

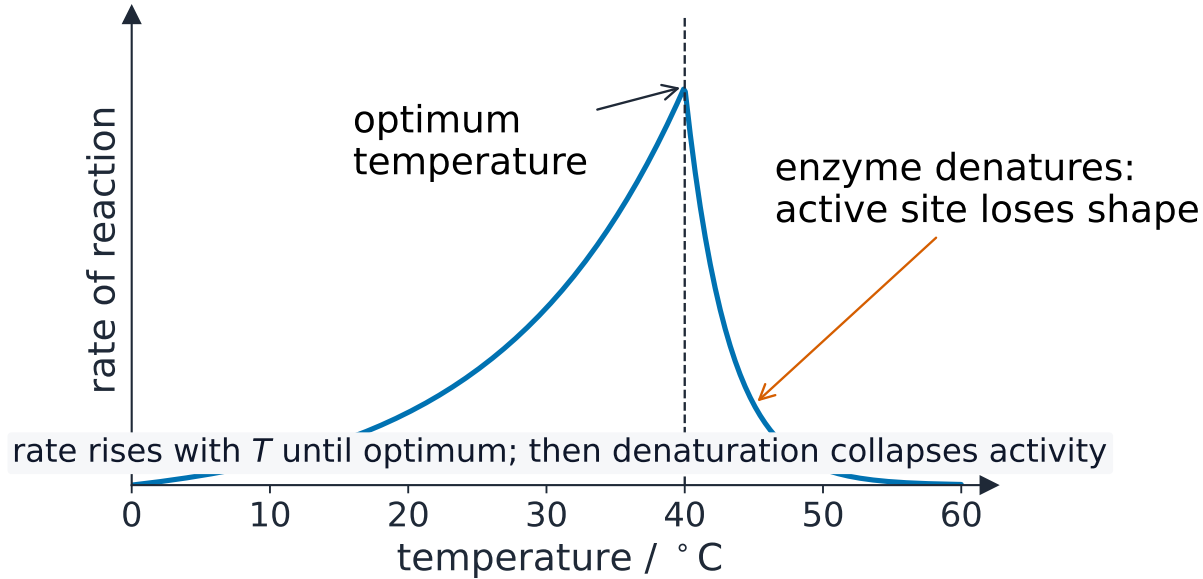
Exercise walk-through

3.2

Factors that affect enzyme action

A-Level Biology

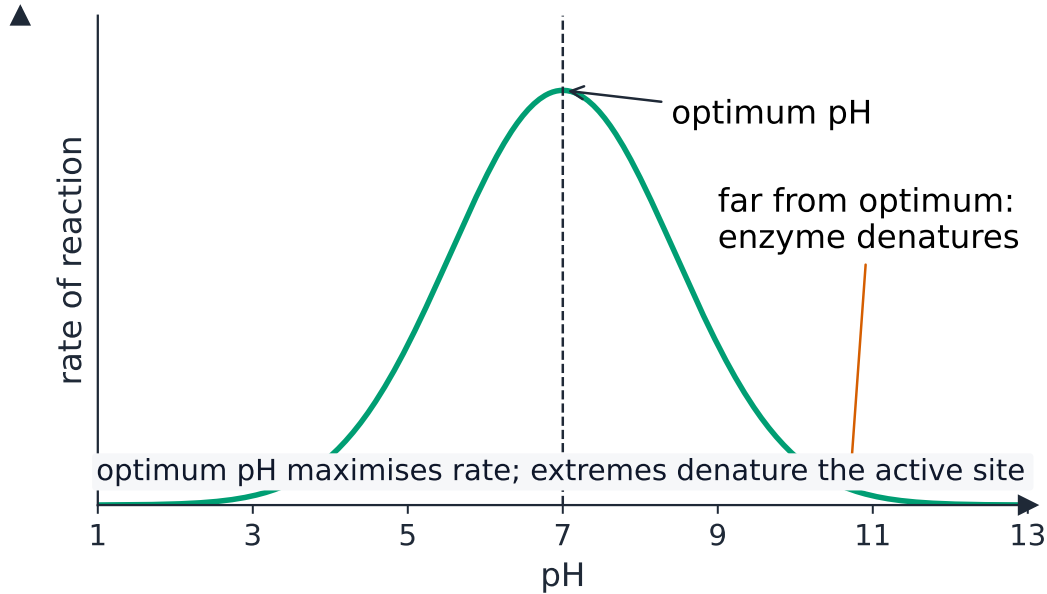
Optimum, then denatures



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A bell-shaped optimum pH



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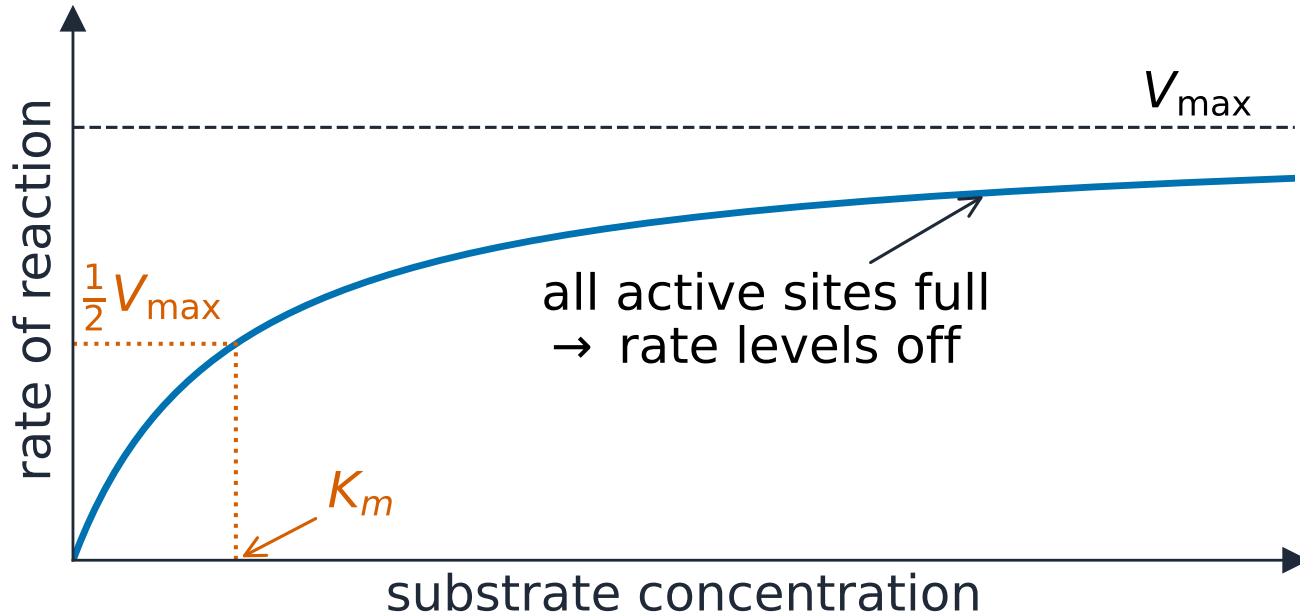
a bell-shaped optimum pH

$V_{\max}$ and the Michaelis–Menten constant

Rate climbs to $V_{\max}$ once all active sites are full.

K_m (**Michaelis–Menten constant**) is the substrate concentration giving half $V_{\max}$ – a **low** K_m means high **affinity**.

$V_{\max}$ and the Michaelis–Menten constant, in detail



$$v = \frac{V_{\max}[S]}{K_m + [S]} \quad \cdot \quad K_m = [S] \text{ at half } V_{\max}$$

Rate climbs to $V_{\max}$ once all active sites are full.

Reversible inhibitors

- **competitive**

($K_m \uparrow$, $V_{\max}$ same)

– binds the active site; more substrate overcomes it

- **non-competitive**

K_m same)

– binds elsewhere; substrate can't help ($V_{\max} \downarrow$,

Exercises 2.1·2.2

2.1 Explain why the rate of an enzyme reaction falls above the optimum temperature.[3]

2.2 State **two** advantages of using an immobilised enzyme rather than a free one. [2]

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2.1

- heat breaks the bonds (hydrogen/ionic) holding the enzyme's shape; the active site changes shape / denatures; so the substrate no longer fits and fewer enzyme–substrate complexes form

2.2 State **two** advantages of using an immobilised enzyme rather than a free one. [2]

2.2

- Any two: re-used many times / product is pure (no enzyme) / more stable to temperature and pH / allows continuous flow

Exercise 3.1

3.1 A competitive inhibitor is added to an enzyme reaction. Compared with no inhibitor, what happens to $V_{\max}$ and K_m ? [1]

☐

A $V_{\max}$ unchanged; K_m increases

B $V_{\max}$ decreases; K_m unchanged

C both increase

D both decrease

Exercise 3.1

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B $V_{\max}$ decreases; K_m unchanged

C both increase

D both decrease

3.1 A

- A competitive inhibitor raises K_m but leaves $V_{\max}$ unchanged (more substrate overcomes it)

Exercise 3.2

3.2 Enzyme Y has a lower K_m than enzyme Z for the same substrate. This means that enzyme Y: [1]

☐

A has a higher affinity for the substrate

B has a higher V_{max}

C is denatured more easily

D works at a higher optimum pH

Exercise 3.2

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B has a higher V_{max}

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3.2 A

- A lower K_m means half V_{max} is reached at lower substrate concentration – higher affinity

Exercise 3.3 (a)

3.3 A student investigates how temperature affects the rate at which catalase breaks down hydrogen peroxide. She measures the volume of oxygen produced in the first minute at five temperatures.

(a) State **two** variables she must control to make this a fair test.

[2]

Exercise 3.3 (a)

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(a) State **two** variables she must control to make this a fair test. [2]

(a)

- any two: substrate (hydrogen peroxide) concentration / volume / enzyme concentration / pH / time

Exercise 3.3 (b)

3.3 A student investigates how temperature affects the rate at which catalase breaks down hydrogen peroxide. She measures the volume of oxygen produced in the first minute at five temperatures.

(b) Describe and explain the results she would expect between 10 °C and 60 °C. [4]

Exercise 3.3 (b)

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(b) Describe and explain the results she would expect between 10 °C and 60 °C. [4]

(b)

- rate rises from 10 °C towards the optimum as molecules gain kinetic energy and collide more often; above the optimum the enzyme denatures, so the rate falls

Exercise 3.3 (c)

3.3 A student investigates how temperature affects the rate at which catalase breaks down hydrogen peroxide. She measures the volume of oxygen produced in the first minute at five temperatures.

(c) Explain why a buffer solution would be used in a similar experiment that varied pH.[2]

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(c)

- a buffer keeps pH constant so that pH is not an uncontrolled variable affecting the rate

Exercise 3.4

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3.4

- at high substrate concentration every active site is occupied / saturated, so adding more substrate cannot increase the rate further – it is at $V_{\max}$