

Chapter 9 Biomolecules

Below, you'll find the solutions to CBSE Class 11 Biology Notes Chapter 9 Biomolecules. These solutions cover various questions and exercises related to the chapter, helping you understand the concepts of biomolecules effectively.

By going through these solutions, you can clarify your doubts, reinforce your understanding, and prepare well for exams. Whether you're a student studying for exams or someone interested in learning about biomolecules, these solutions will be beneficial in enhancing your knowledge and problem-solving skills.

Biomolecules



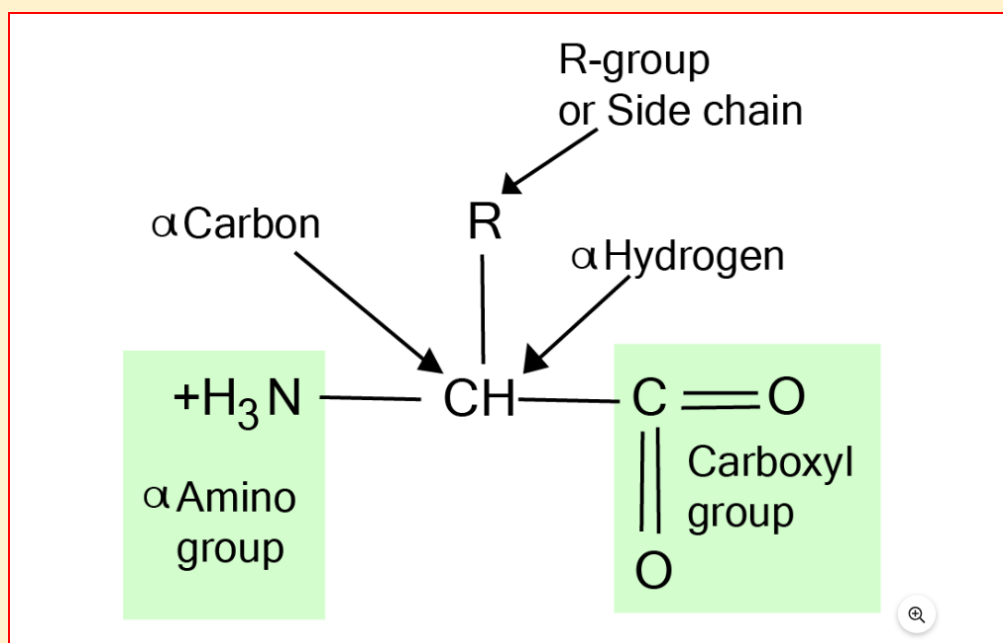
Biomolecules are crucial organic compounds produced by living organisms, serving essential functions and forming the foundation of life itself. These molecules consist of carbon, nitrogen, hydrogen, phosphorus, oxygen, and sulfur. Among the various types of biomolecules, four are particularly common: proteins, carbohydrates, nucleic acids, and lipids. Each of these biomolecules plays a distinct role in biological processes, contributing to the overall functioning and structure of living organisms.

Analysis of chemical composition

When analyzing the chemical composition of living tissues, different methods are employed based on whether the compounds being studied are organic or inorganic. For organic compounds, such as proteins, nucleic acids, and carbohydrates, the tissues are treated with trichloroacetic acid. This treatment involves grinding the tissues to create a slurry, which aids in breaking down the organic matter for analysis.

On the other hand, when analyzing the inorganic chemical composition, such as minerals and metals, the tissues are burned to form ashes. This process involves heating a sample of tissue until it combusts completely, leaving behind only the inorganic components as ash. These methods help scientists understand the chemical makeup of living tissues and provide valuable insights into their biological functions.

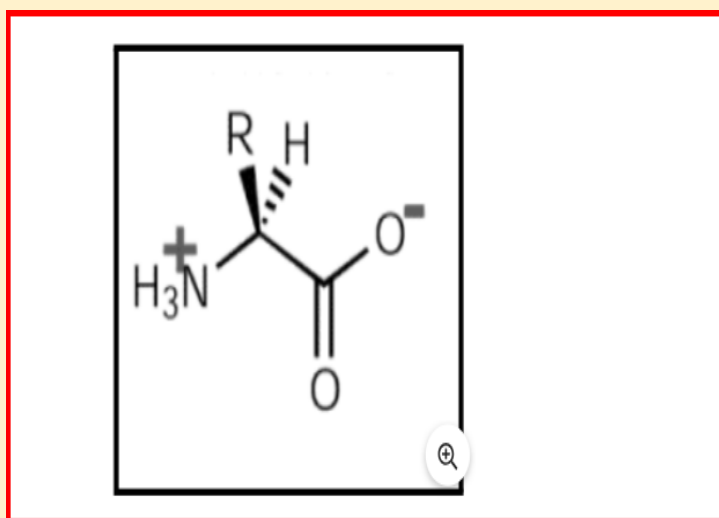
Proteins



In living organisms, there are crucial substances known as proteins, which are a type of nitrogenous organic compounds made up of long chains of amino acids. Amino acids serve as the building blocks of proteins, and there are approximately 22 different types found in nature, consisting of hydrogen, carbon, oxygen, and nitrogen. Each amino acid has an amino group, a hydrogen atom, a carboxyl group, and a unique side chain bonded to the alpha-carbon.

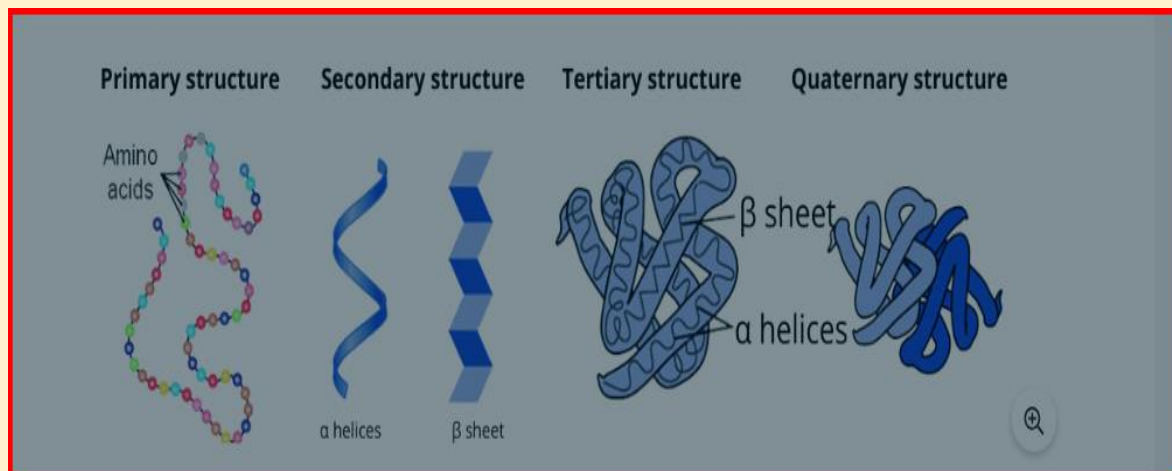
When dissolved in water, amino acids exist as dipolar ions or zwitterions, capable of either donating or accepting protons. They exhibit optical activity, meaning they can rotate polarized light, except for glycine, as they contain a chiral carbon, which is a carbon atom with four different substituents.

Structure of amino acid



Amino acids can combine to form peptides, with two amino acids creating a dipeptide, three forming a tripeptide, and 12 to 20 linking to form an oligopeptide chain. When numerous amino acids join together, they create polypeptides. The first amino acid in a polypeptide chain is called the N terminal or amino-terminal, while the last one is termed the C terminal or carboxyl-terminal.

Formation of peptide bond



Proteins exhibit four levels of organization, each contributing to their overall structure and function:

Primary Structure: This level refers to the linear sequence of amino acids linked together by peptide bonds.

Secondary Structure: At this stage, the protein begins to fold into more complex shapes, typically forming alpha-helices or beta-sheets. These structures are stabilized by hydrogen bonds between the carbonyl and amino groups along the polypeptide backbone.

Tertiary Structure: This level involves the three-dimensional arrangement of the entire protein molecule, including interactions between amino acid side chains. Stabilizing forces such as hydrophobic interactions, hydrogen bonds, electrostatic interactions, van der Waals forces, and covalent bonds help maintain the structure.

Quaternary Structure: Some proteins consist of multiple polypeptide chains that come together to form a functional protein complex. The interactions between these individual chains, such as hydrophobic interactions and hydrogen bonds, contribute to the quaternary

structure. Examples include hemoglobin, which is composed of four subunits.

Levels of protein organization

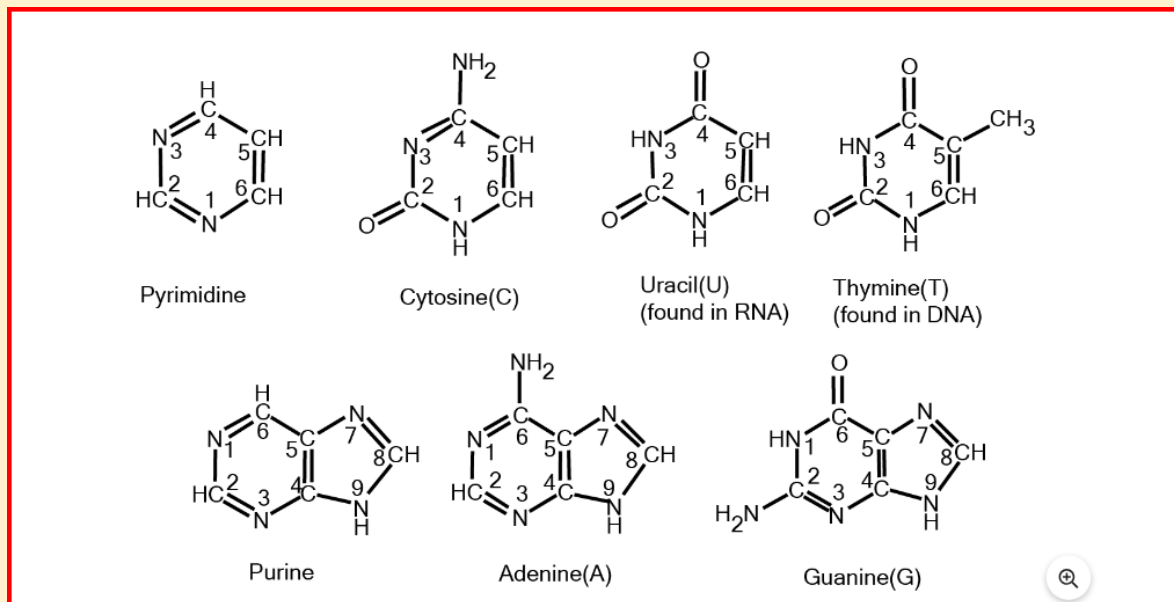
Proteins can also be classified into two main categories based on their shapes and solubility:

- **Fibrous Proteins:** These proteins have an elongated, rod-like shape and are insoluble in water. They primarily serve structural and protective roles in the body.
- **Globular Proteins:** These proteins have a more spherical shape and are soluble in water. They perform a wide range of functions, including enzymatic activity, transport, and immune response.

Nucleic acids

Nucleic acids, discovered by Friedrich Miescher, are another essential class of biomolecules. There are two main types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Nucleic acids are composed of nucleotides, which consist of three components: a nitrogenous base, a five-carbon sugar (deoxyribose in DNA and ribose in RNA), and a phosphate group.

Structure of nucleotide



The nitrogenous bases found in nucleic acids are aromatic molecules with a heterocyclic structure. There are two main types of nucleic acids: purines and pyrimidines.

Purines include adenine and guanine, while pyrimidines include thymine (in DNA), cytosine, and uracil (in RNA).

DNA, or deoxyribonucleic acid, contains deoxyribose, a 5-carbon sugar, while RNA, or ribonucleic acid, contains ribose. When a nucleoside (which consists of a nitrogenous base and a sugar) is combined with a phosphate group, it forms a nucleotide.

Structure of Double-Stranded DNA

There are two main types of DNA structures:

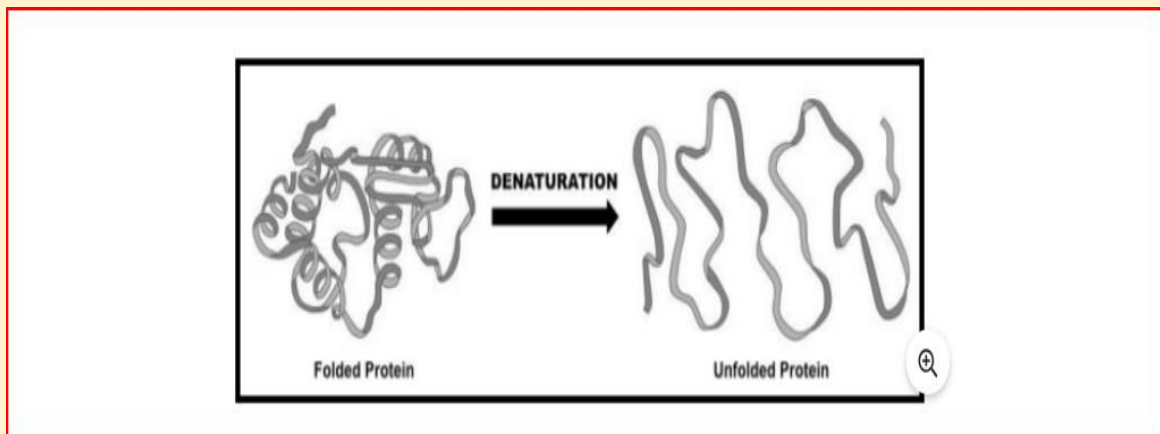
B DNA:

- The long polynucleotide strands coil around an axis.
- The two strands are arranged in an antiparallel manner, meaning they run in opposite directions.

- Adenine nucleoside base pairs with thymine, while guanine base pairs with cytosine.
- Adenine and thymine are held together by two hydrogen bonds, while guanine and cytosine are held together by three hydrogen bonds.

Z DNA:

- This DNA structure is thinner compared to B DNA.
- The purine and pyrimidine bases are arranged alternately.
- The DNA has a high salt concentration to stabilize its structure.



Denaturation of DNA occurs when the two strands separate due to exposure to varying pH, temperature, etc. To restore the original DNA structure, denaturants like pH and temperature need to be removed, a process known as renaturation or annealing.

RNA

RNA, or ribonucleic acid, is single-stranded and found in various forms within the cell:

(i) Messenger RNA (mRNA): Carries genetic information from DNA to the next generation in the form of codons (three nucleotides form a codon), aiding in protein synthesis.

(ii) Transfer RNA (tRNA): Facilitates protein synthesis by interacting between the language of nucleic acid and protein, located in the cytoplasm.

(iii) Ribosomal RNA (rRNA): Constitutes ribosomes, crucial for protein synthesis in both eukaryotes and prokaryotes.

Carbohydrates

Carbohydrates are organic compounds composed of carbon, hydrogen, and oxygen, including polyhydroxy aldehydes or polyhydroxy ketones. Among them, monosaccharides like glucose are the simplest carbohydrates. Disaccharides consist of two monosaccharides joined together, while oligosaccharides are formed by polymerizing 2 to 10 units of monosaccharides. Polysaccharides, on the other hand, are formed when hundreds to thousands of monosaccharides are joined together. Monosaccharides with an aldehyde group are aldoses, while those with a ketone group are ketoses. Trioses are the simplest monosaccharides.

Some common saccharides

Starch, a common saccharide, stores energy in plants. It is composed of several units of glucose and has a branched structure. Starch comprises two different polymers: amylose and amylopectin. Amylose is an unbranched polymer of glucose units, while amylopectin consists of branched polymer chains of glucose units.

Structure of starch

In animals, energy is stored in the form of glycogen, mainly in muscle and liver tissues. Similar to starch, glycogen consists of two different polymers: amylose and amylopectin. It has a highly branched structure, as depicted in Fig. 9.

Cellulose, another polysaccharide found in plant cells, as a structural component. It is composed of unbranched polymer chains of glucose units, providing strength and rigidity to plant cells.

Chitin is a linear polysaccharide found in the exoskeleton of insects and crustaceans. It is composed of N-acetyl-D-glucosamine residues.

Reducing sugars, such as monosaccharides, have the ability to reduce ferric or cupric ions. In contrast, non-reducing sugars like sucrose lack this ability.

Lipids

Lipids are compounds that are poorly or completely insoluble in water but soluble in non-polar solvents like chloroform, ether, or benzene.

Biological Functions of Lipids

Lipids serve several important biological functions:

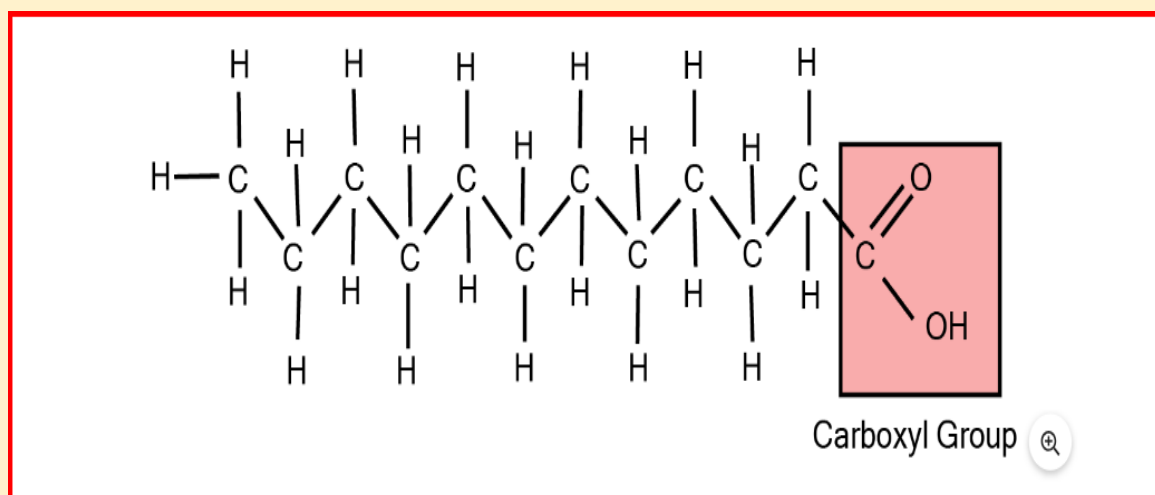
Energy Storage: Lipids are a primary storage form of energy in organisms. They can be stored in adipose tissue and mobilized when energy is needed, providing a long-term energy reserve.

Structural Component of Membranes: Lipids, particularly phospholipids, are essential components of cell membranes. They form

the lipid bilayer, which provides structural integrity to cell membranes and regulates the passage of molecules in and out of cells.

Protection: In addition to providing structural support, certain lipids act as protective barriers. For example, lipids found in the skin help prevent water loss and protect against pathogens. In plants, lipids in the form of waxes provide a protective coating on leaves and stems, reducing water loss and protecting against pests and pathogens.

Fatty Acids



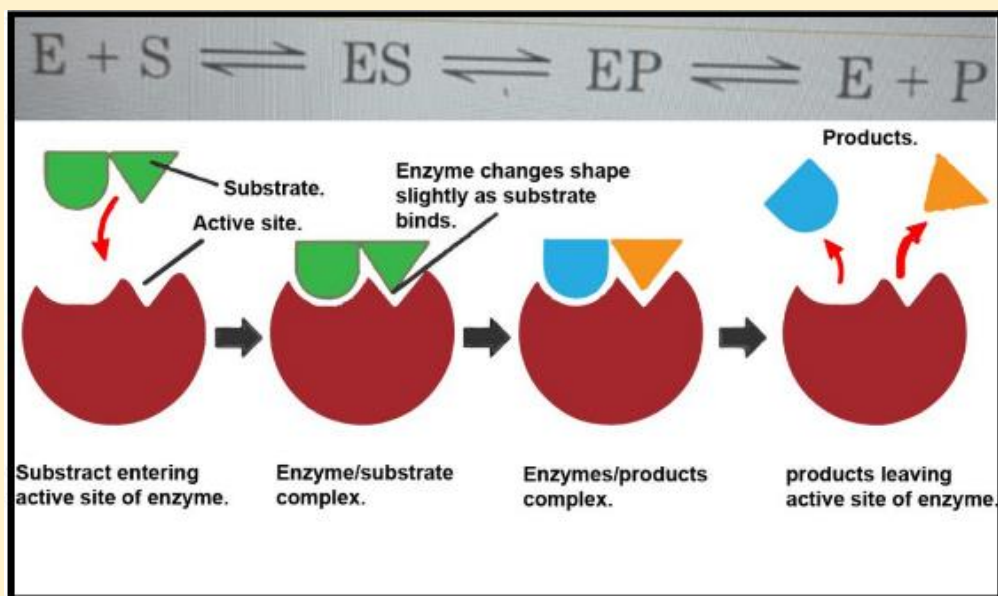
Fatty acids are fundamental building blocks of lipids, consisting of long hydrocarbon chains with a carboxyl group at one end. These chains can be either saturated or unsaturated, depending on the presence of double bonds. Unsaturated fatty acids have one or more double bonds, which introduce kinks in the chain, resulting in both polar and non-polar ends.

Certain unsaturated fatty acids, like linoleate, are considered essential because mammals cannot synthesize them and must obtain them from the diet. Conversely, fatty acids that the body can synthesize are termed non-essential.

Structure of fatty acids

Triacylglycerols, or triglycerides, are another crucial lipid form, composed of fatty acid esters and glycerol. These molecules are non-polar and hydrophobic, making them excellent for energy storage due to their high energy density.

Enzymes



Enzymes are vital proteins responsible for catalyzing biochemical reactions in living organisms. They exhibit various structural levels, including primary, secondary, and tertiary structures, with an active site that binds to substrate molecules. Enzymes possess several key properties:

- Enzymes are proteins, but not all proteins are enzymes.
- They exhibit specificity towards their substrates, catalyzing specific reactions.
- Enzymes function as catalysts, accelerating chemical reactions without being consumed in the process.

- There are six major types of enzymes: oxidoreductases, transferases, hydrolases, lyases, ligases, and isomerases.
- Some enzymes require cofactors or coenzymes for their catalytic activity.
- Cofactors are non-protein molecules that bind to enzymes and activate them, while coenzymes are transiently bound organic compounds.
- Prosthetic groups are tightly bound organic substances within enzymes.

Various factors influence enzyme activity, including temperature, pH, and substrate concentration. Enzymes have optimal temperature and pH ranges for activity, and deviations can lead to inactivation.

Enzyme activity can be modulated by inhibitors, such as competitive inhibitors, which compete with substrates for binding to the enzyme's active site. For instance, malonate can inhibit succinate dehydrogenase by competitively binding to its active site.