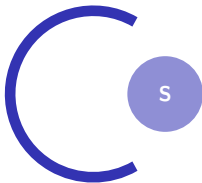


Enzymes

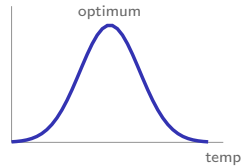
IGCSE Biology ■ Topic 5

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

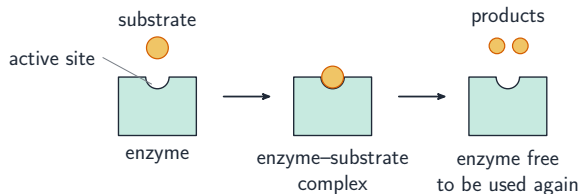
Enzyme action

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

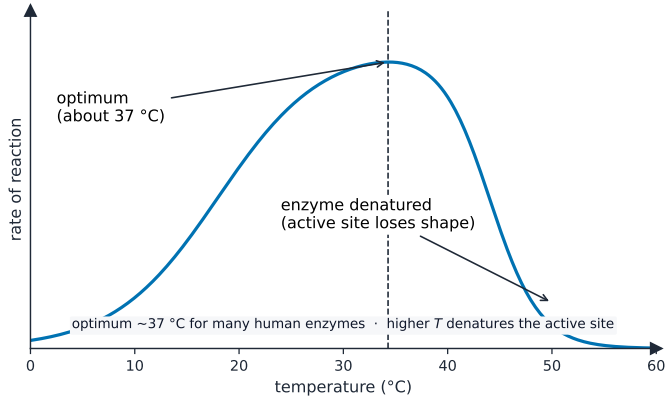
Conditions

The effect of temperature

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

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

The effect of temperature, in detail

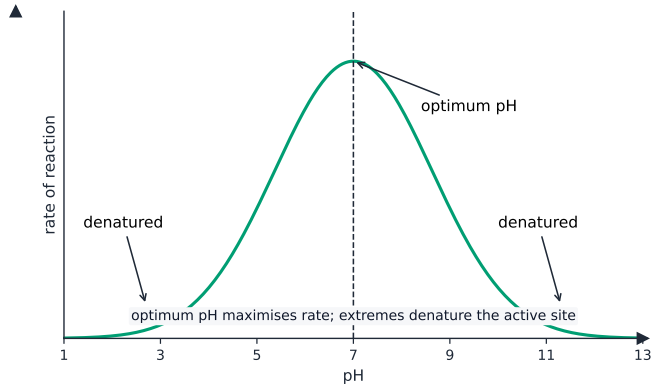


Activity peaks at the **optimum temperature** 最适温度 ($\sim 37^{\circ}\text{C}$).

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



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** $\Rightarrow$ 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.

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

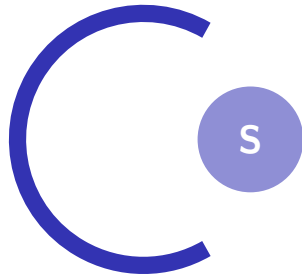
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Denaturing

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)