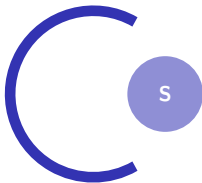


Enzymes

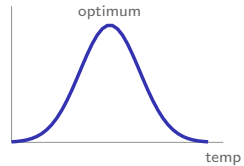
IGCSE Biology ■ Topic 5

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

1

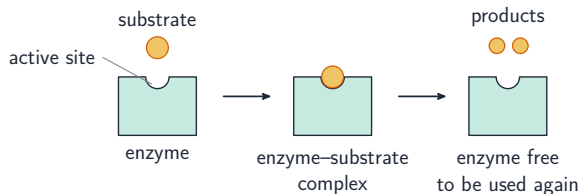
Enzyme action

What enzymes are



- The shape of the active site is **complementary** 互补 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** 酶底物复合物.
- The reaction takes place, and the substrate is changed into one or more **products** 产物.
- The products leave the active site, which is then free to be

How an enzyme works



The **substrate** 底物 fits the **active site** 活性位点 like a key in a lock.

- shapes are **complementary** 互补
- it forms an **enzyme-substrate complex** 酶底物复合物
- **products** 产物 leave; the enzyme is reused

Why enzymes are specific



right substrate
fits



wrong substrate
does not fit

Each enzyme is **specific** 专一 – it works on only **one** substrate. Only the right-shaped substrate fits the active site; the wrong key will not fit.

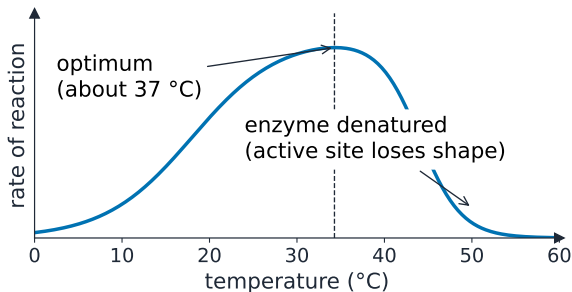
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Conditions

The effect of temperature

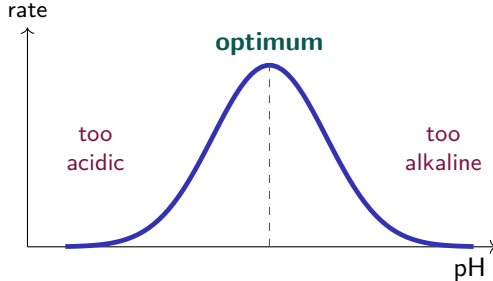
Activity peaks at the **optimum temperature** 最适温度 ($\sim 37^{\circ}\text{C}$).

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



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

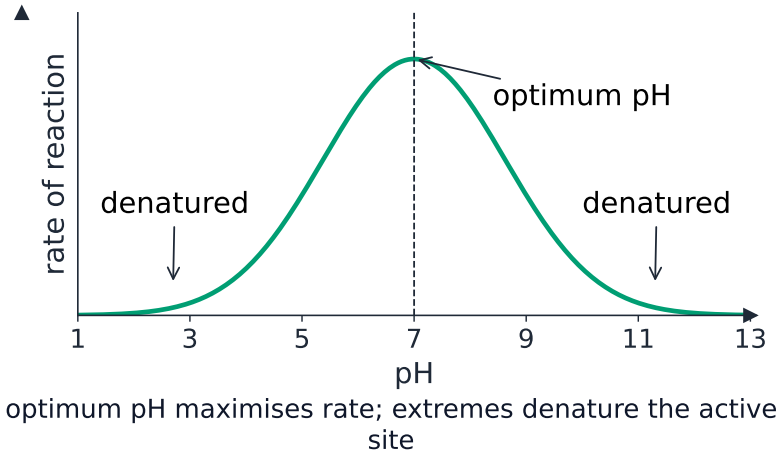
The effect of pH



Optimum pH 最适 pH the pH at which an enzyme works **fastest**; each enzyme has one.

Too far either side changes the **active site's shape**: the substrate no longer fits – **denatured**.

The effect of pH, in detail



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

Enzymes in washing powder



Biological washing powders contain enzymes that break down stains.

What an enzyme actually is

enzymes 酶	biological catalysts 催化剂 – catalysts made by living cells
what they are made of	they are proteins 蛋白质, which is why heat and pH change their shape
what they do	take part in every reaction of metabolism 新陈代谢 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 化学反应 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.

3

Recap

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** 动能.
- 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** 变性.
- 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

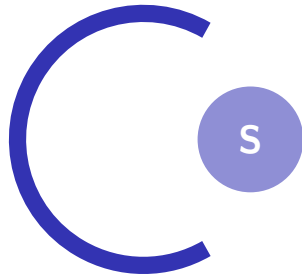
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Denaturing

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)