

Biomolecules — Assignment 2

Class 11 Biology · Higher-difficulty challenge set + integrated problems · Answer key included · Narayan Gurukul Academy

Instructions: (1) Attempt all questions; start with the topic-wise challenge set, then attempt the integrated (multi-topic) problems.
(2) Give all answers with correct SI units. $g = 10 \text{ m/s}^2$ unless stated.
(3) A final answer key is provided at the end — try the full set before checking it.

Part A — Topic-wise challenge questions

Chemical Composition of Living Tissue

1. Distinguish between micromolecules and macromolecules.
2. State the role of water in living organisms.
3. Describe the chemical composition of living tissue.

Proteins

1. Distinguish between essential and non-essential amino acids.
2. State two functions of proteins.
3. Describe the four levels of protein structure.

Polysaccharides

1. Distinguish between starch and cellulose.
2. State two functions of polysaccharides.
3. Compare starch, glycogen and cellulose.

Nucleic Acids

1. Distinguish between DNA and RNA.
2. State two functions of nucleic acids.
3. Describe the structure of DNA.

Lipids

1. Distinguish between fats and oils.
2. State two functions of lipids.
3. Explain the structure and functions of phospholipids.

Enzymes

1. State two properties of enzymes.
2. Distinguish between a cofactor and a coenzyme.
3. Explain the mechanism of enzyme action.

Metabolism and Living State

1. Distinguish between catabolism and anabolism.
2. Why is metabolism essential for the living state?
3. Explain the concept of metabolism with examples.

Part B — Integrated problems (multi-topic)

1. Describe the chemical composition of a living cell, naming the micromolecules and macromolecules.
2. Explain the four levels of protein structure with a suitable example.
3. Compare starch, glycogen and cellulose with respect to monomer, linkage and function.
4. Describe the structure of a nucleotide and distinguish DNA from RNA.
5. Explain the mechanism of enzyme action and the effect of temperature and pH on it.
6. Distinguish anabolism from catabolism, giving one example of each.

Answer Key

Chemical Composition of Living Tissue

Micromolecules have a molecular weight below 1000 Da (water, salts, sugars, amino acids) and macromolecules above (proteins, nucleic acids, polysaccharides). Water is the universal solvent — it acts as a medium for reactions, a transport medium and a temperature buffer. Living tissue contains water, inorganic ions and organic biomolecules (carbohydrates, proteins, lipids, nucleic acids).

Proteins

Essential amino acids cannot be synthesised by the body and must be obtained from the diet; non-essential amino acids can be synthesised. Two functions: proteins act as enzymes and as structural components (e.g. keratin). Four levels: primary (sequence of amino acids), secondary (α -helix/ β -sheet), tertiary (three-dimensional shape) and quaternary (assembly of subunits).

Polysaccharides

Starch is a storage polysaccharide of plants (α -glucose, branched); cellulose is a structural polysaccharide of plant cell walls (β -glucose, unbranched). Two functions: energy storage and structural support. Starch (plant storage, α -glucose), glycogen (animal storage, more branched, α -glucose) and cellulose (plant structural, β -glucose, unbranched).

Nucleic Acids

DNA has deoxyribose, thymine and is double-stranded; RNA has ribose, uracil and is usually single-stranded. Two functions: storage and transmission of genetic information (DNA) and protein synthesis (RNA). DNA is a double helix of two antiparallel strands with base pairing A–T and G–C.

Lipids

Fats are solid at room temperature (saturated); oils are liquid (unsaturated). Two functions: energy storage and as components of cell membranes. Phospholipids have a phosphate-containing head (hydrophilic) and two fatty-acid tails (hydrophobic) — they form the bilayer of cell membranes.

Enzymes

Two properties: enzymes are highly specific and are protein catalysts that lower activation energy. A cofactor is a non-protein helper (e.g. a metal ion); a coenzyme is an organic cofactor (often a vitamin derivative, e.g. NAD). Enzyme action: the substrate binds the active site forming an enzyme–substrate complex, which converts into product, releasing the enzyme (lock-and-key / induced-fit).

Metabolism and Living State

Catabolism is the breakdown of complex molecules releasing energy (e.g. respiration); anabolism is the synthesis of complex molecules using energy (e.g. photosynthesis). Metabolism is essential because the living state is a non-equilibrium steady state maintained only by continuous metabolic reactions.

Integrated problems

1: Micromolecules (<1000 Da) — water, salts, sugars, amino acids; macromolecules (>1000 Da) — proteins, nucleic acids, polysaccharides. 2: Primary (sequence), secondary (α -helix/ β -sheet), tertiary (3-D shape), quaternary (sub-units). 3: Starch (α -glucose, branched, plant storage), glycogen (α -glucose, more branched, animal storage), cellulose (β -glucose, unbranched, structural). 4: Nucleotide = sugar + phosphate + nitrogenous base; DNA (deoxyribose, thymine, double-stranded) vs RNA (ribose, uracil, single-stranded). 5: Enzyme–substrate complex $\rightarrow$ product; activity is maximal at an optimum temperature and pH and falls outside it (denaturation at high temperature/pH extremes). 6: Anabolism — synthesis (photosynthesis); catabolism — breakdown (respiration).