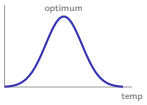
Enzymes

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



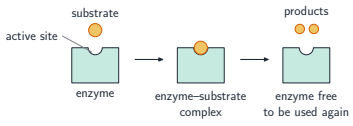
temperature and pH

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.

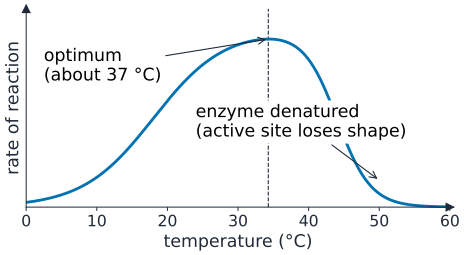
2 Conditions

The effect of temperature

Activity peaks at the **optimum temperature** 最适温度 (∼37°C).

> Too hot → the active site loses shape: the enzyme is **denatured** 变性 (permanent – not "killed").

The effect of temperature, in detail



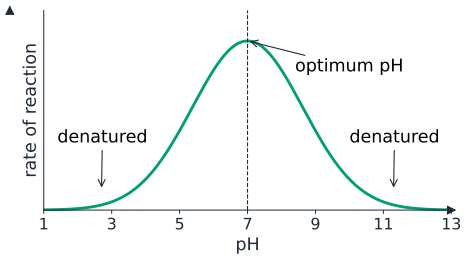
optimum ∼37 °C for many human enzymes · higher T denatures the active site

> Activity peaks at the **optimum temperature** 最适温度 (∼37°C).

The effect of pH

Each enzyme has one **optimum pH** 最适 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



optimum pH maximises rate; extremes denature the active site

> 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 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 ⇒ rate rises.
- At the optimum (≈ 37°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 ⇒ rate falls to zero.

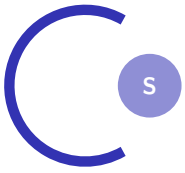
Never say the enzyme is "killed" – it is not alive. Say denatured: the active site changes shape so the substrate no longer fits.

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)