

CLASS 12

CHEMISTRY

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NCERT Solutions for Class 12 Chemistry Chapter 10: Biomolecules – Free PDF Download

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About NCERT Class 12 Chemistry Chapter 10: Biomolecules

Biomolecules are the organic compounds that make life's chemistry possible — carbohydrates, proteins, nucleic acids, vitamins and hormones. This is the final chapter of Class 12 Chemistry Part II and pulls together earlier organic-chemistry ideas (functional groups, stereochemistry, oxidation-reduction) to explain how sugars store energy and build plant structure, how amino acids fold into functional proteins, how enzymes catalyse biochemical reactions with remarkable specificity, why vitamin deficiencies cause specific diseases, and how DNA and RNA store and transmit genetic information. The chapter is organised into six sections — 10.1 Carbohydrates, 10.2 Proteins, 10.3 Enzymes, 10.4 Vitamins, 10.5 Nucleic Acids and 10.6 Hormones — and is a high-yield, frequently-tested chapter for both board exams and competitive exams like NEET.

NCERT Solutions for Class 12 Chemistry Chapter 10: Biomolecules – All Exercises

Q10.1 What are monosaccharides?

Ans: Monosaccharides are carbohydrates that cannot be further hydrolysed into simpler polyhydroxy aldehyde or polyhydroxy ketone units. About 20 monosaccharides occur in nature; examples include glucose (an aldohexose), fructose (a ketohexose) and ribose (an aldopentose).

Q10.2 What are reducing sugars?

Ans: Carbohydrates that reduce Fehling's solution and Tollens' reagent are called reducing sugars. All monosaccharides (whether aldoses or ketoses) are reducing sugars, and so are most disaccharides such as maltose and lactose; sucrose is the common exception — it is a non-reducing sugar.

Q10.3 Write two main functions of carbohydrates in plants.

Ans: (i) Polysaccharides such as starch act as the plant's stored form of energy/food reserve. (ii) Cellulose, also a polysaccharide, builds the structural framework of the plant cell wall.

Q10.4 Classify the following into monosaccharides and disaccharides: ribose, 2-deoxyribose, maltose, galactose, fructose and lactose.

Ans: **Monosaccharides:** ribose, 2-deoxyribose, galactose, fructose. **Disaccharides:** maltose, lactose.

Q10.5 What do you understand by the term glycosidic linkage?

Ans: A glycosidic linkage is the C–O–C oxide linkage formed between two monosaccharide units when a molecule of water is lost — it is the bond that joins monosaccharides together in disaccharides and polysaccharides.

Q10.6 What is glycogen? How is it different from starch?

Ans: Glycogen is the carbohydrate stored in the bodies of animals (sometimes called "animal starch"); the liver, muscles and brain store glucose as glycogen. Structurally it resembles amylopectin but is **even more highly branched**. It differs from starch in two main ways: glycogen occurs in animals while starch occurs in plants, and glycogen has a greater degree of branching than either of starch's two components (amylose and amylopectin).

Q10.7 What are the hydrolysis products of (i) sucrose and (ii) lactose?

Ans: (i) Sucrose on hydrolysis gives an equimolar mixture of **D-(+)-glucose and D-(–)-fructose** — since the mixture's net optical rotation is levorotatory (opposite to sucrose's own dextrorotatory rotation), this hydrolysis product is called **invert sugar**. (ii) Lactose on hydrolysis gives **D-glucose and D-galactose**.

Q10.8 What is the basic structural difference between starch and cellulose?

Ans: Both are glucose polymers, but starch is a polymer of **α-D-glucose** (present as amylose, an unbranched helical chain, and amylopectin, a branched chain), while cellulose is a polymer of **β-D-glucose** joined in long, unbranched straight chains. This single anomeric difference (α vs β linkage) explains why starch is digestible by humans and gives a blue colour with iodine, while cellulose is not digestible by humans (it is purely structural, e.g. in plant cell walls) and gives no colour with iodine.

Q10.9 What happens when D-glucose is treated with the following reagents? (i) HI (ii) Bromine water (iii) HNO₃

Ans: (i) **HI** (strong reducing agent, prolonged action) reduces D-glucose all the way to **n-hexane** — this result is what first proved that all six carbon atoms of glucose form a straight, unbranched chain. (ii) **Bromine water** (a mild oxidising agent) oxidises only the aldehyde group at C1 to –COOH, giving **gluconic acid** (a monocarboxylic acid). (iii) **Dilute HNO₃** (a stronger oxidising agent) oxidises both the –CHO at C1 and the terminal –CH₂OH at C6 to –COOH, giving **saccharic acid** (glucaric acid, a dicarboxylic acid).

Q10.10 Enumerate the reactions of D-glucose which cannot be explained by its open chain structure.

Ans: (i) Despite having a free –CHO group, glucose does **not** give Schiff's test. (ii) Glucose pentaacetate does not react with hydroxylamine (NH₂OH), showing the absence of a free –CHO group in that form. (iii) Glucose exists in **two crystalline anomeric forms**: α-D-glucose (m.p. 419K, [α]_D=+111°) and β-D-glucose (m.p. 423K, [α]_D=+19.2°) — an open-chain structure with a single terminal –CHO cannot account for two distinct crystalline forms. (iv) Glucose shows **mutarotation**: the specific rotation of either freshly-prepared pure form gradually drifts (+111° → +52.5° for α; +19.2° → +52.5° for β) until it settles at a common equilibrium value. All four observations are explained only if glucose exists predominantly as a **cyclic (pyranose) hemiacetal structure**, not an open chain.

Q10.11 What are essential and non-essential amino acids? Give two examples of each type.

Ans: **Essential amino acids** are those the human body cannot synthesise on its own and must obtain from the diet — examples: valine, leucine (also commonly cited: lysine, threonine). **Non-essential amino acids** are those the body can synthesise for itself — examples: glycine, alanine.

Q10.12 Define the following as related to proteins: (i) Primary structure (ii) Peptide linkage (iii) Denaturation

Ans: (i) **Primary structure**: the specific, fixed sequence in which amino acids are linked together in a polypeptide/protein chain. (ii) **Peptide linkage**: the amide bond (–CO–NH–) formed between the –COOH group of one amino acid and the –NH₂ group of the next, with the elimination of one water molecule. (iii) **Denaturation**: the loss of a protein's biological activity that occurs when its native secondary and tertiary structure is disrupted (by heat, or a change in pH, etc.) — hydrogen bonds break and globules unfold to random coils, while the primary structure (the sequence of peptide bonds) remains intact.

Q10.13 What are the common types of secondary structure of proteins?

Ans: The two common types of protein secondary structure are the **α-helix** and the **β-pleated sheet** structure.

Q10.14 What type of bonding helps in stabilising the α-helix structure of proteins?

Ans: **Hydrogen bonding** stabilises the α-helix — specifically, hydrogen bonds form between the C=O

group of one peptide linkage and the N–H group of another peptide linkage roughly four residues further along the same chain, holding the helix in its coiled shape.

Q10.15 Differentiate between globular and fibrous proteins.

Ans: In **fibrous proteins**, polypeptide chains lie parallel to one another and are held together by hydrogen bonds and disulphide bonds into long, thread-like fibres; they are generally insoluble in water (e.g. keratin, myosin). In **globular proteins**, the polypeptide chain coils up on itself into a compact, roughly spherical shape; they are generally soluble in water (e.g. insulin, albumin).

Q10.16 How do you explain the amphoteric behaviour of amino acids?

Ans: An amino acid carries both an acidic ($-\text{COOH}$) and a basic ($-\text{NH}_2$) group on the same molecule. In solution, the $-\text{COOH}$ group loses a proton and the $-\text{NH}_2$ group accepts one, so the amino acid exists as a **zwitterion** (a dipolar ion, $^+\text{H}_3\text{N}-\text{CHR}-\text{COO}^-$) carrying both a positive and a negative centre with zero net charge. Because of this dual character, an amino acid can react as an acid (donating a proton from $-\text{NH}_3^+$) or as a base (accepting a proton at $-\text{COO}^-$) depending on the pH of the medium — this dual acid/base behaviour is called amphoteric behaviour.

Q10.17 What are enzymes?

Ans: Enzymes are **biological catalysts**. Almost all enzymes are globular proteins that catalyse the biochemical reactions occurring in living organisms with a very high degree of specificity and efficiency, typically under mild physiological conditions of temperature and pH.

Q10.18 What is the effect of denaturation on the structure of proteins?

Ans: On denaturation, a protein's secondary and tertiary structure is destroyed — globules unfold into random coils and the helical structure uncoils — so the protein **loses its biological/catalytic activity**. The primary structure, i.e. the sequence of amino acids joined by peptide bonds, remains unaffected. Common examples are the coagulation of egg white on boiling and the curdling of milk on souring.

Q10.19 How are vitamins classified? Name the vitamin responsible for the coagulation of blood.

Ans: Vitamins are classified into two groups based on their solubility: **fat-soluble vitamins** (A, D, E and K, which are stored in the liver and adipose/fatty tissues) and **water-soluble vitamins** (the B-complex vitamins and vitamin C, which are mostly excreted in urine and not stored in the body, except vitamin B_{12}). **Vitamin K** is responsible for the coagulation (clotting) of blood.

Q10.20 Why are vitamin A and vitamin C essential to us? Give their important sources.

Ans: **Vitamin A** (retinol) is essential for maintaining good/healthy eyesight; its deficiency causes night blindness (xerophthalmia). Important sources: fish liver oil, carrots, butter and milk. **Vitamin C** (ascorbic acid) keeps the teeth, gums and bones healthy and helps heal wounds; its deficiency causes scurvy (bleeding gums, loosening of teeth). Important sources: citrus fruits (amla, oranges) and green leafy vegetables.

Q10.21 What are nucleic acids? Mention their two important functions.

Ans: Nucleic acids are biopolymers found mainly in the cell nucleus, made up of repeating nucleotide units (each nucleotide = a nitrogenous base + a pentose sugar + a phosphate group). Two important functions: (i) they are responsible for the **transmission of hereditary characters** from one generation to the next (the role of DNA); (ii) they carry the genetic "message" that **directs protein synthesis** within the cell (the role of various RNAs).

Q10.22 What is the difference between a nucleoside and a nucleotide?

Ans: A **nucleoside** consists of just a nitrogenous base linked to a pentose sugar (no phosphate group). A **nucleotide** is formed when a nucleoside's sugar is further esterified with a phosphoric acid group at its 5' position — i.e. a nucleotide = base + sugar + phosphate, one unit more than a nucleoside.

Q10.23 The two strands in DNA are not identical but are complementary. Explain.

Ans: The two polynucleotide strands of DNA are held together by hydrogen bonds between specific, fixed pairs of nitrogenous bases: **adenine always pairs with thymine** (via 2 hydrogen bonds) and **guanine always pairs with cytosine** (via 3 hydrogen bonds). Because this base-pairing rule is fixed, the sequence of bases on one strand automatically determines (dictates) the sequence on the other strand — wherever one strand has adenine, the other must have thymine at that position, and so on. This means the two strands carry matching, rule-linked but non-identical sequences; they are said to be **complementary** to each other rather than identical copies.

Q10.24 Write the important structural and functional differences between DNA and RNA.

Ans:

Sugar: DNA contains β -D-2-deoxyribose; RNA contains β -D-ribose.

Pyrimidine base: DNA has cytosine and **thymine**; RNA has cytosine and **uracil** in place of thymine.

Strands: DNA is usually double-stranded (double helix); RNA is usually single-stranded.

Location: DNA is found mainly in the nucleus; RNA is found mainly in the cytoplasm.

Function: DNA carries and transmits hereditary/genetic information and is capable of self-replication; RNA directs protein synthesis, existing as mRNA, tRNA and rRNA.

Stability: DNA is chemically more stable; RNA is less stable and more reactive.

Q10.25 What are the different types of RNA found in the cell?

Ans: There are three main types of RNA. **Messenger RNA (m-RNA)** carries the genetic coding information copied from DNA to the site of protein synthesis (the ribosome). **Transfer RNA (t-RNA)** transports/reads specific amino acids to the ribosome for incorporation into the growing polypeptide chain during translation. **Ribosomal RNA (r-RNA)** is a structural and catalytic component of the ribosome itself, where protein synthesis takes place.

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