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Class	9th	Chapter	07
Subject	BIOLOGY	Board	Federal

CHAPTER 7: METABOLISM

Section I: MCQs

1. Which is true about enzyme? A) all enzymes are not protein B) all enzymes are vitamins **C) all enzymes are proteins** D) all proteins are enzyme

2. Lock and key hypothesis of enzyme action supports that: A) active sites are flexible **B) active sites are rigid** C) active site efficiency increases D) active site can change its shape

3. Which graph shows how temperature affects the rate of an enzyme-controlled reaction? A) Graph A **B) Graph B** C) Graph C D) Graph D

4. What is true about cofactors? A) break hydrogen bond in proteins **B) help facilitate enzyme activity** C) increase activation energy D) are composed of proteins

5. Change in pH can alter the active site by affecting the:A) Ionization of amino acids B) Shape of substrate C) Ionization of cofactor D) Ionization of coenzyme

6. The catalytic region on enzyme recognizes and binds the substrate and carries the reaction. This region is called as: A) cofactor B) activator C) Inhibitor **D) active site**

7. The graph shows the activity of three digestive enzymes at different pH levels. Which statement is correct? A) Enzyme X and Y are both active at pH 7 B) Enzyme X and Z are both active at pH 4 **C) Enzyme Y and Z are both active at pH 4** D) Enzyme Y and Z are both active at pH 7

8. The diagram shows an amylase molecule catalysing the breakdown of a starch molecule. Which are the labelled parts P, Q, R and S? A) P: Enzyme, Q: Product, R: Substrate, S: Active site B) R: Enzyme, S: Product, P: Substrate, Q: Active site C) S: Enzyme, P: Product, Q: Substrate, R: Active site **D) S: Enzyme, R: Product, P: Substrate, Q: Active site**

9. Glycolysis is the breakdown of: A) fructose **B) glucose** C) lactose D) maltose

10. The mechanism of ATP synthesis is:A) phosphorylation B) photosynthesis C) respiration D) glucose

11. In aerobic respiration pyruvic acid changes to: A) glucose B) fructose **C) Acetyl CoA** D) citric acid

12. Which of these uses oxygen as the final acceptor? A) glycolysis **B) electron transport chain** C) Krebs cycle D) photosynthesis

13. Which of these produces carbon dioxide?A) Krebs cycle B) electron transport chain C) glycolysis D) photosynthesis

14. What are the products of light reactions in photosynthesis? A) ATP, NADPH and oxygen B) ATP and NADP C) ATP, PGA and oxygen D) PGA and oxygen

15. The diagram shows an overview of photosynthesis. Which numbered molecules is organic biomolecule? A) I B) II **C) III** D) IV

16. Which feature helps plants to make most food by the process of photosynthesis? A) broad and flat leaves B) spiny leaves C) yellow leaves D) curled leaves

17. The diagram shows a pond weed in a test tube filled with water. Which conditions would cause the plant to produce more bubbles? A) Dissolved CO_2: Present, Light: Bright, Temperature: Cool **B) Dissolved CO_2: Present, Light: Bright, Temperature: Warm** C) Dissolved CO_2: Present, Light: Dim, Temperature: Cool D) Dissolved CO_2: Absent, Light: Dim, Temperature: Warm

18. Which of the following processes is used by plants to make oxygen during the process of photosynthesis? A) intake of water B) intake of CO_2 **C) photolysis of water** D) Calvin cycle

19. The diagram shows overview of cellular respiration. Which labelled part represents NADH? A) X only B) Y only C) Z only **D) both Y and Z**

20. A child left a carton on the lawn for two days. When the carton was picked up, the grass under it had turned yellow. What caused the grass to change colour? A) lack of oxygen B) lack of carbon dioxide **C) lack of light** D) lack of water

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Section II: Short Answer Questions

1. **Why enzymes are called biological catalyst?** Enzymes are proteinaceous molecules produced by living cells that accelerate biochemical reactions without being consumed themselves. Because they speed up metabolic processes inside biological systems under mild conditions, they are termed biological catalysts.
2. **Name the factors affecting enzyme activity.** The primary factors affecting enzyme activity include temperature, pH, substrate concentration, and enzyme concentration. Inhibitors and activators also significantly regulate the rate of enzyme-catalyzed reactions.
3. **At what pH pepsin and trypsin enzymes act the best?** Pepsin functions best in a strongly acidic medium with an optimum pH of around 2.0. In contrast, trypsin operates most efficiently in an alkaline medium with an optimum pH of about 8.0.
4. **What happens to an enzyme when it is frozen below 0°C?** Freezing an enzyme below 0°C does not permanently damage or denature its structure. Instead, the enzyme's catalytic activity is temporarily halted due to reduced kinetic energy, and it regains full activity upon thawing.
5. **Which protein digesting enzyme functions in acidic medium?** Pepsin is the primary protein-digesting enzyme secreted in the stomach that functions effectively in an acidic medium. Its optimal acidic environment is maintained by hydrochloric acid (HCl) in gastric juice.
6. **How enzyme lowers the activation energy?** Enzymes lower activation energy by physically bringing substrate molecules into precise alignment and stressing chemical bonds. This transition state stabilization reduces the energy threshold required for a reaction to proceed.
7. **Why are enzyme specific and why can't each one speed up many different reactions?** Enzymes are highly specific because their active sites possess unique shapes and chemical properties that match only specific substrates. Consequently, an enzyme can only catalyze a particular reaction or group of related reactions.
8. **Why small quantity of enzyme is enough for catalysing large number of substrate molecules into products?** Enzymes remain unchanged and are not consumed or altered during the chemical reactions they catalyze. Once a product is released, the enzyme's active site becomes free to bind with another substrate molecule repeatedly.
9. **According to induced fit model, the active site is flexible. Does it mean that any substrate can attach with this flexible active site? If not, then explain.** No, any substrate cannot attach because flexibility only allows the active site to mold precisely around a complementary substrate. The fundamental lock-and-key specificity and chemical affinity are still strictly required for binding.
10. **Sketch the structure of ATP.** ATP consists of an adenine nitrogenous base attached to a 5-carbon ribose sugar, which in turn is bonded to a linear chain of three high-energy phosphate groups.

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11. **Write the equation of: a) photosynthesis b) fermentation c) aerobic respiration.** a) Photosynthesis: $6CO_2 + 12H_2O \xrightarrow{\text{Light/Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$

b) Fermentation (Alcoholic): $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

c) Aerobic Respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy (ATP)

12. **Name the products of anaerobic respiration in muscle cells.** The primary product of anaerobic respiration in active human muscle cells is lactic acid (lactate) along with a small net yield of ATP energy.
13. **Why a part of photosynthesis is called dark reactions.** It is called the dark reaction because its biochemical steps (such as the Calvin cycle) do not directly require light energy to proceed. However, it typically occurs during daylight while dependent on the ATP and NADPH produced in light reactions.
14. **How photosynthesis and aerobic respiration are interlinked with each other?** Photosynthesis produces glucose and oxygen, which serve as the essential reactants for cellular respiration in living organisms. Conversely, respiration releases carbon dioxide and water, which are required by plants for photosynthesis.

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Section III: Extensive Answer Questions

1. **Define enzyme and describe their characteristics and specifications.**
    - **Definition:** Enzymes are organic catalysts (mostly globular proteins) synthesized by living cells that speed up the rate of biochemical reactions without themselves undergoing any permanent change.
    - **Characteristics:**
        - They are remarkably efficient and can accelerate reactions millions of times faster.
        - They are highly specific in their action, where each enzyme catalyzes a specific reaction.
        - They are sensitive to changes in temperature, pH, and substrate concentration.
        - They remain unchanged at the end of the reaction and can be reused.
    - **Specificity:** Models like the *Lock and Key Model* (rigid active site) and the *Induced Fit Model* (flexible molding active site) explain how enzymes recognize only complementary substrates.
2. **What is energy of activation? Explain with reference to enzyme.**
    - **Definition:** Activation energy is defined as the minimum amount of energy required to trigger a chemical reaction by breaking existing bonds and initiating the formation of new bonds.
    - **Role of Enzymes:** In biological systems, uncatalyzed reactions require very high activation energy. Enzymes lower this energy barrier by forming temporary enzyme-substrate complexes, weakening bonds, and bringing reactants closer together. This allows metabolic reactions to occur rapidly at normal body temperatures (e.g., 37°C) without heat damage.
3. **What happens to enzymes when you increase or decrease? (a) Temperature (b) pH (c) Substrate concentration.**
    - **(a) Temperature:** As temperature rises, molecular motion increases, raising enzyme activity up to an **optimum temperature** (typically 37°C–40°C). Beyond this point, excessive heat vibrations break internal bonds, causing the enzyme to denature and lose function. Low temperatures only slow down activity without permanent damage.
    - **(b) pH:** Every enzyme functions within a narrow pH range with a distinct **optimum pH**. Any deviation in pH alters the ionization of amino acid residues at the active site, disrupting its shape and drastically reducing catalytic activity.
    - **(c) Substrate Concentration:** Increasing substrate concentration increases the rate of reaction linearly at first. Eventually, a point is reached (**saturation point** / V_{max}) where all enzyme active sites are fully occupied, and further addition of substrate has no effect on the reaction rate.

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4. **Only the related key can open the lock. How this fact is true for enzyme? Explain with examples.**
    - This concept is explained by Emil Fischer's **Lock and Key Hypothesis** (1894). Just like a specific key fits into a unique lock, a specific substrate fits precisely into the complementary shape of an enzyme's active site.
    - **Example:** The enzyme *sucrase* has an active site shaped specifically to bind with the disaccharide *sucrose*. It cannot break down other sugars like lactose or maltose because their molecular structures do not fit into its active site, exactly as a wrong key cannot open a locked door.
5. **Describe the structure and uses of ATP.**
    - **Structure:** Adenosine Triphosphate (ATP) is composed of three main components:
        1. **Adenine:** A nitrogenous base.
        2. **Ribose:** A 5-carbon pentose sugar.
        3. **Phosphate group chain:** A sequence of three phosphate groups linked by high-energy covalent bonds.
    - **Uses:** ATP is known as the **"energy currency"** of the cell. It powers vital cellular processes including active transport across cell membranes, muscle contraction, nerve impulse transmission, and the synthesis of macromolecules (anabolism).
6. **Describe and sketch light reactions of photosynthesis.**
    - **Location:** The light-dependent reactions take place on the **thylakoid membranes** inside chloroplasts.
    - **Process:** Chlorophyll molecules absorb sunlight, exciting electrons that travel along an electron transport chain. Light energy splits water molecules into oxygen, hydrogen ions, and electrons (**photolysis**). The energy released drives the synthesis of ATP (photophosphorylation) and reduces NADP+ to **NADPH**, releasing oxygen gas as a byproduct.
7. **Describe and sketch dark reactions of photosynthesis.**
    - **Location:** The dark reactions (also known as the **Calvin Cycle**) take place in the **stroma** of the chloroplast.
    - **Process:** Although termed "dark," this phase occurs during daylight using the chemical energy (ATP and NADPH) produced during light reactions. Carbon dioxide molecules are captured and fixed into organic molecules through a series of enzyme-assisted steps, ultimately reducing them to high-energy sugars (glucose/G3P).
8. **Explain the factors affecting rate of photosynthesis.**
    - **Light Intensity:** Increasing light intensity increases the rate of photosynthesis up to a certain saturation point, after which it plateaus.

- **Carbon Dioxide Concentration:** Higher CO_2 levels increase the rate of sugar production until limited by other factors.
- **Temperature:** Photosynthesis relies on enzymes; extreme cold slows it down, optimal warmth maximizes it, and excessive heat denatures photosynthetic enzymes.
- **Water Availability:** Water stress causes stomata to close, restricting CO_2 entry and reducing photosynthetic output.

9. **Compare respiration and photosynthesis with examples.**

- **Photosynthesis:** An anabolic (building) process occurring in chloroplasts of plant cells. It converts light energy, CO_2, and water into glucose and oxygen ($6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$).
- **Respiration:** A catabolic (breaking down) process occurring in the mitochondria of all living cells. It breaks down glucose using oxygen to release energy, CO_2, and water ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ Energy).
- **Relationship:** They are complementary cyclic processes that maintain global carbon and oxygen balance.

10. **What are the advantages and significance of anaerobic respiration and fermentation in your daily life?**

- **Significance:** Anaerobic respiration and fermentation allow organisms to generate ATP energy in environments lacking oxygen (such as waterlogged soils or intensely exercising muscles).
- **Daily Life Applications:**
  - **Baking & Brewing:** Yeasts perform alcoholic fermentation to produce carbon dioxide (making bread dough rise) and alcohol.
  - **Dairy Industry:** Lactic acid bacteria are used to ferment milk for producing yogurt, cheese, and butter.
  - **Muscular Activity:** Human muscle cells utilize anaerobic pathways during intense exercise when oxygen supply temporarily falls behind metabolic demand.

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