Factors Affecting Enzyme Activity

Name: _____ Class: _____ Date: _____

Read and Learn

Enzyme activity describes how quickly an enzyme catalyses a reaction.

Temperature: At low temperatures, molecules move slowly and successful collisions between enzymes and substrates happen less often. Increasing temperature usually increases enzyme activity up to an **optimum temperature**, where the reaction rate is highest.

Above the optimum, activity decreases as enzymes become **denatured**. Their three-dimensional shape changes, including the active site, so substrates no longer bind correctly. Cooling a denatured enzyme does not usually restore its function. Low temperatures generally slow enzymes without denaturing them.

pH: Each enzyme has an **optimum pH**. Conditions away from this optimum can affect the active site and reduce activity. Extreme pH can denature enzymes. Different enzymes have different optimum conditions.

For example, **pepsin** works best in the acidic conditions of the stomach, while many other digestive enzymes work best near neutral or slightly alkaline pH.

Multiple Choice

Circle the correct answer.

1. Why does warming an enzyme from a low temperature toward its optimum usually increase activity?

A. The enzyme is used up more quickly.
B. Molecules move faster, increasing successful collisions.
C. The substrate becomes a new enzyme.
D. Every enzyme gains additional active sites.

2. What is an enzyme's optimum temperature?

A. The temperature at which it first freezes
B. The highest temperature it can ever experience
C. The temperature at which its reaction rate is highest
D. The temperature at which all its substrates disappear

3. What happens when an enzyme becomes denatured?

A. Its shape changes, affecting its active site.
B. It permanently becomes a substrate.
C. It gains the ability to catalyse every reaction.
D. Its reaction rate always increases.

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4. Which statement about optimum pH is correct?

A. All enzymes work best at pH 7.
B. All enzymes work best in acidic conditions.
C. pH affects substrates but never enzymes.
D. Different enzymes can have different optimum pH values.

Complete the Sentences

Word bank: active site • denatured • optimum • slowly

1. At low temperatures, molecules move more _____.
2. Conditions producing the highest enzyme activity are called _____ conditions.
3. A change in the shape of the _____ may prevent a substrate from binding correctly.
4. An enzyme whose structure has been disrupted by high temperature may be _____.

Plot and Interpret: Temperature

The table shows results for **one enzyme**. All other conditions were kept constant.

Temperature (°C)	Reaction rate (arbitrary units)
10	10
20	25
30	45
40	60
50	20
60	0

On graph paper, plot temperature on the horizontal axis and reaction rate on the vertical axis. Draw a smooth curve through or near the points.

1. Which tested temperature produced the highest reaction rate?

_____ °C

2. Describe how the reaction rate changes between 10 °C and 40 °C.

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3. Explain the decrease in reaction rate between 40 °C and 60 °C.

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4. Do these results prove that the exact optimum is 40 °C? Suggest how you could investigate more closely.

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Plot and Interpret: pH

The table shows results for **two different enzymes** tested at the same temperature.

pH	Enzyme A rate (arbitrary units)	Enzyme B rate (arbitrary units)
2	60	0
4	25	5
6	5	30
8	0	60
10	0	10

Plot both sets of results on one graph. Put pH on the horizontal axis and reaction rate on the vertical axis. Label each curve.

1. State the pH giving the highest measured activity for each enzyme.

Enzyme A: _____ Enzyme B: _____

2. Which enzyme is better suited to the acidic conditions of the stomach?

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3. What do the different peaks show about enzyme optimum conditions?

Apply Your Understanding

1. An enzyme is cooled from its optimum temperature to 5 °C. Explain why its activity decreases and predict what may happen when it is warmed back to its optimum.

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2. A student says, “Boiling an enzyme makes it work faster because the particles move faster.” Explain why this is usually incorrect.

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Graph 1:

Graph 2:

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Factors Affecting Enzyme Activity — Answer Key

Multiple Choice

1. **B** — Molecules move faster, increasing successful collisions.
2. **C** — The temperature at which its reaction rate is highest.
3. **A** — Its shape changes, affecting its active site.
4. **D** — Different enzymes can have different optimum pH values.

Complete the Sentences

1. **slowly**
2. **optimum**
3. **active site**
4. **denatured**

Plot and Interpret: Temperature

Graph: Temperature (°C) on the horizontal axis; reaction rate (arbitrary units) on the vertical axis. The curve rises to the highest plotted point at **(40, 60)**, then falls to **(60, 0)**.

1. Highest measured reaction rate: 40 °C

2. Change between 10 °C and 40 °C:

The reaction rate increases from **10 to 60 arbitrary units**.

3. Decrease between 40 °C and 60 °C:

High temperatures increasingly denature the enzyme. Its active site changes shape, so fewer substrates bind correctly and the reaction rate decreases.

4. Is the exact optimum definitely 40 °C?

No. It is the best temperature tested, but the exact optimum could lie between the tested temperatures. Test smaller temperature intervals around 40 °C, keeping other conditions constant and repeating measurements.

Plot and Interpret: pH

Graph: pH on the horizontal axis; reaction rate (arbitrary units) on the vertical axis. Both curves should be labelled. Enzyme A's highest plotted point is **(2, 60)**; enzyme B's is **(8, 60)**.

1. Highest measured activity:

- **Enzyme A: pH 2**
- **Enzyme B: pH 8**

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2. Better suited to the stomach: Enzyme A, because it has its highest measured activity in strongly acidic conditions.

3. Meaning of the different peaks:

Different enzymes have different optimum pH values. A pH that suits one enzyme may produce little or no activity in another.

Apply Your Understanding

1. Cooling an enzyme to 5 °C

Molecules move more slowly, so successful enzyme–substrate collisions occur less frequently. Cooling generally does not denature the enzyme. When warmed back to its optimum, its activity should return toward its previous level, provided it remains undamaged and substrate is available.

2. Boiling an enzyme

Although particles move faster, boiling usually denatures the enzyme. Changes to its active site prevent substrates from binding correctly, so activity decreases or stops rather than increasing.

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