

Exercise walk-through

Environmental Impacts on Enzyme Function ■ 3.2

eXercise

You must be able to

- describe how **temperature** and **pH** affect enzyme rate
- explain **denaturation** 变性 at extremes
- describe the effect of substrate concentration (saturation)

Method — Temperature

Rate rises with temperature up to an **optimum**, then falls sharply as the enzyme **denatures** (its shape and active site are destroyed). Too cold = slow; too hot = denatured.

Method — pH

Each enzyme has an **optimum pH**. Far from it, the active site's shape is disrupted, lowering the rate; extreme pH can denature the enzyme.

Method — Substrate concentration

Rate rises with more substrate until all active sites are busy (**saturation**); then adding more substrate does not increase the rate (the plateau).

Method — A worked graph reading

An enzyme's rate-vs-temperature curve rises to a peak at $\sim 37^{\circ}\text{C}$ (human optimum) and then drops steeply — the drop is denaturation, not just slowing.

Practice 2.1 ■ 1 mark

What happens to an enzyme's shape at very high temperature?

Solution 2.1

Method: Temperature

Worked steps

It denatures (the active site loses its shape) **B1**.

Practice 2.2 ■ 1 mark

What is meant by an enzyme's optimum pH?

Solution 2.2

Worked steps

The pH at which the enzyme works fastest **B1**.

Practice 2.3 ■ 1 mark

Why does rate level off at high substrate concentration?

Solution 2.3

Method: Substrate concentration

Worked steps

All the active sites are occupied (saturated), so more substrate cannot be processed faster **B1**.

Exam-style 3.1 ■ 1 mark

Above its optimum temperature, an enzyme's rate falls sharply because the enzyme

- A** speeds up
- B** denatures
- C** gains substrate
- D** freezes

Solution 3.1

Method: Temperature

A speeds up

B denatures 

C gains substrate

D freezes

Worked steps

B — denatures.

Exam-style 3.2 ■ 1 mark

An enzyme's activity is measured at pH 2, 7, and 11, with the highest activity at pH 7.

- (a) State the optimum pH.
- (b) Explain why activity is low at pH 2 and pH 11.

Solution 3.2

Worked steps

(a) pH 7 **B1**. (b) At pH 2 and 11 the active site's shape is disrupted (or the enzyme denatures), so the substrate no longer fits and the rate falls **M1** **A1**.

Exam-style 3.3 ■ 3 marks

Describe and explain the shape of a graph of reaction rate against substrate concentration.

Solution 3.3

Method: Substrate concentration

Worked steps

Rate rises steeply with substrate at first (more collisions with active sites) **M1**, then levels off **M1** once all active sites are saturated, so adding more substrate has no further effect **A1**.