

Chapter 10: Biomolecules

NCERT · Class 12 · Chemistry

Textbook exercises

Question 1

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

Solution

Answer: Glucose and sucrose have several -OH groups, allowing them to form hydrogen bonds with water, making them soluble. Cyclohexane and benzene do not have -OH groups, so they cannot form hydrogen bonds and remain insoluble in water.

Question 2

What are the expected products of hydrolysis of lactose?

Solution

Answer: Lactose is made up of β -D-galactose and β -D-glucose. When lactose undergoes hydrolysis, it breaks down into these two simpler sugars.

Question 3

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

The pentaacetate of D-glucose cannot react with hydroxylamine, showing it lacks a free aldehyde group.

- The open-chain form of D-glucose contains a free aldehyde group, which can react with hydroxylamine to form an oxime.
- Pentaacetate of D-glucose does not have this open-chain structure, so the aldehyde group is not available for reaction.
- Therefore, the absence of reaction with hydroxylamine indicates the aldehyde group is not present in pentaacetate.

Solution

Solution coming soon.

Question 4

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

Amino acids form zwitterions in water, making them more soluble and increasing their melting points compared to halo acids.

- Amino acids have both carboxyl and amino groups, letting them act as both acids and bases.
- In water, they exist as zwitterions (both positive and negative charges on the molecule).
- This zwitterionic form results in strong attractions between molecules, raising melting points and water solubility compared to halo acids.

Solution

Solution coming soon.

Question 5

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

Solution

Answer: When eggs are boiled, their proteins denature and coagulate. The water gets absorbed by the coagulated proteins through hydrogen bonding.

Question 6

Why cannot vitamin C be stored in our body?

Solution

Answer: Vitamin C is water soluble. Since water-soluble substances are regularly lost in urine, vitamin C cannot be stored in the body.

Question 7

What products would be formed when a nucleotide from DNA containing thymine is hydrolyzed?

Solution

Answer: On hydrolysis, such a nucleotide from DNA gives thymine, β -D-2-deoxyribose, and phosphoric acid.

Question 8

When RNA is hydrolyzed, there is no relationship among the quantities of different bases obtained.

What does this fact suggest about the structure of RNA?

Random quantities of bases after RNA hydrolysis suggest RNA is single stranded.

- In DNA, adenine always pairs with thymine and cytosine pairs with guanine, resulting in equal quantities after hydrolysis.
- In RNA, no pairing restricts the ratio of bases, so unequal amounts are obtained.
- This shows RNA is single-stranded, unlike the double-stranded DNA.

Solution

Solution coming soon.

Question 9

What are monosaccharides?

Solution

Answer: Monosaccharides are the simplest form of carbohydrates. They cannot be broken down into simpler sugars. Monosaccharides can be classified by the number of carbon atoms (e.g., pentose for 5 carbons) and by their functional group (aldoses have an aldehyde group, ketoses have a ketone group). For example, a 5-carbon ketone sugar = ketopentose.

Question 10

What are reducing sugars?

Solution

Answer: Reducing sugars are carbohydrates that can reduce Fehling's solution and Tollen's reagent. All monosaccharides and most disaccharides, except sucrose, are reducing sugars.

Question 11

Write two main functions of carbohydrates in plants.

Solution

Answer: The two main functions of carbohydrates in plants are: (i) starch acts as an energy storage molecule, (ii) cellulose builds the plant cell wall.

Question 12

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

Solution

Answer: Monosaccharides: Ribose, 2-deoxyribose, galactose, fructose. Disaccharides: Maltose, lactose.

Question 13

What do you understand by the term glycosidic linkage?

Solution

Answer: A glycosidic linkage is a bond formed between two monosaccharide units via an oxygen atom after removing a water molecule. Example: Sucrose has a glycosidic linkage between α -D-glucose and β -D-fructose.

Question 14

What is glycogen? How is it different from starch?

Glycogen is an animal storage carbohydrate, more highly branched than starch.

- In animals, excess carbohydrates are stored as glycogen, which is highly branched.
- Starch, the plant storage carbohydrate, is made of two components: amylose (linear) and amylopectin (branched).
- Glycogen resembles amylopectin's structure but is even more branched.

Solution

Solution coming soon.

Question 15

What are the hydrolysis products of (i) sucrose and (ii) lactose?

Solution

Answer: (i) Sucrose hydrolyzes to give α -D-glucose and β -D-fructose.

(ii) Lactose hydrolyzes to give β -D-galactose and β -D-glucose.

Question 16

What is the basic structural difference between starch and cellulose?

Starch and cellulose are both carbohydrates but differ in structure and function.

- Starch is made of α -D-glucose units with two forms: amylose (linear) and amylopectin (branched).
- Cellulose is made of β -D-glucose units linked in straight chains with β -glycosidic bonds.
- Starch stores energy in plants; cellulose provides structural support to cell walls.

Solution

Solution coming soon.

Question 17

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

D-glucose undergoes different reactions with each reagent, producing different products.

- (i) With HI: D-glucose is converted to n-hexane upon long heating.
- (ii) With bromine water: D-glucose forms gluconic acid.
- (iii) With nitric acid (HNO_3): D-glucose is oxidized to saccharic acid.

Solution

Solution coming soon.

Question 18

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

Some behaviors of D-glucose (like different melting forms and reaction patterns) are not explained by its open-chain structure.

- D-glucose forms two crystalline forms (α and β) with different melting points, which isn't possible for a simple open-chain structure.
- Pentaacetate of glucose does not react with hydroxylamine, indicating the -CHO group is not free, which conflicts with the open-chain model.
- Reactions like Schiff's test and 2,4-DNP test are not given by glucose, though they are by typical aldehydes.

Solution

Solution coming soon.

Question 19

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

Essential amino acids can't be made by the body and must come from diet; non-essential ones can be synthesized within.

- Essential amino acids: must be obtained from food—examples: leucine and valine.
- Non-essential amino acids: can be made by the body—examples: alanine and glycine.

Solution

Solution coming soon.

Question 20

Define the following as related to proteins (i) Peptide linkage (ii) Primary structure (iii) Denaturation.

These are three key terms explaining how proteins are structured and behave.

- (i) Peptide linkage: A bond formed by removing a water molecule between -COOH of one amino acid and -NH₂ of another.
- (ii) Primary structure: The precise order of amino acids in a protein chain; even a small change creates a new protein.
- (iii) Denaturation: Loss of protein shape and biological activity due to changes in temperature or pH, where secondary and tertiary structures break but the primary sequence stays unchanged.

Solution

Solution coming soon.

Question 21

What are the common types of secondary structures of proteins?

Proteins mainly have two common secondary structures— α -helix and β -pleated sheet.

- α -helix: Right-handed helical structure stabilized by hydrogen bonds between nearby amino acids.
- β -pleated sheet: Sheet-like arrangement stabilized by hydrogen bonds between parallel or antiparallel stretches of polypeptide chain.

Solution

Solution coming soon.

Question 22

What type of bonding helps in stabilizing the α -helix structure of proteins?

Solution

Answer: The α -helix structure in proteins is stabilized by hydrogen bonds between the $-\text{NH}_2$ group of one amino acid and the $-\text{COOH}$ group of another amino acid in nearby turns of the helix.

Question 23

Differentiate between globular and fibrous proteins.

Fibrous protein	Globular protein
It is a fibre-like structure formed by the polypeptide chain. They are held together by strong hydrogen and disulphide bond.	The polypeptide chain in this protein is folded around itself, which gives rise to a spherical structure.
Insoluble in water.	Soluble in water.
Used for structural purposes. For example, keratin is present in nails and hair; collagen is present in tendons, and myosin is present in muscles.	All enzymes along with some hormones such as insulin are globular proteins.

Solution

Solution coming soon.

Question 24

How do you explain the amphoteric behaviour of amino acids?

Amino acids act as both acids and bases due to carboxyl and amino groups, forming zwitterions.

- The carboxyl group donates a proton, and the amino group accepts a proton when in water, creating a dipolar ion known as a zwitterion.
- This property allows amino acids to react both as acids and as bases.

Solution

Solution coming soon.

Question 25

What are enzymes?

Solution

Answer: Enzymes are proteins that act as biological catalysts. They help speed up reactions inside living things, work on specific substrates, and their names usually end in '-ase' (e.g., maltase or oxidoreductase).

Question 26

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

Denaturation disrupts the protein's structure except for the sequence of amino acids.

- Denaturation causes the protein's globular structure to unfold and its helix to uncoil, losing its function.
- The primary structure (amino acid sequence) remains unchanged; only secondary and tertiary structures are lost.
- An example is the hardening of egg white on boiling.

Solution

Solution coming soon.

Question 27

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

Vitamins are classified by their solubility; vitamin K is needed for blood clotting.

- Vitamins are divided into fat-soluble (A, D, E, K) and water-soluble (B group, C) categories.
- Vitamin K helps the blood coagulate (clot).

Solution

Solution coming soon.

Question 28

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

Solution

Answer: Deficiency of vitamin A causes night blindness and eye problems; its sources include fish liver oil, carrots, butter, and milk. Lack of vitamin C leads to scurvy (bleeding gums); it is present in citrus fruits and green leafy vegetables.

Question 29

What are nucleic acids? Mention their two important functions.

Nucleic acids are biomolecules in cell nuclei that store genetic information and help synthesize proteins.

- Nucleic acids are found in the nuclei of living cells as components of chromosomes (main types: DNA and RNA).
- Functions:
 - DNA controls inheritance of traits (heredity).
 - DNA and RNA are involved in protein synthesis within cells.

Solution

Solution coming soon.

Question 30

What is the difference between a nucleoside and a nucleotide?

Both are made from sugar and base, but nucleotides also have phosphoric acid.

- Nucleoside = sugar + base. Example: base joined to the 1' position of the sugar.
- Nucleotide = sugar + base + phosphoric acid. All three parts are joined together.

Solution

Solution coming soon.

Question 31

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

Solution

Answer: In DNA, cytosine pairs with guanine and adenine pairs with thymine, so the strands hold together by specific hydrogen bonds. This makes the strands complementary, not identical.

Question 32

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

DNA	RNA
The sugar present here is β -D-2-deoxyribose.	The sugar present here is β -D-ribose.
It contains thymine (T).	It contains uracil (U).
The helical structure is double-stranded.	The helical structure is single-stranded.
Functional differences: It is the chemical basis of heredity. They do not synthesize proteins but transfer coded messages for the synthesis of proteins in the cells.	Functional differences: It is not responsible for heredity. Proteins are synthesized by RNA molecules in the cells.

Solution

Solution coming soon.

Question 33

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

Solution

Answer: The types of RNA in cells are: messenger RNA (mRNA), ribosomal RNA (rRNA), and transfer RNA (tRNA).
