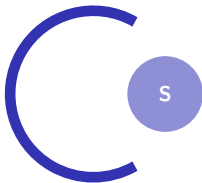


Enzymes

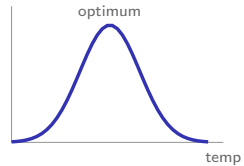
IGCSE Biology ■ Topic 5

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

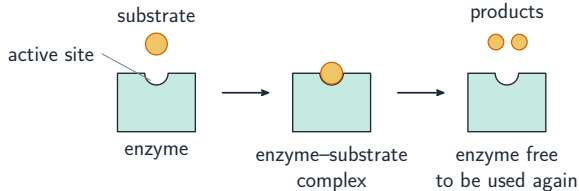


What enzymes are



- The shape of the active site is **complementary** to the shape of the substrate – they fit together like a key in a lock.
- The substrate slots into the active site. **(Supplement)** This makes an **enzyme-substrate complex** .
- The reaction takes place, and the substrate is changed into one or more **products** .
- The products leave the active site, which is then free to be

How an enzyme works



The **substrate** fits the **active site** like a key in a lock.

- shapes are **complementary**
- it forms an **enzyme-substrate complex**
- **products** leave; the enzyme is reused

Why enzymes are specific



right substrate
fits



wrong substrate
does not fit

Each enzyme is **specific** – it works on only **one** substrate. Only the right-shaped substrate fits the active site; the wrong key will not fit.

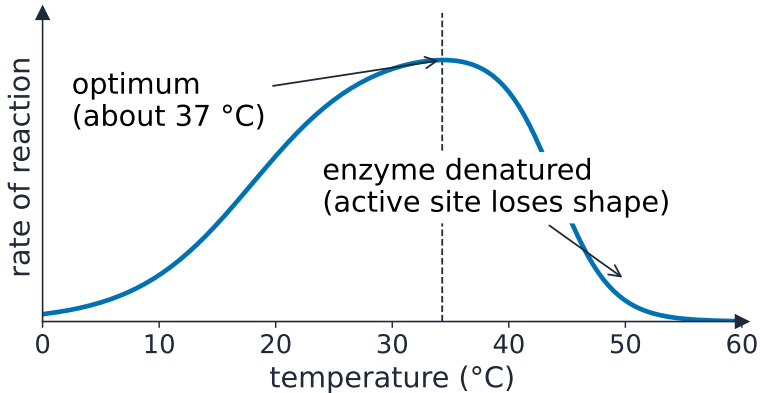


The effect of temperature

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

Too hot $\rightarrow$ the active site loses shape: the enzyme is **denatured** (permanent – **not** “killed”).

The effect of temperature, in detail



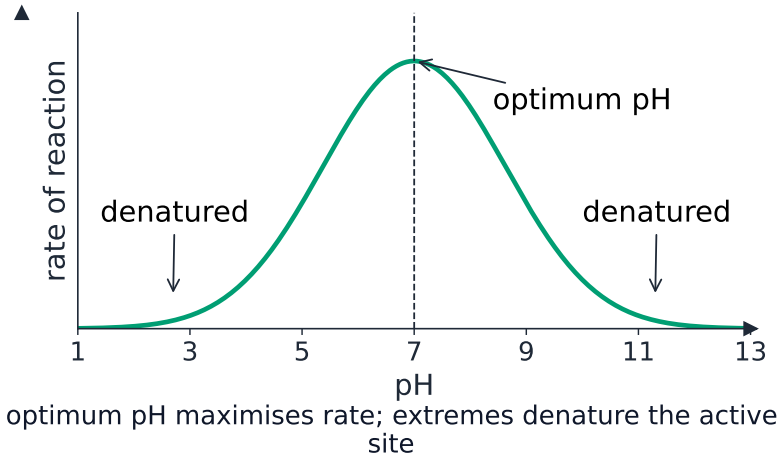
optimum $\sim 37^{\circ}\text{C}$ for many human enzymes · higher T denatures the active site

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

The effect of pH

Each enzyme has one **optimum pH**. Too far from it changes the active site's shape, so the substrate no longer fits – denatured again.

The effect of pH, in detail



Each enzyme has one optimum pH; far from it the enzyme is denatured

What enzymes are, continued



Biological washing powders contain enzymes that break down stains.

What an enzyme actually is

enzymes

biological **catalysts** – catalysts made by living cells

what they are made of

they are **proteins**, which is why heat and pH change their shape

what they do

take part in every reaction of **metabolism** and **speed it up** without being used up

why vital

without them the reactions that keep you alive would be **far too slow** to sustain an organism

how they are investigated

measure how fast the **chemical reaction** goes at different temperatures or pH values

“Made by living cells” is the phrase that distinguishes a biological catalyst from any other, and it is the marked half of the definition.

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.



Worked example – enzymes and temperature

Explain the shape of a graph of enzyme activity against temperature.

- Below the optimum: heating gives molecules more **kinetic energy** .
- More successful collisions with the **active site** $\Rightarrow$ rate rises.
- At the **optimum** ($\approx 37^{\circ}\text{C}$ in humans) the rate is highest.
- Above it, the bonds holding the enzyme's shape break: it is **denatured** .
- The active site no longer fits the substrate $\Rightarrow$ **rate falls to zero**.

Never say the enzyme is “killed” – it is not alive. Say **denatured**: the **active site changes shape** so the substrate no longer fits.

Worked example – turning a time into a rate

A reaction finishes in 50 s at 20 °C and in 20 s at 37 °C. Which is faster, and by how much?

- A **shorter** time means a **faster** rate, so turn each time into a rate.
- $\text{rate} = 1000 \div \text{time}$. At 20 °C:
 $1000 \div 50 = 20$ units.
- At 37 °C: $1000 \div 20 = 50$ units.
- $50 \div 20 = 2.5$, so 37 °C is **2.5 times faster**.

Never write that the rate “went up by 30 s” – a time is **not** a rate. Convert first, and remember the bigger rate always goes with the smaller time.

Topic 5 – key takeaways

1

Enzymes

protein catalysts; not used up

2

Lock & key

substrate fits the complementary active site

3

Specific

one enzyme, one substrate shape

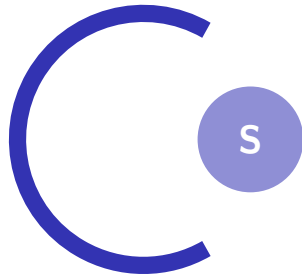
4

Denaturing

too hot or wrong pH wrecks the shape

Check yourself

- 1 What type of molecule is an enzyme?
- 2 What is the pocket the substrate fits called?
- 3 What is the optimum temperature for a human enzyme?
- 4 What happens to an enzyme above its optimum?



Answers 1. a protein 2. the active site 3. about 37°C 4. it is denatured (loses its shape)