CLASS 11 BIOLOGY NCERT SOLUTIONS

NCERT Solutions for Class 11 Biology Chapter 9: Biomolecules – Free PDF Download

Chapter 9, Biomolecules, takes a chemical view of the living cell, explaining how carbon compounds such as amino acids, sugars, fatty acids and nucleotides combine to form the four major biomacromolecules of life: proteins, polysaccharides, nucleic acids and lipids. It also builds up the four levels of protein struc...

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Chapter 9, **Biomolecules**, takes a chemical view of the living cell, explaining how carbon compounds such as amino acids, sugars, fatty acids and nucleotides combine to form the four major biomacromolecules of life: **proteins**, **polysaccharides**, **nucleic acids** and **lipids**. It also builds up the four levels of protein structure and explains how **enzymes** work as biological catalysts, including their classification, mechanism of action, and the factors that affect enzyme activity. These Class 11 Biology Chapter 9 solutions are also useful as quick revision notes before exams.

Exercises

Q1. What are macromolecules? Give examples.

Macromolecules (or biomacromolecules) are the large, polymeric organic compounds found in the acid-insoluble fraction of a cell. Barring lipids, they typically have molecular weights of ten thousand daltons and above, and are built by the polymerisation of many small monomer units. There are four classes of biomacromolecules: **proteins** (polymers of amino acids, e.g., collagen, trypsin, insulin), **polysaccharides** (polymers of monosaccharides, e.g., starch, cellulose, glycogen), **nucleic acids** (polymers of nucleotides, e.g., DNA and RNA), and **lipids** (small molecules that nevertheless appear in the acid-insoluble/macromolecular fraction because they occur as part of membranes, e.g., fats, phospholipids).

Q2. What is meant by tertiary structure of proteins?

The **tertiary structure** of a protein is the further folding of its secondary structure (helices and sheets) upon itself, like a hollow woollen ball, to give the protein a compact, specific three-dimensional shape. This folding is held in place by hydrogen bonds, ionic bonds, disulphide bonds and hydrophobic interactions between amino acid side chains that can lie far apart in the primary sequence but are brought close together in the folded molecule. Tertiary structure is essential for a protein's biological activity, since it determines the shape of functional regions such as an enzyme's **active site**.

Q3. Find and write down structures of 10 interesting small molecular weight biomolecules. Find if there is any industry which manufactures the compounds by isolation. Find out who are the buyers.

Ten common small (micro) molecular weight biomolecules, along with their broad category, are: **glycine** and **alanine** (amino acids), **glucose** and **ribose** (sugars), **glycerol** (a trihydroxy alcohol used to make fats), **palmitic acid** (a saturated fatty acid), **adenine** (a nitrogen base), **adenosine** (a nucleoside made of adenine and ribose), **adenylic acid** (a nucleotide, i.e., adenosine plus a phosphate group), and **cholesterol** (a steroid lipid). Several of these are manufactured industrially by isolation or fermentation: glucose and starch derivatives are produced by starch and glucose industries from maize/corn for the food and pharmaceutical sectors; amino acids and vitamins are produced by biotechnology and fermentation companies and sold to pharmaceutical, food-supplement and cosmetic industries; cholesterol derivatives are supplied to pharmaceutical companies that manufacture steroid hormones and vitamin D analogues.

Q4. Find out and make a list of proteins used as therapeutic agents. Find other applications of proteins (e.g., Cosmetics etc.)

Proteins used as **therapeutic agents** include: **insulin** (to manage diabetes mellitus), **antibodies/immunoglobulins** (for passive immunisation and in diagnostic kits), **clotting factors** such as thrombin and fibrinogen (to control bleeding), **interferons** (as antiviral and anticancer agents), **growth**

hormone (to treat pituitary dwarfism), **streptokinase** (to dissolve blood clots in heart-attack patients) and **erythropoietin** (to treat anaemia). Beyond therapy, proteins have several other applications: structural proteins such as collagen and keratin are used in cosmetics and hair-care products; enzymes like proteases and lipases are added to detergents; casein and whey proteins are used in nutritional/protein supplements; and enzymes such as rennin are used in the food industry, for example in cheese-making.

Q5. Explain the composition of triglyceride.

A **triglyceride** (fat or oil) is formed when one molecule of **glycerol** — a trihydroxy propane bearing three –OH groups — is esterified with three molecules of **fatty acids**. Each fatty acid has a carboxyl (–COOH) group attached to a hydrocarbon (R) chain, which may be saturated (no C=C double bond) or unsaturated (one or more C=C double bonds). During esterification, each hydroxyl group of glycerol reacts with the carboxyl group of a fatty acid, releasing one water molecule per bond and forming an **ester bond**, so three ester bonds are formed in total. If all three fatty acids are identical, a simple triglyceride is formed; if they differ, a mixed triglyceride results. Triglycerides rich in saturated fatty acids are solid at room temperature and are called **fats**, while those rich in unsaturated fatty acids have a lower melting point and remain liquid, being called **oils**.

Q6. Can you attempt building models of biomolecules using commercially available atomic models (Ball and Stick models)?

Yes, this is a practical, hands-on exercise meant to be carried out with a molecular model kit. In a **ball-and-stick model**, coloured balls of different sizes represent atoms (for example, black/grey for carbon, white for hydrogen, red for oxygen, and blue for nitrogen), while sticks represent the covalent bonds joining them, with the correct bond angles and relative bond lengths. Using such a kit, one can build simple biomolecules such as glucose, glycerol, glycine or alanine to visualise their actual three-dimensional shape — this helps in understanding concepts such as the tetrahedral geometry around a carbon atom and the spatial arrangement of functional groups like –NH2, –COOH and –OH.

Q7. Draw the structure of the amino acid, alanine.

Alanine is a simple, neutral α-amino acid in which the R group (side chain) is a methyl group (–CH3). Like all amino acids, it has a central α-carbon attached to four different groups: an amino group (–NH2), a carboxyl group (–COOH), a hydrogen atom (–H), and the R group. Its condensed structural formula is written as **CH3–CH(NH2)–COOH**, i.e., a methyl group and an amino group both attached to the carbon that also bears the carboxyl group. In solution, alanine can exist in its **zwitterionic form**, CH3–CH(NH3+)–COO–, since the amino group can accept a proton while the carboxyl group loses one.

Q8. What are gums made of? Is Fevicol different?

Gums are complex, branched **hetero-polysaccharides** made up of several different types of sugar units and their chemically modified derivatives (such as galactose, arabinose, rhamnose and glucuronic acid). They are natural plant secretions, usually exuded at a wound or cut surface as a protective, sealing response (e.g., gum arabic, gum karaya). **Fevicol**, in contrast, is chemically quite different — it is a synthetic adhesive based on **polyvinyl acetate (PVA) resin**, a man-made polymer produced by industrial polymerisation, and is not a natural polysaccharide or biomolecule at all.

Q9. Find out a qualitative test for proteins, fats and oils, amino acids and test any fruit juice, saliva, sweat and urine for them.

Standard qualitative tests are: the **Biuret test** for proteins, in which a peptide-bond-containing sample turns violet/purple on treatment with dilute copper sulphate in an alkaline medium; the **Ninhydrin test** for amino acids, in which the sample turns blue-purple (or yellow for the secondary amine proline) on boiling with ninhydrin reagent; and the **emulsion/grease-spot test** for fats and oils, in which a sample dissolved in ethanol and poured into water forms a milky-white emulsion, or leaves a translucent, non-drying spot on paper. Applying these tests to common body fluids: **saliva** contains proteins (including the enzyme amylase) and gives a positive Biuret and Ninhydrin test but is negative for fats; **sweat** is largely water, salts and urea, and is generally negative for proteins, fats and amino acids; **urine** normally shows only a trace/negative protein test (a strongly positive test may indicate proteinuria, a kidney-related disorder) but is positive for some nitrogenous compounds; and **fruit juice** is mainly a sugar solution and typically tests negative for protein and fat, though it may show a weak positive Ninhydrin reaction depending on the fruit.

Q10. Find out how much cellulose is made by all the plants in the biosphere and compare it with how much of paper is manufactured by man and hence what is the consumption of plant material by man annually. What a loss of vegetation!

Plants across the biosphere are estimated to synthesise roughly **100 billion (about 10^11) tonnes of cellulose every year** through photosynthesis, making cellulose the single most abundant organic compound on Earth. In comparison, global **paper production** — most of which uses cellulose from wood pulp — is only around a few hundred million tonnes annually (on the order of 400 million tonnes), a very small fraction of the cellulose plants actually produce. Even so, this level of paper manufacture represents an enormous consumption of trees and plant material every year, contributing significantly to deforestation, since trees are felled far faster than they can regrow — underlining the importance of paper recycling and afforestation.

Q11. Describe the important properties of enzymes.

Important properties of **enzymes** include:

Biocatalysts: Enzymes are almost always proteins (a few catalytic RNA molecules, called **ribozymes**, are an exception) that enormously speed up biochemical reactions without being consumed or permanently altered themselves.

Lowering activation energy: They act by lowering the **activation energy** needed for a substrate to be converted into product, without changing the equilibrium of the reaction; the substrate binds at the enzyme's **active site** to form a transient enzyme–substrate (ES) complex.

Substrate specificity: Each enzyme is highly specific, usually acting only on a particular substrate or catalysing only one type of reaction.

Sensitivity to temperature and pH: Enzymes show maximal activity at a particular **optimum temperature** and **optimum pH**; activity falls off on either side of these values, and high temperatures denature the enzyme by disrupting its tertiary structure.

Saturation kinetics: Reaction velocity rises with increasing substrate concentration, but only up to a maximum velocity (Vmax), beyond which adding more substrate has no further effect because all enzyme molecules are already saturated.

Susceptibility to inhibitors: Enzyme activity can be blocked by inhibitors; a **competitive inhibitor**

structurally resembles the substrate and competes with it for the active site (e.g., malonate inhibiting succinic dehydrogenase).

Requirement of cofactors: Many enzymes need non-protein **cofactors** — prosthetic groups, coenzymes, or metal ions — bound to the protein (apoenzyme) portion to become catalytically active.

Class 11 Biology Chapter 9 – Notes and Extra Questions

The current NCERT exercise for Chapter 9 has **11 questions** — noticeably fewer than the 15-question exercise found in pre-2023 editions of the textbook, since questions on illustrating glycosidic/peptide/phosphodiester bonds, Sanger's method for determining amino acid sequence, protein denaturation during curd/yoghurt formation, and titrating an amino acid against a weak base were dropped as standalone exercise items during the rationalisation (though the underlying concepts of peptide and glycosidic bonds remain part of the chapter text). Note that several of the current questions (Q3, Q6, Q9, Q10) are activity- or project-based rather than purely descriptive, so students should actually attempt the qualitative tests and model-building exercises rather than only memorising the written answers. Because this chapter is dense with terminology, focus especially on the four levels of protein structure (primary, secondary, tertiary, quaternary), the difference between a prosthetic group and a coenzyme, the six classes of enzymes, and the concept of activation energy and competitive inhibition — these areas are frequently tested in short-answer and MCQ format even though they are not phrased as separate textbook exercise questions.

How many questions are there in the NCERT Class 11 Biology Chapter 9 exercise?

After the 2023 rationalisation, Chapter 9 (Biomolecules) has **11 exercise questions**, down from 15 in the pre-2023 edition. The removed questions dealt with illustrating a glycosidic, peptide and phosphodiester bond; Sanger's method of finding the amino acid sequence of a protein; explaining denaturation during the conversion of milk to curd; and titrating an amino acid against a weak base.

What is the difference between a prosthetic group and a coenzyme?

Both are organic **cofactors** required by certain enzymes, but they differ in how tightly they bind. A **prosthetic group** is tightly and more or less permanently bound to the apoenzyme, such as the haem group in catalase and peroxidase. A **coenzyme**, on the other hand, associates with the apoenzyme only transiently, typically during the catalytic reaction itself, and can dissociate afterward — examples include NAD and NADP, which are derived from the vitamin niacin.

What is a competitive inhibitor? Give an example.

A **competitive inhibitor** is a molecule that closely resembles the structure of an enzyme's normal substrate and therefore competes with the substrate for binding at the enzyme's active site. When the inhibitor occupies the active site, the actual substrate cannot bind, so the enzyme's catalytic activity decreases. A classic example is **malonate**, which competitively inhibits the enzyme **succinic dehydrogenase** because its structure closely resembles that of the natural substrate, succinate.

What are the four levels of protein structure?

The four levels are: **primary structure**, the linear sequence of amino acids in the polypeptide chain; **secondary structure**, the local folding of the chain into regular patterns such as the alpha helix or beta-pleated sheet, held by hydrogen bonds; **tertiary structure**, the overall three-dimensional folding of the whole chain, stabilised by hydrogen, ionic, disulphide and hydrophobic bonds; and **quaternary structure**, the spatial arrangement of two or more folded polypeptide subunits relative to each other, as seen in human haemoglobin, which is made of two alpha and two beta subunits.