

Exercise walk-through

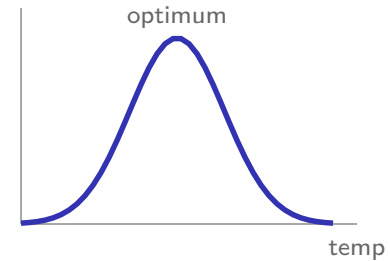
5.1

Enzymes

IGCSE Biology

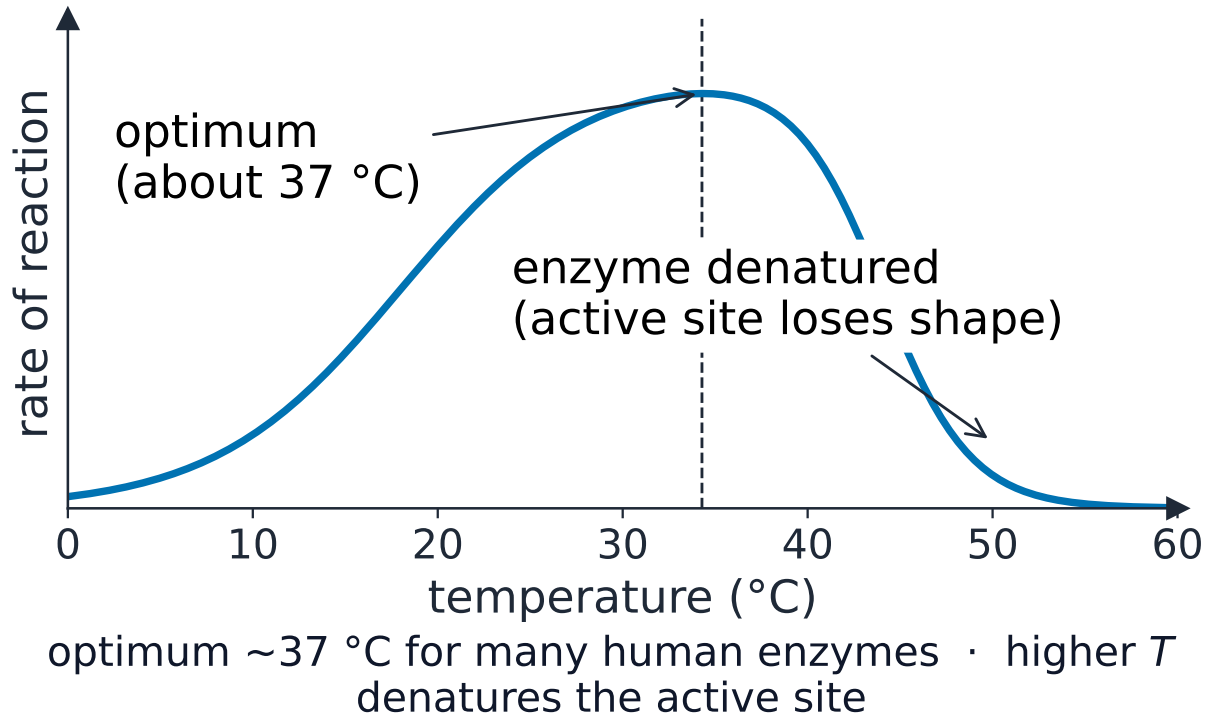
What we will cover

- 1 What enzymes are
- 2 How an enzyme works
- 3 Why enzymes are specific
- 4 The effect of temperature
- 5 The effect of pH



temperature and pH

The effect of temperature, in detail



Activity peaks at the **optimum temperature** ($\sim 37^{\circ}\text{C}$).

Exam tips

- An enzyme is both a **protein** and a biological catalyst: it speeds up a reaction and is **not** used up.
- Describe the shape: the active site is **complementary** to the substrate (the lock-and-key idea). Each enzyme is **specific** to one substrate.
- Low temperature → slow (too little kinetic energy). Optimum → fastest. Too hot → **denatured** (the active site loses its shape, permanently).
- The wrong pH also **denatures** the enzyme by changing the shape of the active site.
- “Denatured” does **not** mean “killed” – enzymes are not alive. Say that the shape of the active site has changed so the substrate no longer fits.

Exercises 2.1-2.3

2.1 Define a catalyst.

[1]

2.2 State the type of molecule that all enzymes are made of.

[1]

2.3 State two conditions that can denature an enzyme.

[2]

Exercises 2.1-2.3

2.1 Define a catalyst.

[1]

2.1

- a catalyst **speeds up a reaction** but is **not used up**

2.2 State the type of molecule that all enzymes are made of.

[1]

2.2

- all enzymes are **proteins**

2.3 State two conditions that can denature an enzyme.

[2]

2.3

- a **temperature** above the optimum
- a **pH** far from the optimum

Exercises 2.4-2.5

2.4 Explain why an enzyme works on only one substrate.

[2]

2.5 Predict what happens to the rate if the substrate concentration is raised while enzyme concentration stays the same.

[2]

Exercises 2.4-2.5

2.4 Explain why an enzyme works on only one substrate.

[2]

2.4

- the active site has a shape **complementary** to one substrate
 - a different substrate **does not fit**, so no reaction is catalysed
-

2.5 Predict what happens to the rate if the substrate concentration is raised while enzyme concentration stays the same.

[2]

2.5

- the rate **increases at first**
- then **levels off** because all active sites are occupied

Exercise 3.1

3.1 Above its optimum temperature, an enzyme's rate falls because the enzyme is: [1]

☐

A used up

B denatured (active site changes shape)

C killed

D diluted

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☐

A used up

B denatured (active site changes shape)

C killed

D diluted

3.1 B

- the **active site changes shape** – the enzyme is **denatured**
- A is false (catalysts are not used up); C is for organisms; D is wrong

Exercise 3.2 (a)

3.2 An enzyme has a specific substrate.

(a) Explain, using the lock-and-key model, why an enzyme is specific.

[2]

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(a) Explain, using the lock-and-key model, why an enzyme is specific.

[2]

(a)

- the active site is complementary to **one** substrate
- only that substrate fits, so the enzyme is **specific**

Exercise 3.2 (b)

3.2 An enzyme has a specific substrate.

(b) Explain why a very low pH reduces the enzyme's activity.

[2]

Exercise 3.2 (b)

3.2 An enzyme has a specific substrate.

(b) Explain why a very low pH reduces the enzyme's activity.

[2]

(b)

- the wrong pH **changes the shape** of the active site
- the substrate no longer fits – the enzyme is **denatured**

Exercise 3.3

3.3 Explain why enzyme activity increases as the temperature rises from 10 °C to 37 °C. [2]

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3.3

- molecules gain **kinetic energy** and move faster
- enzyme and substrate **collide more often**

Exercise 3.4 (a)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(a) Complete the table by predicting the relative rate at each temperature. [3]

Temperature / °C	Predicted rate (high / medium / very low)
10	
40	
70	

Exercise 3.4 (a)

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(a) Complete the table by predicting the relative rate at each temperature. [3]

Temperature / °C	Predicted rate (high / medium / very low)
10	
40	
70	

(a)

- 10 °C: **medium/low**
- 40 °C: **high**
- 70 °C: **very low**

Exercise 3.4 (b)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(b) Explain the rate you predicted at 10 °C.

[2]

Exercise 3.4 (b)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(b) Explain the rate you predicted at 10 °C. [2]

(b)

- little kinetic energy at 10 °C
- fewer **successful collisions**

Exercise 3.4 (c)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(c) Explain, in terms of the active site, why the rate at 70 °C is very low and does not recover on cooling. [3]

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(c) Explain, in terms of the active site, why the rate at 70 °C is very low and does not recover on cooling. [3]

(c)

- bonds holding the shape are **broken**
- the active site **changes shape**, so the substrate no longer fits
- the enzyme is **permanently denatured**

Exercise 3.4 (d)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(d) State two variables the student must keep constant.

[2]

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3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(d) State two variables the student must keep constant. [2]

(d)

- any **two** of: peroxide concentration/volume / catalase amount / pH / time counted

Exercise 3.4 (e)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(e) The student repeats the experiment at pH 3 and pH 7 at 40 °C, and finds the rate is much lower at pH 3. Explain this result. [2]

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(e) The student repeats the experiment at pH 3 and pH 7 at 40 °C, and finds the rate is much lower at pH 3. Explain this result. [2]

(e)

- pH 3 is far from catalase's optimum (~pH 7)
- the active site is **altered**, so the rate **falls**

Exercise 3.4 (f)

3.4 A student measures how fast the enzyme catalase breaks down hydrogen peroxide, by counting the oxygen bubbles released each minute at different temperatures.

(f) State why the enzyme does not need replacing after each reaction. [2]

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(f) State why the enzyme does not need replacing after each reaction. [2]

(f)

- an enzyme is a **catalyst** and is **not used up**
- the same molecule catalyses the reaction **again and again**