Table of Contents

Biomolecules

Introduction to Biomolecules

Biomolecules are naturally occurring organic compounds that are essential constituents of living organisms. They include carbohydrates, proteins, nucleic acids, vitamins, and hormones, each playing vital roles in biological processes.

Carbohydrates

Carbohydrates are optically active polyhydroxy aldehydes or ketones, or compounds that yield such units upon hydrolysis. They serve as primary energy sources and structural components in organisms.

Proteins

Proteins are complex polyamides formed from amino acids linked by peptide bonds. They are crucial for growth, repair, enzymatic activities, and various biological functions.

Nucleic Acids

Nucleic acids, including DNA and RNA, are polymers of nucleotides responsible for storing and transferring genetic information and protein synthesis.

Vitamins

Vitamins are organic micronutrients required in small quantities for normal metabolism and physiological functions. They are classified based on solubility into fat-soluble and water-soluble vitamins.

Hormones

Hormones are chemical messengers produced by endocrine glands that regulate physiological activities and maintain homeostasis.

Solved Examples

Practice Set

Answer Key

Carbohydrates Classification and Importance

Definition and Classification

Carbohydrates are optically active polyhydroxy aldehydes or ketones. They are classified based on molecular size into monosaccharides, oligosaccharides, and polysaccharides.

Monosaccharides

Monosaccharides are simple sugars that cannot be hydrolyzed further. They are soluble in water and classified as aldoses (with aldehyde group) or ketoses (with ketone group). Examples include glucose (aldohexose) and fructose (ketohexose).

Oligosaccharides

Oligosaccharides yield two to ten monosaccharide units upon hydrolysis. Disaccharides, such as sucrose, lactose, and maltose, are common examples.

Polysaccharides

Polysaccharides are complex carbohydrates yielding many monosaccharide units on hydrolysis. Examples include starch, cellulose, and glycogen. They are generally non-sweet and serve as storage or structural materials.

Reducing and Non-Reducing Sugars

Reducing sugars contain free aldehyde or ketone groups and can reduce Fehling's or Tollen's reagents (e.g., glucose, maltose). Non-reducing sugars lack free aldehyde or ketone groups and do not reduce these reagents (e.g., sucrose).

Importance of Carbohydrates

- Primary energy source for the body.
- Fibre aids digestion and regulates cholesterol.

- Structural components in plants and bacteria.
- Storage molecules as starch in plants and glycogen in animals.

Solved Examples

Practice Set

Answer Key

Glucose and Fructose Structure and Reactions

Glucose Structure

Glucose is a six-carbon aldose sugar with an aldehyde group and multiple hydroxyl groups. It exists in open-chain and cyclic forms (alpha and beta anomers) that interconvert via mutarotation.

Reactions of Glucose

- Reaction with HI converts glucose to n-hexane, indicating a straight chain of six carbons.
- Reactions with hydroxylamine, HCN, and bromine water confirm the presence of the aldehyde group.
- Reaction with acetic anhydride forms glucose pentaacetate, showing five hydroxyl groups.
- Oxidation with nitric acid forms saccharic acid, indicating primary alcohol groups.

Fructose Structure

Fructose is a ketohexose sugar obtained from sucrose hydrolysis. It exists in open-chain and cyclic furanose forms with alpha and beta anomers differing in hydroxyl group orientation.

Solved Examples

Practice Set

Answer Key

Polysaccharides: Starch, Cellulose, Glycogen

Starch

Starch is the main plant storage polysaccharide composed of amylose (linear chains of α-D-glucose linked by C1–C4 glycosidic bonds) and amylopectin (branched chains with C1–C4 and C1–C6 linkages).

Cellulose

Cellulose is a structural polysaccharide in plants, consisting of β-D-glucose units linked by C1–C4 glycosidic bonds forming straight chains, providing rigidity to cell walls.

Glycogen

Glycogen is the animal storage polysaccharide found in liver and muscles, similar to amylopectin but more highly branched, serving as a glucose reserve.

Solved Examples

Practice Set

Answer Key

Proteins, Nucleic Acids, Vitamins and Hormones

Proteins

Proteins are polymers of amino acids linked by peptide bonds. They have primary, secondary (α-helix and β-pleated sheet), tertiary, and quaternary structures. Proteins perform structural, enzymatic, transport, motor, hormonal, and storage functions.

Denaturation of Proteins

Denaturation involves the disruption of hydrogen bonds due to changes in temperature or pH, leading to loss of protein structure and biological activity, e.g., coagulation of egg white.

Enzymes

Enzymes are protein biocatalysts that accelerate specific biochemical reactions. Examples include amylase, maltase, lipase, and trypsin.

Nucleic Acids

Nucleic acids are polymers of nucleotides composed of a pentose sugar, phosphate group, and nitrogenous base. DNA contains deoxyribose and thymine, forming a double

helix, while RNA contains ribose and uracil, usually single-stranded.

Vitamins

Vitamins are essential organic micronutrients classified as fat-soluble (A, D, E, K) and water-soluble (B-complex, C). They perform specific biological functions and must be obtained from diet or synthesized by gut bacteria.

Hormones

Hormones are intercellular messengers produced by endocrine glands, including steroids (e.g., testosterone), polypeptides (e.g., insulin), and amino acid derivatives (e.g., epinephrine). They regulate physiological processes and maintain homeostasis.

Solved Examples

Practice Set

Answer Key

Quick Reference Table

Common Mistakes and Misconceptions

Glossary