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Class	9th	Chapter	07
Subject	Biology	Board	Punjab

CHAPTER 7: ENZYMES

EXERCISE SOLUTION

A. Select the Correct Answers for the Following Questions

1. Primarily, all enzymes are:

a) Nucleic acids b) Proteins c) Carbohydrates d) Lipids

Answer: b) Proteins

2. Which best defines an enzyme?

a) A chemical that breaks down food.
b) A hormone that regulates metabolism.
c) A protein that speeds up reactions.
d) A molecule that stores energy.

Answer: c) A protein that speeds up reactions.

3. What can happen if an enzyme is exposed to a temperature higher than its optimum temperature?

a) Enzyme activity rate will increase.
b) The enzyme's shape will change, potentially reducing its activity.
c) The enzyme will speed up the reaction and remain stable.
d) The enzyme will become a substrate itself.

Answer: b) The enzyme's shape will change, potentially reducing its activity.

4. Enzymes are specific in their action because:

a) Their active sites fit specific substrates.
b) They are always proteins.
c) They are consumed in reactions.
d) They work only at high temperatures.

Answer: a) Their active sites fit specific substrates.

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5. Prosthetic groups are:

a) Required by all enzymes.
b) Proteins in nature.
c) Loosely attached to enzymes.
d) Tightly bound to enzymes.

Answer: d) Tightly bound to enzymes.

6. How does increasing temperature affect enzyme activity?

a) Increases activity to a point.
b) Always decreases activity.
c) Makes enzymes non-functional.
d) Has no effect on enzymes.

Answer: a) Increases activity to a point.

7. How does a competitive inhibitor affect enzyme action?

a) Attaches to the substrate.
b) Changes the enzyme's shape.
c) Attaches to and blocks the active site.
d) Blocks the cofactors.

Answer: c) Attaches to and blocks the active site.

8. An enzyme works best at a pH of 7.4. It is placed in an acidic solution with a pH of 4.0. How will this affect the enzyme?

a) The active site will be modified, reducing substrate binding.
b) The enzyme will catalyse reactions faster due to increased H^+ ions.
c) The enzyme will gain additional active sites.
d) The substrate will become inactive in an acidic environment.

Answer: a) The active site will be modified, reducing substrate binding.

9. What is TRUE according to the induced-fit model of enzyme action?

a) The enzyme's active site changes shape to bind the substrate.
b) The substrate changes shape to bind the active site.
c) No shape changes occur in the active site or substrate.
d) The substrate attaches to the enzyme at a site other than the active site.

Answer: a) The enzyme's active site changes shape to bind the substrate.

10. What is TRUE about the optimum pH values of the following digestive enzymes?

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a) Pepsin works at low pH, while trypsin works at high pH.
b) Both work at high pH.
c) Both work at low pH.
d) Pepsin works at high pH, while trypsin works at low pH.

Answer: a) Pepsin works at low pH, while trypsin works at high pH.

B. Write Short Answers

1. Define metabolism. Differentiate between catabolism and anabolism.

Answer: Metabolism is the sum total of all biochemical reactions taking place in a living organism.

Catabolism: These are metabolic pathways that break down complex molecules into simpler ones, releasing energy. Example: cellular respiration.

Anabolism: These are metabolic pathways that synthesize complex molecules from simpler precursors, requiring an input of energy. Example: photosynthesis.

2. Which type of metabolism demands an input of energy? Give an example.

Answer: Anabolism demands an input of energy. Examples include the synthesis of proteins from amino acids and the formation of glucose during photosynthesis.

3. Define an enzyme. What is its role in metabolism?

Answer: An enzyme is a biological catalyst, typically a globular protein, that accelerates the rate of metabolic chemical reactions by lowering their activation energy without being consumed in the process.

4. What is the active site of an enzyme? State its importance in enzyme specificity.

Answer: The active site is a specialized pocket or cleft on the surface of an enzyme molecule where substrate molecules bind and undergo a chemical reaction. Its unique shape and chemical properties ensure that specific substrates can bind, determining enzyme specificity.

5. Provide an example of a specific enzyme-substrate pair.

Answer: The enzyme sucrase specifically binds to the substrate sucrose and catalyses its breakdown into glucose and fructose.

6. What is the effect of substrate concentration on enzyme activity?

Answer: Initially, increasing substrate concentration increases the rate of enzyme activity. However, once all enzyme active sites are fully saturated, the reaction rate reaches a maximum plateau (Vmax), and further increases in substrate concentration have no effect.

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7. Provide two examples of enzymes that operate optimally at specific pH values.

Answer:

- **Pepsin:** Operates optimally in acidic conditions, around pH 2, in the stomach.
- **Trypsin:** Operates optimally in basic or alkaline conditions, around pH 8, in the small intestine.

8. What do you mean by optimum temperature and pH?

Answer:

Optimum Temperature: The specific temperature at which an enzyme exhibits its maximum rate of reaction.

Optimum pH: The specific pH value at which an enzyme functions with maximum catalytic efficiency.

9. Which type of enzyme inhibitors inhibit enzymes without attaching to the active site?

Answer: Non-competitive inhibitors bind to an allosteric site on the enzyme rather than directly occupying the active site.

10. Differentiate between competitive and non-competitive inhibition.

Answer:

Competitive Inhibition: Inhibitor molecules compete with the substrate for binding to the enzyme's active site. This type of inhibition can often be overcome by increasing the substrate concentration.

Non-competitive Inhibition: Inhibitor molecules bind to a site other than the active site, known as an allosteric site. This can alter enzyme activity and reduce the reaction rate. In pure non-competitive inhibition, increasing substrate concentration does not overcome the inhibition.

C. Write Answers in Detail

1. Describe the characteristics of enzymes.

Answer: Enzymes have the following characteristics:

1. Catalytic Efficiency: Enzymes accelerate reaction rates without being consumed or permanently altered in the reactions they catalyse.

2. High Specificity: Each enzyme usually catalyses a specific reaction involving particular substrates because of the unique properties of its active site.

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3. Protein Nature: Most enzymes are globular proteins, although some catalytic RNA molecules, called ribozymes, also exist.

4. Sensitivity to Temperature and pH: Enzymes function best within particular temperature and pH ranges. Extreme conditions may alter their structure and reduce their activity.

5. Reversibility: Many enzyme-catalysed reactions are reversible, depending on the reaction conditions.

6. Requirement for Cofactors or Coenzymes: Some enzymes require non-protein components, such as metal ions, cofactors, coenzymes, or prosthetic groups, to function efficiently.

2. Describe how temperature extremes can inhibit enzyme activity and lead to enzyme denaturation.

Answer:

Low Temperatures: Low temperatures reduce the kinetic energy of molecules, resulting in fewer effective collisions between enzymes and substrates. Consequently, enzyme activity slows down, although the enzyme generally remains structurally intact.

High Temperatures: As temperature rises, enzyme activity generally increases until the optimum temperature is reached. Above this temperature, excessive molecular movement disrupts interactions that maintain the enzyme's three-dimensional structure. The active site changes shape, reducing the enzyme's ability to bind its substrate.

This structural alteration is called **denaturation**. Severe heat may cause irreversible denaturation and permanently destroy catalytic activity.

3. How does pH affect enzyme activity?

Answer: Changes in pH alter the ionization state of amino acid side chains within an enzyme's active site and may also affect the substrate. Every enzyme has an optimum pH at which it works most efficiently.

Deviations above or below this optimum can disrupt ionic interactions and hydrogen bonds, alter the shape of the active site, reduce substrate-binding affinity, and decrease the reaction rate. Extreme pH values may cause permanent denaturation of the enzyme.

4. Describe the factors that affect the activity of enzymes.

Answer: The main factors affecting enzyme activity are:

1. Temperature: The reaction rate increases with temperature up to the optimum temperature. Beyond this point, denaturation may occur, causing activity to decrease.

2. pH: Each enzyme has an optimum pH. Deviations from this value reduce activity and extreme changes may denature the enzyme.

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3. Substrate Concentration: Increasing substrate concentration increases the reaction rate until the enzyme's active sites become saturated.

4. Enzyme Concentration: Increasing enzyme concentration increases the reaction rate when sufficient substrate is available.

5. Inhibitors: Competitive and non-competitive inhibitors reduce enzyme activity by interfering with substrate binding or enzyme function.

6. Activators and Cofactors: Certain metal ions, coenzymes, and other required components enhance or enable the catalytic function of some enzymes.

5. Compare the lock-and-key and induced-fit models of enzyme action.

Answer:

Lock-and-Key Model: Proposed by Emil Fischer in 1894, this model suggests that an enzyme's active site has a rigid, pre-formed shape that fits its specific substrate, just as a key fits into a lock. In the simplest version of this model, the active site does not undergo a major shape change when the substrate binds.

Induced-Fit Model: Proposed by Daniel Koshland in 1958, this model suggests that an enzyme's active site is flexible rather than completely rigid. When a substrate approaches and binds, it induces a conformational change in the enzyme, allowing the active site to fit the substrate more closely and facilitate catalysis.

Main Difference: The lock-and-key model emphasizes a pre-existing complementary shape, whereas the induced-fit model emphasizes flexibility and a shape change upon substrate binding. The induced-fit model better explains many aspects of modern enzyme action.

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