NCERT Exemplar Solutions of Class 11 Biology – Chapter 9: Biomolecules

LONG ANSWER TYPE QUESTIONS

1. Formation of the enzyme-substrate complex (ES) is the first step in catalysed reactions. Describe the other steps until the formation of the product.

Solution:

1. **Substrate binding**: The substrate binds to the active site of the enzyme, which fits into the active site
2. **Induced fit**: The binding of the substrate helps the enzyme alter its shape and fit more tightly
3. **Catalysis**: The active site of the enzyme breaks the chemical bonds of the substrate, thus forming new enzyme-product complex
4. **Product release**: The product is released by the enzyme, and the free enzyme is ready to bind another substrate molecule and run through the catalytic cycle again

Enhanced Explanation: The enzyme catalytic cycle follows these detailed steps:

- **E + S ⇌ ES** (Enzyme + Substrate ⇌ Enzyme-Substrate complex)
- **ES → EP** (Enzyme-Substrate complex → Enzyme-Product complex)
- **EP → E + P** (Enzyme-Product complex → Enzyme + Product)

Key features:

- **Specificity**: Each enzyme is specific for particular substrates
- **Lower activation energy**: Enzymes reduce the energy barrier for reactions
- **Enzyme recycling**: The enzyme remains unchanged and can be reused
- **Regulation**: Enzyme activity can be controlled by inhibitors, activators, and allosteric modifications

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2. What are the different classes of enzymes? Explain any two with the type of reaction they catalyse.

Solution: There are six different classes of enzymes: **Oxidoreductase, Transferase, Hydrolase, Lyase, Isomerase, Ligase**.

a) Oxidoreductases: These enzymes help in simultaneous oxidation and reduction of two substrates. **Reaction**: S reduced + S' oxidized → S oxidized + S' reduced **Example**: Lactate dehydrogenase catalyzes the oxidation of lactate to pyruvate

b) Hydrolases: These enzymes facilitate the hydrolysis of molecules by adding water.

Reaction: Sucrose + H_2O → Glucose + Fructose

Example: Digestive enzymes like amylase, pepsin, and lipase

Enhanced Explanation: Complete enzyme classification:

1. **Oxidoreductases**: Catalyze redox reactions (e.g., dehydrogenases, oxidases)
2. **Transferases**: Transfer functional groups between molecules (e.g., aminotransferases)
3. **Hydrolases**: Break bonds using water (e.g., proteases, lipases)
4. **Lyases**: Add or remove groups to form double bonds (e.g., decarboxylases)

5. **Isomerases**: Rearrange atoms within molecules (e.g., glucose isomerase)
6. **Ligases**: Join molecules using ATP energy (e.g., DNA ligase)

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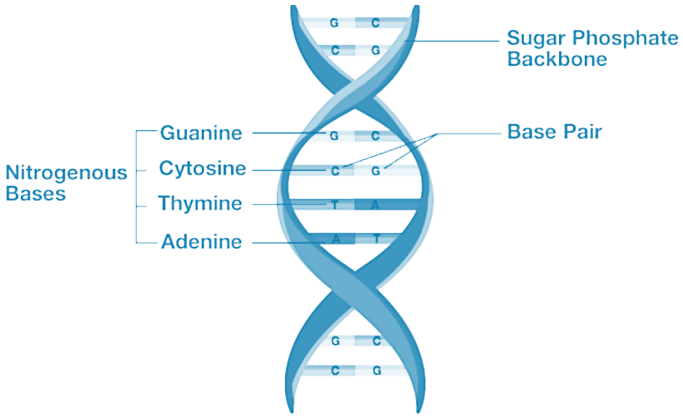
3. Nucleic acids exhibit secondary structure. Describe through Watson-Crick Model.



Solution: DNA is made up of two polynucleotide chains arranged in a double helix. The backbone consists of sugar-phosphate while the nitrogenous bases are present on the inner side. These nitrogenous bases pair with each other through hydrogen bonds. This hydrogen bonding confers stability to the helix.

Enhanced Explanation: Watson-Crick DNA Model features:

- **Double helix structure**: Two antiparallel polynucleotide strands
- **Base pairing rules**: A pairs with T (2 H-bonds), G pairs with C (3 H-bonds)
- **Major and minor grooves**: Created by the helical twisting
- **Right-handed helix**: B-form DNA with 10 base pairs per complete turn
- **Uniform diameter**: ~2 nm due to purine-pyrimidine pairing
- **Complementary strands**: Enable replication and transcription

Structural components:

- **Sugar-phosphate backbone**: Provides structural framework
- **Nitrogenous bases**: Store genetic information
- **Hydrogen bonds**: Stabilize base pairs
- **Van der Waals forces**: Stack bases vertically

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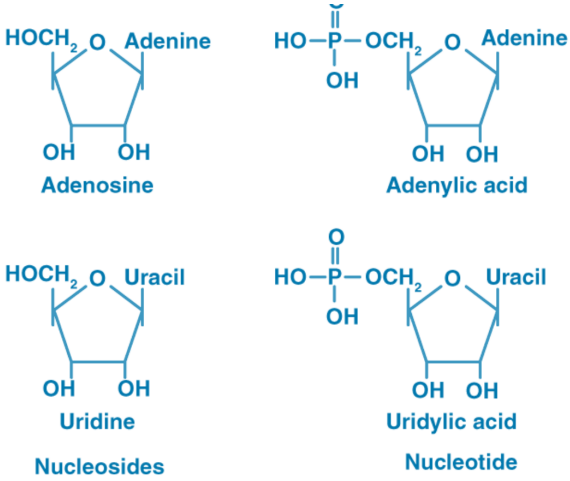
4. What is the difference between a nucleotide and nucleoside? Give two examples of each with their structure.



Solution: Nucleotides are the monomers of nucleic acids formed of nucleoside and phosphate group.

Nucleosides are constituents of nucleotides consisting of nitrogenous base and sugar only.

Examples of Nucleosides:

- Adenosine, Guanosine, Thymidine, Uridine, Cytidine

Examples of Nucleotides:

- Adenylic acid (AMP), Thymidylic acid (TMP), Guanylic acid (GMP), Uridylic acid (UMP), Cytidylic acid (CMP)

Enhanced Explanation: Structural differences:

- **Nucleoside** = Nitrogenous Base + Sugar (ribose or deoxyribose)
- **Nucleotide** = Nitrogenous Base + Sugar + Phosphate group(s)

Functions:

- **Nucleosides**: Intermediate compounds in nucleotide synthesis
- **Nucleotides**: Building blocks of DNA/RNA, energy carriers (ATP), coenzymes (NAD^+, FAD)

Phosphate variations:

- **Monophosphate**: One phosphate group (AMP)
- **Diphosphate**: Two phosphate groups (ADP)
- **Triphosphate**: Three phosphate groups (ATP)

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5. Describe various forms of lipid with a few examples.

Solution: Lipids are classified into three categories:

1. Simple Lipids:

- Esters of fatty acids
- Examples: Triglycerides, fats, and waxes

2. Compound Lipids:

- Contain additional groups other than fats and alcohols
- Examples: Phospholipids, glycolipids

3. Derived Lipids:

- Consist of hydrocarbon rings and long hydrocarbon chains
- Examples: Steroids, cholesterol

Enhanced Explanation: Detailed lipid classification:

Simple Lipids:

- **Triglycerides**: Energy storage molecules (1 glycerol + 3 fatty acids)
- **Waxes**: Protective coatings (fatty acid + long-chain alcohol)

Compound Lipids:

- **Phospholipids**: Cell membrane components (contain phosphate group)
- **Glycolipids**: Membrane components with carbohydrate groups
- **Lipoproteins**: Transport lipids in blood

Derived Lipids:

- **Steroids**: Four-ring structure (cholesterol, hormones)
- **Prostaglandins**: Signaling molecules
- **Terpenes**: Plant compounds (essential oils)

Functions of lipids:

- Energy storage and metabolism
- Cell membrane structure
- Signaling molecules
- Insulation and protection
- Vitamin absorption (fat-soluble vitamins A, D, E, K)