OH to form glucose CHO oxime. Which suggest that glucose contains a carbonyl $(CHOH)_4$ (>C=O) groups.

On the basis of above observations, the following open CH_2OH chain structure for glucose can be written as follows :



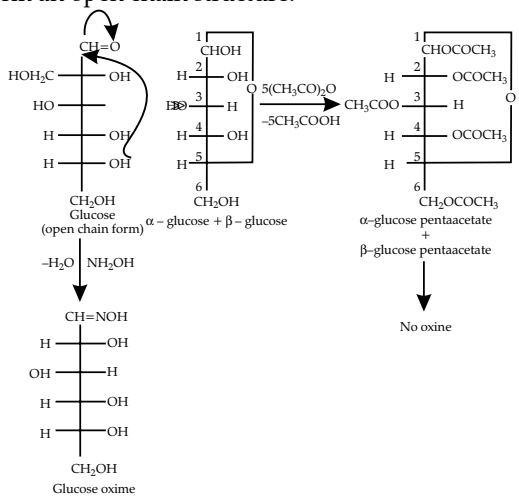
[1]

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



(Glucose) **Oxime**

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



[5]

TOPIC-2
Proteins

Quick Review

- Proteins are the polymers of about 20 different α-amino acids which are linked by peptide bonds. 10 amino acids are called essential amino acids because they cannot be synthesised by our body, hence must be provided through diet.
- Proteins perform various structural and dynamic functions in the organisms.
- Proteins which contain only α-amino acids are called simple proteins.
- The secondary or tertiary structures of proteins get disturbed on change of pH or temperature and they are not able to perform their functions. This is called denaturation of proteins.

TIPS...

- *Learn the concept of Proteins and it types with the help of Flow chart.*
- *Always relate the concept of protein with daily life examples.*
- *For explanation use diagrams, flow charts and examples.*

TRICKS...

- *Make a flow chart for quick revision.*
- *Learn the concept through examples and diagrams.*
- *Jot down the important points during the study.*

Multiple Choice Questions (1 mark each)

Tick One Option

Q. 1. Proteins are found to have two different types of secondary structures, viz. α-helix and β-pleated sheet structure. α-helix structure of protein is stabilised by

(a) Peptide bonds.
(b) van der Waals forces.
(c) Hydrogen bonds.
(d) Dipole-dipole interactions.

[NCERT Exemp. Q. 5, Page 203]

Ans. Correct option : (c)

Explanation : α-helix structure of protein is stabilised by Hydrogen bonds. A polypeptide chain forms all possible hydrogen bonds by twisting into right-handed helix with the –NH group of each amino acid residue hydrogen bonded to >C=O of an adjacent turn of helix.

Q. 2. Each polypeptide in a protein has amino acids linked with each other in a specific sequence. This sequence of amino acids is said to be :

(a) primary structure of proteins.
(b) secondary structure of proteins.
(c) tertiary structure of proteins.
(d) quaternary structure of proteins

[NCERT Exemp. Q. 11, Page 205]

Ans. Correct option : (a)

Explanation : The sequence of amino acids in a polypeptide chain is called primary structure of proteins.

Tick Two or More Options

Q. 1. Proteins can be classified into two types on the basis of their molecular shape *i.e.*, fibrous proteins and globular proteins. Examples of globular proteins are :

(a) Insulin. **(b) Keratin.**
(c) Albumin. **(d) Myosin.**

[NCERT Exemp. Q. 21, Page 207]

Ans. Correct options : (a) and (c).

Explanation : The structure of protein which results when the chain of polypeptides coil around to give a spherical shape are known as globular protein. These proteins are soluble in water (*e.g.*, insulin and albumin are globular proteins).

Q. 2. Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecule. Which of the following are acidic?

(a) $(CH_3)_2CH-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$

(b) $HOOC-CH_2-CH_2-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$

(c) $H_2N-CH_2-CH_2-CH_2-COOH$

(d) $HOOC-CH_2-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$

[NCERT Exemp. Q. 23, Page 208]

Ans. Correct option : (b) and (d).

Explanation : Amino acids with more than one –COOH group one against $–NH_2$ group are acidic in nature.

$HOOC-CH_2-CH_2-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$

and $HOOC-CH_2-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$

Q. 3. Lysine, $H_2N-(CH_2)_4-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$ **is _____.**

(a) α-Amino acid. **(b) Basic amino acid.**
(c) Amino acid synthesised in body.
(d) β-Amino acid. **[NCERT Exemp. Q. 24, Page 208]**

Ans. Correct options : (a), (b) and (c).

Explanation : Lysine whose structure formula is written as :

(i) It is an α-amino acid.
(ii) It is basic amino acid because number of NH_2 groups (2) is greater than number of COOH group.
(iii) It is non-essential amino acid because it is synthesized in our body.

Q. 4. In fibrous proteins, polypeptide chains are held together by :

(a) van der Waals forces. **(b) disulphide linkage.**
(c) electrostatic forces of attraction.
(d) hydrogen bonds. **[NCERT Exemp. Q. 26, Page 209]**

Ans. Correct options : (b) and(d).

Explanation : In fibrous proteins, polypeptide chains are held together by disulphide linkage and hydrogen bonds.

Assertion and Reason

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices :

(a) Assertion and reason both are correct and reason explains the assertion.

(b) Both assertion and reason are wrong statements.

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

(d) Assertion is wrong statement reason is correct statement.

(e) Assertions and reason both are correct statement but reason does not explain assertion.

Q. 1. Assertion : All naturally occurring α-amino acids except glycine are optically active.
Reason : Most naturally occurring amino acids have L-configuration.
[NCERT Exemp. Q. 63, Page 213]

Ans. (e)
Explanation : All amino acids except glycine contain at least one chiral carbon.

Q. 2. Assertion : Glycine must be taken through diet.
Reason : It is an essential amino acid.
[NCERT Exemp. Q. 65, Page 213]

Ans. (b)
Explanation : Glycine is non-essential amino acid because it is synthesized in our body.

Very Short Answer Type Questions (1 or 2 marks each)

Q. 1. Amino acids can be classified as α-, β-, γ-, δ- and so on depending upon the relative position of amino group with respect to carboxyl group. Which type of amino acids form polypeptide chain in proteins? [NCERT Exemp. Q. 38, Page 210]

Ans. α-amino acid, $R-\underset{\underset{NH_2}{|}}{CH}-COOH$ forms polypeptide chains in proteins. **[1]**

Q. 2. α -helix is a secondary structure of proteins formed by twisting of polypeptide chain into right handed screw like structures. Which types of interactions are responsible for making the α-helix structure stable? [NCERT Exemp. Q. 39, Page 210]

Ans. In α-helix structure of proteins, a polypeptide chain is stabilize by the formation of intramolecular H-bonding between–NH-group of amino acids in one turn with the >C=O groups of amino acids belonging to adjacent turn. **[2]**

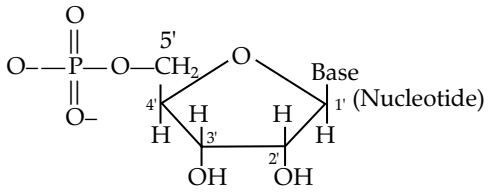
Q. 3. Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. When a protein in its native form, is subjected to a physical change like change in temperature or a chemical change like, change in pH, denaturation of protein takes place. Explain the cause.
[NCERT Exemp. Q. 48, Page 211]

Ans. Due to physical or chemical change, hydrogen bonds in proteins are disturbed, globules unfold and helix gets uncoiled therefore primary and secondary structure of protein loses its biological activity. This is called denaturation of proteins. **[3]**

Short Answer Type Questions (3 marks each)

Q. 1. In nucleoside a base is attached at 1′ position of sugar moiety. Nucleotide is formed by linking of phosphoric acid unit to the sugar unit of nucleoside. At which position of sugar unit is the phosphoric acid linked in a nucleoside to give a nucleotide? [NCERT Exemp. Q. 31, Page 209]

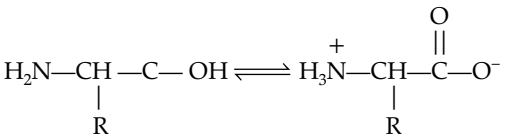
Ans. Phosphoric acid unit is linked preferably at 5′-position of sugar moiety of a nucleoside to give a nucleotide.



[3]

Q. 2. Amino acids behave like salts rather than simple amines or carboxylic acids. Explain.
[NCERT Exemp. Q. 46, Page 210]

Ans. In an aqueous solution, the –COOH group of an amino acid loses a proton and $-NH_2$ group accepts a proton to form zwitter ion (salt). [1]



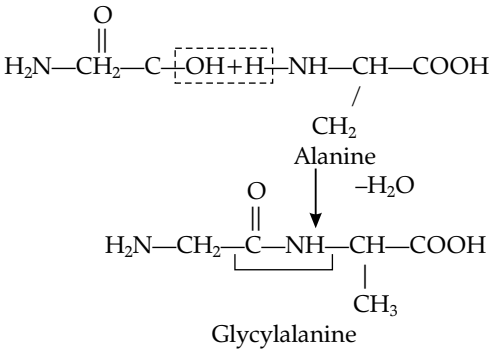
[2]

Q. 3. Structures of glycine and alanine are given below. Show the peptide linkage in glycylalanine.

[NCERT Exemp. Q. 47, Page 210]

$H_2N—CH_2—COOH$ (Glycine) : $H_2N—CH_2—COOH$ (CH_3) (Alanine)

Ans. The carbonyl group of glycine and amino group of alanine when combines together, they form glycylalanine through a peptide (–CO–NH) linkage. **[1]**

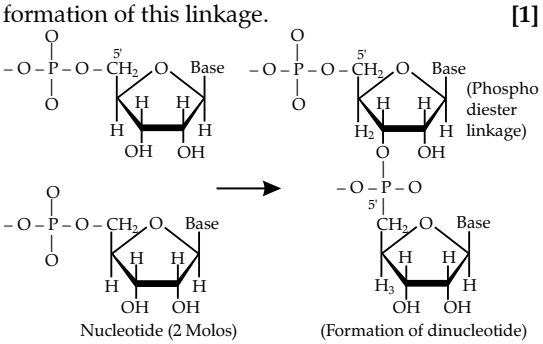


[2]

Q. 4. Which moieties of nucleosides are involved in the formation of phosphodiester linkages present in dinucleotides? What does the word diester in the name of linkage indicate? Which acid is involved in the formation of this linkage?

[NCERT Exemp. Q. 51, Page 211]

Ans. Nucleosides are linked to phosphoric acid at 5′-position of sugar moiety to form a nucleotide. Further, nucleotides (two molecule) are joined together by phosphodiester linkage between 5′ and 3′ carbon atoms of pentose sugar to form dinucleotide. Phosphoric acid is involved in the formation of this linkage. **[1]**

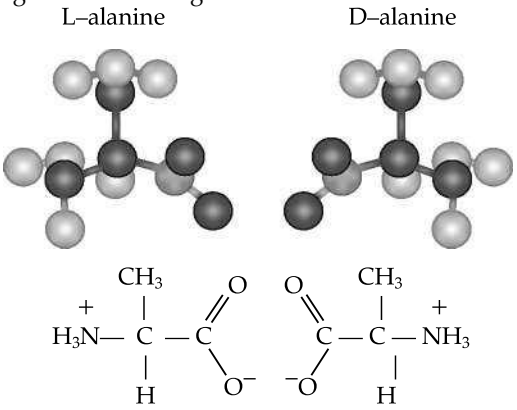


[2]

Q. 5. Describe the term D- and L- configuration used for amino acids with examples.

[NCERT Exemp. Q. 55, Page 211]

Ans. D-L system (also called Fischer-Rosanoff convention) is mainly used for naming α-amino acids and sugars. Every amino acid (except glycine) can occur in two isomeric forms, because of the possibility of forming two different enantiomers (stereoisomers) around the central carbon atom. By convention, these are called L- and D- forms, analogous to left-handed and right-handed configurations.



Only L-amino acids are manufactured in cells and incorporated into proteins. Some D-amino acids are found in the cell walls of bacteria, but not in bacterial proteins.

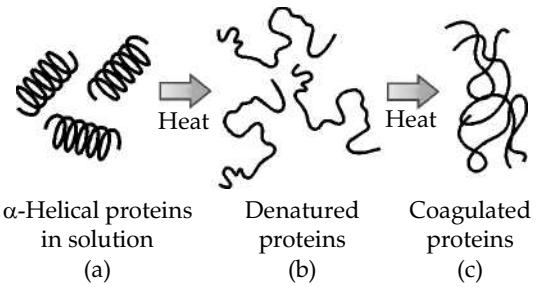
Glycine, the simplest amino acid, has no enantiomers because it has two hydrogen atoms attached to the central carbon atom. Only when all four attachments are different can enantiomers occur. **[3]**

Q. 6. Coagulation of egg white on boiling is an example of denaturation of protein. Explain it in terms of structural changes. [NCERT Exemp. Q. 57, Page 211]

Ans. When an egg is boiled, the soluble globular protein, albumin present in it is converted into insoluble fibrous protein. During this denaturation :

(i) Biological activity is lost.

(ii) Secondary and tertiary structure of albumin protein are destroyed while the primary structure remains intact. **[1]**



Egg white is a viscous solution however when you boil it, the proteins are denatured and become solid *via* coagulation. **[2]**

Long Answer Type Questions (5 marks each)

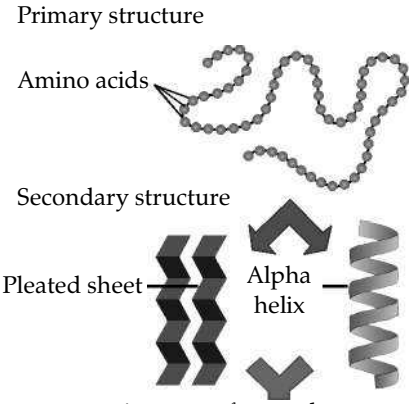
Q. 1. Explain the terms-primary and secondary structure of proteins. What is the difference between α-helix and β-pleated sheet structure of proteins?

[NCERT Exemp. Q. 70, Page 213]

Ans. The structure of a protein is vital to its function. After the protein is synthesized by the ribosome, it must fold itself into a specific conformation which will make it functional. This folding is accomplished in the following stages.

Primary structure : The native conformation of a chain of amino acids, as it gets synthesized by the ribosome, is the protein's primary structure. It is simply the sequence of amino acids strung together, before it takes further shape. **[1]**

Secondary structure : The chain of amino acids (also called the polypeptide chain), next form alpha helix and beta pleated sheets depending on how the backbone of the chain interacts with itself by forming hydrogenbonds. Hydrogen bonds are formed between the carbonyl oxygen of one amino acid and the aminohydrogen of another amino acid. **[1]**



There are two main types of secondary structures. Two fibrous structures-the **alpha helix**, and the **beta pleated sheet**, which are structural components of the cell. The **alpha helix** is formed when the polypeptide chains twist into a spiral. This allows all amino acids in the chain to form hydrogen bonds with each other.

(i) Alpha helix :

(a) Rod like.

(b) CO and NH of the main chain are hydrogen bonded together, allowing the main chain to be buried.

(c) N-H bonding scheme.

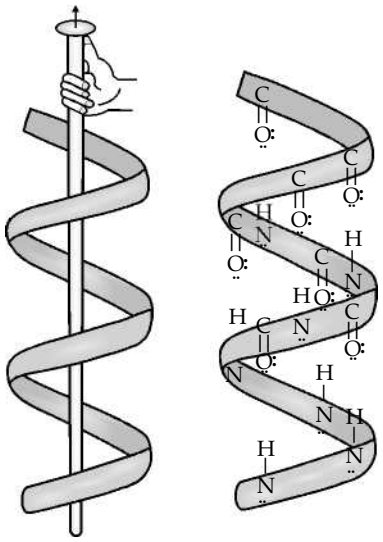
(d) All alpha carbons are H-bonded and in line with each other.

(e) R groups are on the outside and backbone on the inside.

(f) Always right handed (clockwise).

(g) Can be a single chain (usually less than 45 angstroms).

(h) Residues that are 1 and 2 residues apart are on opposite sides, while residues that are 3 and 4 residues apart are on the same side; this allows small steric hindrance.



The α-Helix structure proteins

(i) 1.5 angstroms rise (from one alpha carbon to the second).

(j) 100-degree rotation.

(k) 3.6 residues per turn. **[1½]**

(ii) Beta sheet

(a) Sheet like.

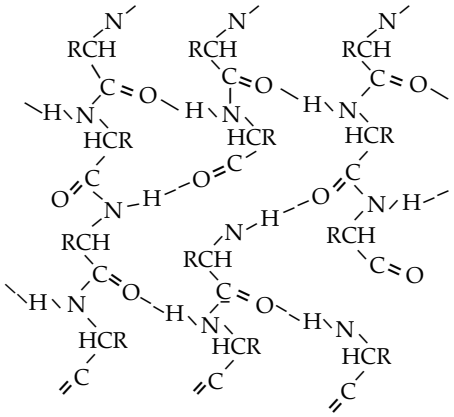
(b) Beta sheets are formed by linking 2 or more beta strands by H bonds.

(c) Side chain of adjacent residues point in opposite directions.

(d) Only trans peptide bonds give R groups on opposite sides.

(e) Cannot exist as a single beta strand; must be 2 or more.

(f) In proteins, 4–5 strands make up a beta sheet; it is possible to be made of more than 10.



β-Pleated sheet structure of proteins

[1½]

TOPIC-3
Enzymes and Vitamins

Quick Review

- Enzymes are biocatalysts which speed up the reactions in biosystems.
- Enzymes are very specific and selective in their action and chemically all enzymes are proteins.
- Vitamins are accessory food factors required in the diet. They are classified as fat soluble (A, D, E and K) and water soluble (B group and C).
- Deficiency of vitamins leads to many diseases.

TIPS...

- *Learn the concept of enzymes and vitamins with the help of Flow chart.*
- *Always relate the vitamins concept with daily life examples.*
- *For explanation use, flow charts and examples.*

TRICKS...

- *Learn Enzymes and vitamins through examples.*

Multiple Choice Questions **(1 mark each)**

Q. 1. Which of the following acids is a vitamin?
(a) Aspartic acid **(b) Ascorbic acid**
(c) Adipic acid **(d) Saccharic acid**
[NCERT Exemp. Q. 7, Page 204]

Ans. Correct option : (b)
Explanation : Ascorbic acid is vitamin C. Aspartic acid is amino acid. Adipic acid and saccharic acid are dicarboxylic acids.

Q. 2. Which of the following B group vitamins can be stored in our body?
(a) Vitamin B_1 **(b) Vitamin B_2**
(c) Vitamin B_6 **(d) Vitamin B_{12}**
[NCERT Exemp. Q. 13, Page 205]

Ans. Correct option : (d)
Explanation : Vitamin B_{12} can be stored in our body because it is insoluble in water.

Q. 3. Which of the following terms are correct about enzyme?
(a) Proteins **(b) Dinucleotides**
(c) Nucleic acids **(d) Biocatalysts**
[NCERT Exemp. Q. 28, Page 209]

Ans. Correct options : (a) and (d)
Explanation : Enzymes are protein molecules and they act as biocatalysts for the reactions taking place in the body.

Matching Types

Q. 1. Match the following enzymes given in Column I with the reactions they catalyse given in Column II.

	Column I (Enzymes)		Column II (Reactions)
(i)	Invertase	(a)	Decomposition of urea into NH_3 and CO_2.
(ii)	Maltase	(b)	Conversion of glucose into ethyl alcohol.
(iii)	Pepsin	(c)	Hydrolysis of maltose into glucose
(iv)	Urease	(d)	Hydrolysis of cane sugar
(v)	Zymase	(e)	Hydrolysis of proteins into peptides

[NCERT Exemp. Q. 59, Page 212]

Ans. Correct option : (i) → (d) (ii) → (c) (iii) → (e) (iv) → (a) (v) → (b)

Column I	Column II	Explanation
Invertase	D	**Invertase** is an enzyme that catalyses the hydrolysis (breakdown) of sucrose (table sugar).
Maltase	C	The maltase enzyme is a protein that is perfectly shaped to accept a maltose molecule and break the bond. The two glucose molecules are released.
Pepsin	E	Pepsin is an enzyme present in stomach. It degrades food proteins into peptides.
Urease	A	It is an enzyme that catalyses the hydrolysis of urea into carbon dioxide and ammonia.
Zymase	B	It is a mixture of enzymes obtained from yeast which catalyse the breakdown of sugars in alcoholic fermentation.

Q. 2. Match the vitamins given in Column I with the deficiency disease they cause given in Column II.

[NCERT Exemp. Q. 58, Page 211]

	Column I (Vitamins)		Column II (Diseases)
(i)	Vitamin A	(a)	Pernicious anaemia
(ii)	Vitamin B_1	(b)	Increased blood clotting time
(iii)	Vitamin B_{12}	(c)	Xerophthalmia
(iv)	Vitamin C	(d)	Rickets
(v)	Vitamin D	(e)	Muscular weakness
(vi)	Vitamin E	(f)	Night blindness
(vii)	Vitamin K	(g)	Beri-beri
		(h)	Bleeding gums
		(i)	Osteomalacia

Ans. Correct option :
(i) → (c), (f) (ii) → (g) (iii) → (a) (iv) → (h) (v) → (d), (i) (vi) → (e), (vii) →(b)

Column I	Column II	Explanation
Vitamin A	C, F	It is also known as retinol because it produces the pigments in the retina of the eye. **Vitamin A** promotes good vision, especially in low light. Deficiency of Vitamin A causes night blindness and Xeropthalmia.
Vitamin B_1	G	Vitamin B_1, also called thiamine or thiamin, is one of eight B vitamins.Also known as aneurin, this vitamin helps prevent neuritic and beri-beri.

Vitamin B_{12}	A	Vitamin B_{12} is a nutrient that helps keep the body's nerve and blood cells healthy and helps make DNA, the genetic material in all cells. Vitamin B_{12} also helps prevent a type of anemia. Pernicious anemia, which makes it hard for your body to absorb vitamin B_{12}.
Vitamin C	H	**Vitamin C**, also known as L-ascorbic acid, is a water-soluble vitamin that is naturally present in some foods, added to others, and available as a dietary supplement. Signs of **vitamin deficiency** include dry and splitting hair; gingivitis (inflammation of the gums) and bleeding gums.
Vitamin D	D, I	Too little **vitamin D** results in soft bones in children (rickets) and fragile, (osteomalacia).
Vitamin E	E	**Vitamin E** is a fat-soluble nutrient found in many foods. In the body, it acts as an antioxidant, helping to protect cells from the damage caused by free radicals. The vitamin E deficiency associated with this disease **causes** problems **such** as poor transmission of nerve impulses, muscle weakness etc.
Vitamin K	B	**Vitamin K** is a group of structurally similar, fat-soluble vitamins that the human body requires for complete synthesis of certain proteins that are prerequisites for blood coagulation and which the body also needs for controlling binding of calcium in bones and other tissues. Severe **vitamin K deficiency** can cause bruising and bleeding problems because the blood will take longer to clot.

Assertion and Reason

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices :

(a) Assertion and reason both are correct and reason explains the assertion.

(b) Both assertion and reason are wrong statements.

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

(d) Assertion is wrong statement and reason is correct statement.

(e) Assertion and reason both are correct statements but reason does not explain assertion.

Q. 1. Assertion : In presence of enzyme, substrate molecule can be attacked by the reagent effectively.

Reason : active sites of enzymes hold the substrate molecule in a suitable position.

[NCERT Exemp. Q. 66, Page 213]

Ans. Correct option : (a)

Explanation : In presence of enzyme, substrate molecule can be attached by the reagent effectively because active sites of enzymes hold the substrate molecule in a suitable position.

Q. 2. Assertion : Vitamin D can be stored in our body.

[NCERT Exemp. Q. 61, Page 212]

Reason : Vitamin D is fat soluble vitamin.

Ans. Correct option : (a)

Explanation : Vitamin D can be stored in our body because it is fat soluble vitamin.

Very Short Answer Type Questions **(1 or 2 marks each)**

Q. 1. Aldopentoses named as ribose and 2-deoxyribose are found in nucleic acids. What is their relative configuration? [NCERT Exemp. Q. 36, Page 210]

Ans. Both aldopentoses named as ribose and 2-deoxyribose have D-configuration. [1]

Q. 2. Some enzymes are named after the reaction, where they are used. What name is given to the class of enzymes which catalyse the oxidation of one substrate with simultaneous reduction of another substrate.[NCERT Exemp. Q. 40, Page 210]

Ans. Enzyme oxidoreductase catalyse the oxidation of one substrate with simultaneous reduction of another substrate. **[1]**

Q. 3. Why must vitamin C be supplied regularly in diet? [NCERT Exemp. Q. 44, Page 210]

Ans. Vitamin C is water soluble therefore it is readily excreted in urine and can't be stored in our body and hence, it should be supplied regularly in diet. [1]

Q. 4. How do enzymes help a substrate to be attacked by the reagent effectively?

[NCERT Exemp. Q. 54, Page 211]

Ans. Active sites of enzymes hold the substrate molecule in a suitable position, so that it can be attacked by the reagent effectively. **[1]**

TOPIC-4
Nucleic Acid

Quick Reveiw

- Nucleic acids are the polymers of nucleotides which in turn consist of a base, a pentose sugar and phosphate moiety.
- Nucleic acids are responsible for the transfer of characters from parents to offsprings. There are two types of nucleic acids –DNA and RNA.
- DNA contains a five-carbon sugar molecule called 2-deoxyribose whereas RNA contains ribose. Both DNA and RNA contain adenine, guanine and cytosine. The fourth base is thymine in DNA and uracil in RNA.
- The structure of DNA is a double strand whereas RNA is a single-strand molecule.
- DNA is the chemical basis of heredity and have the coded message for proteins to be synthesised in the cell.
- There are three types of RNA — *m*RNA, *r*RNA and *t*RNA which actually carry out the protein synthesis in the cell.

TIPS...

- *Learn the concept of nucleic acid (DNA and RNA) with the help of Flow chart.*
- *For explanation use diagrams.*

TRICKS...

- *Try to understand your study rather than memorizing.*
- *Make stick on notes of various formulas and place them on your study table. Try and read and memorise these notes every time you pass the table.*

Multiple Choice Questions **(1 mark each)**

Tick One Option

Q. 1. Nucleic acids are the polymers of :

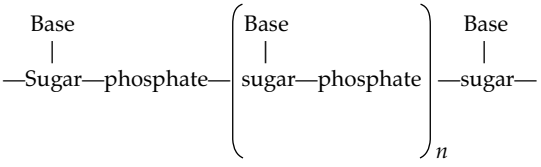
(a) Nucleosides. **(b) Nucleotides.**

(c) Bases. **(d) Sugars.**

[NCERT Exemp. Q. 9, Page 204]

Ans.Correct option : (b)

Explanation : Nucleic acids are the polymers of nucleotides in which nucleic acids are linked together by phosphodiester linkage.



Q. 2. Dinucleotide is obtained by joining two nucleotides together by phosphodiester linkage. Between which carbon atoms of pentose sugars of nucleotides are these linkages present?

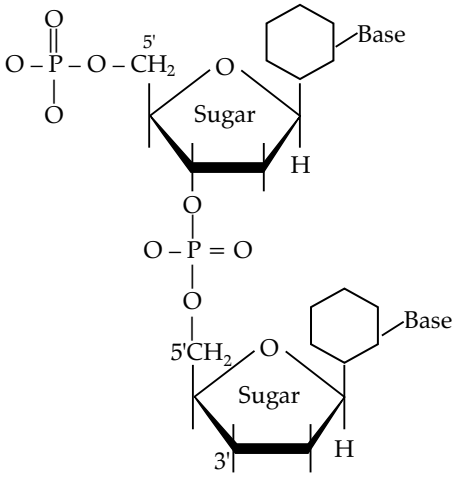
(a) 5′ and 3′ **(b) 1′ and 5′**

(c) 5′ and 5′ **(d) 3′ and 3′**

[NCERT Exemp. Q. 8, Page 204]

Ans. Correct option : (a)

Explanation : 5′ and 3′ are present between pentose sugars of nucleotides.



Q. 3. DNA and RNA contain four bases each. Which of the following bases is not present in RNA?

(a) Adenine **(b) Uracil**

(c) Thymine **(d) Cytosine**

[NCERT Exemp. Q. 12, Page 205]

Ans. Correct option : (c)

Explanation : DNA contains four bases : Adenine, guanine, thymine and cytosine. While RNA contains four bases : Adenine, guanine, uracil and cytosine.

Q. 4. Which of the following bases is not present in DNA?

(a) Adenine **(b) Thymine**

(c) Cytosine **(d) Uracil**

[NCERT Exemp. Q. 14, Page 205]

Ans. Correct option : (d)

Explanation : Uracil is not present in DNA, instead thymine is present.

Tick Two or More Options

Q. 1. Which of the following are purine bases?

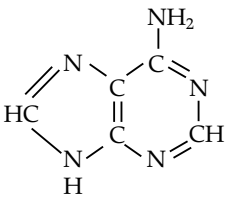
(a) Guanine **(b) Adenine**

(c) Thymine **(d) Uracil**

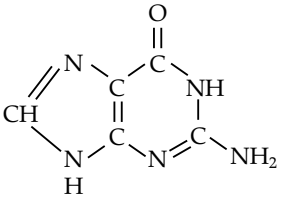
[NCERT Exemp. Q. 27, page 209]

Ans. Correct options : (a) and (b).

Explanation : Purines consist of six membered and five membered nitrogen containing ring fused together. Guanine and adenine are purine bases while thymine and uracil are pyrimidine bases.



Adenine (A)



Guanine (G)

Long Answer Type Questions

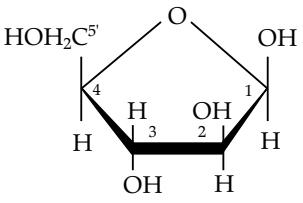
(4 or 5 marks each)

Q. 1. Write the structures of fragments produced on complete hydrolysis of DNA. How are they linked in DNA molecule? Draw a diagram to show pairing of nucleotide bases in double helix of DNA. **[NCERT Exemp. Q. 71, Page 213]**

Ans. Complete hydrolysis of DNA yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds called bases.

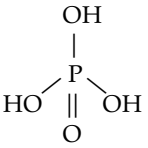
Structures :

(i) Sugar :

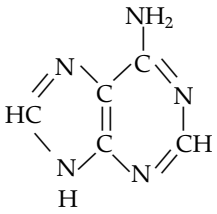


β-D-2-doxyribose

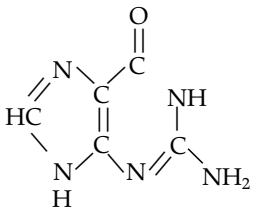
(a) Phosphoric acid :



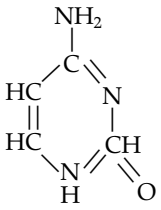
(b) Nitrogen base : DNA contains four bases : Adenine, Guanine, Thymine and Cytosine. **[1½]**



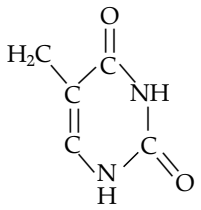
Adenine [A]



Guaninc [G]



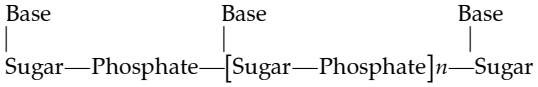
Cytosine [C]



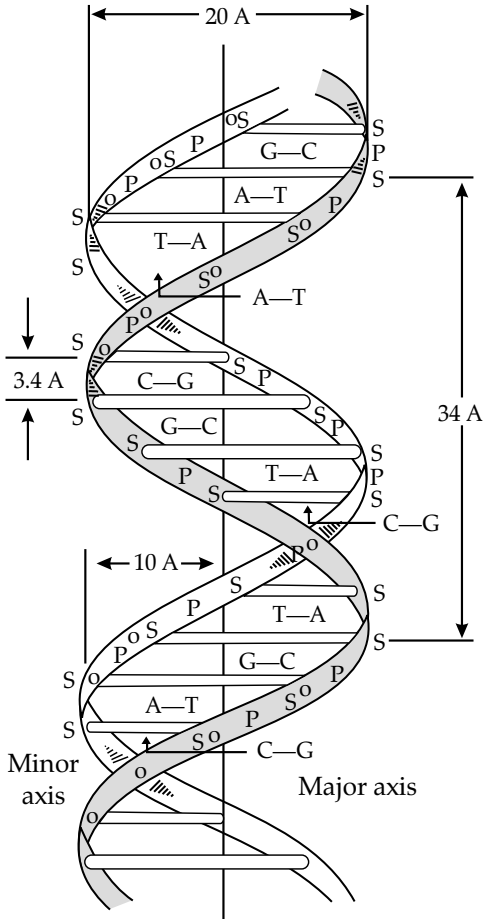
Thymine [T]

A unit formed by the attachment of a base to I′-position of sugar is called nucleoside. **[1½]**

When nucleoside links to phosphoric acid at 5′-position of sugar moiety, a nucleotide is formed. Nucleotides are joined together by phosphodiester linkage between 5′- and 3′- carbon atoms of the pentose sugar.



In DNA, two chains of nucleic acid coil about each other and held together by H-bonds between bases of two chains.



Double Helical Structure for DNA (Watson and Crick) **[2]**