Enzyme Specificity

Name: _____ **Date:** _____

Read and Learn

Enzymes are biological catalysts that speed up reactions without being used up. Most enzymes are proteins folded into a particular three-dimensional shape.

A **substrate** is a substance an enzyme acts on. It binds to a region of the enzyme called the **active site**. The active site has a shape and chemical properties suited to particular substrates. This explains **enzyme specificity**.

The **lock-and-key model** compares an enzyme to a lock and its substrate to a matching key. A suitable substrate fits into the active site, forming an **enzyme–substrate complex**. The reaction occurs, the products leave, and the enzyme can be used again.

Enzyme + substrate → enzyme–substrate complex → enzyme + products

This is a simplified model: real enzymes are flexible and may change shape slightly when substrates bind.

An enzyme usually catalyses one reaction or a small group of closely related reactions. Unrelated substrates generally do not bind correctly or become positioned appropriately for the reaction.

Example: Lactase

Lactase catalyses the breakdown of lactose, a sugar found in milk.

Lactose + water → glucose + galactose

Lactase is the enzyme, lactose is its main food substrate, and glucose and galactose are the products. Water also participates in the reaction.

Multiple Choice

Circle the correct answer.

1. What does enzyme specificity mean?

A. Enzymes can act on every substance.
B. Enzymes act on particular substrates.
C. Enzymes are used up after one reaction.
D. Enzymes work only outside cells.

2. Where does a substrate bind to an enzyme?

A. The active site
B. The cell membrane
C. The nucleus
D. The product

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Enzyme Specificity

3. In the lock-and-key model, what does the key represent?

A. The enzyme
B. The active site
C. The substrate
D. The product

4. Why can an enzyme usually be used again?

A. Its products turn into new enzymes.
B. It is not used up by the reaction.
C. It becomes a different substrate.
D. Its active site disappears after the reaction.

Complete the Sentences

Word bank: active site • products • shape • substrate

1. The substance an enzyme acts on is called its _____.
2. The substrate binds to the enzyme's _____.
3. Substances formed during the reaction are called _____.
4. An enzyme's three-dimensional _____ helps determine its function.

Put the Steps in Order

Write **1–4** beside the steps.

_____ The products leave the active site.

_____ A suitable substrate binds to the enzyme's active site.

_____ The enzyme is available to catalyse another reaction.

_____ The enzyme helps convert the bound substrate into products.

Identify the Enzyme, Substrates, and Products

1. Sucrase catalyses this reaction:

Sucrose + water → glucose + fructose

a. Name the enzyme: _____

b. Name the sugar substrate: _____

c. Name the two sugar products: _____

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2. Catalase catalyses this reaction:

Hydrogen peroxide → water + oxygen

a. Name the enzyme: _____

b. Name the substrate: _____

c. Name the products: _____

True or False?

Write **T** or **F**. Correct each false statement.

1. Any substrate can bind successfully to any enzyme. _____

Correction: _____

2. An enzyme's active site helps determine which substrates it acts on. _____

Correction: _____

3. Enzymes are converted into products during the reactions they catalyse. _____

Correction: _____

Apply Your Understanding

1. Lactase breaks down lactose but does not normally break down sucrose. Explain why.

2. High temperatures can change an enzyme's shape, including its active site. Explain how this could affect enzyme activity.

3. A student says, "Cells need only one enzyme because all enzymes speed up reactions." Explain why cells need many different enzymes.

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Enzyme Specificity — Answer Key

Multiple Choice

1. **B** — Enzymes act on particular substrates.
2. **A** — The active site.
3. **C** — The substrate.
4. **B** — It is not used up by the reaction.

Complete the Sentences

1. **substrate**
2. **active site**
3. **products**
4. **shape**

Put the Steps in Order

In the order presented on the worksheet:

- **3** — The products leave the active site.
- **1** — A suitable substrate binds to the enzyme's active site.
- **4** — The enzyme is available to catalyse another reaction.
- **2** — The enzyme helps convert the bound substrate into products.

Identify the Enzyme, Substrates, and Products

1. Sucrase reaction

a. Enzyme: **Sucrase**
b. Sugar substrate: **Sucrose**
c. Sugar products: **Glucose and fructose**

2. Catalase reaction

a. Enzyme: **Catalase**
b. Substrate: **Hydrogen peroxide**
c. Products: **Water and oxygen**

True or False?

1. **False.** Only suitable substrates bind successfully to an enzyme's active site because its shape and chemical properties are specific.
2. **True.**
3. **False.** Substrates are converted into products. Enzymes are not used up and can catalyse further reactions.

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Apply Your Understanding

Accept scientifically correct answers in students' own words.

1. Why does lactase break down lactose but not normally sucrose?

Lactase's active site has a shape and chemical properties suited to lactose. Sucrose has a different structure and does not bind in the correct way for lactase to catalyse its breakdown.

2. How could high temperatures affect enzyme activity?

High temperatures can change the enzyme's three-dimensional shape, including its active site. This is called **denaturation**. The substrate may no longer bind correctly, reducing or stopping the enzyme's activity.

3. Why do cells need many different enzymes?

Cells carry out many different chemical reactions involving different substrates. Each enzyme usually catalyses one reaction or a small group of closely related reactions, so many enzymes are needed to support metabolism.

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