

Enzymes

A-Level Biology ■ Topic 3

A-Level Biology



Enzymes

What we will cover

- 1 How enzymes work
- 2 Activation energy
- 3 Measuring the rate
- 4 Temperature & pH
- 5 $V_{\max}$ & K_m
- 6 Inhibitors & immobilisation



enzymes catalyse reactions

1

How enzymes work

How enzymes work

The **active site** 活性位点 is complementary to the **substrate** 底物.

lock and key

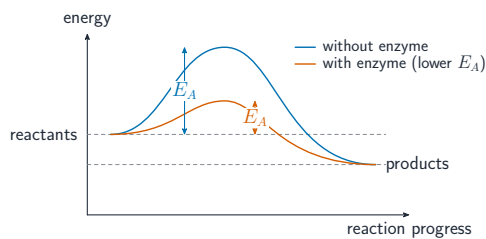
the site is a rigid match
for one substrate

induced fit

the site moulds around
the substrate as it binds

Both form an enzyme-substrate complex that lowers activation energy. Induced fit is the better model.

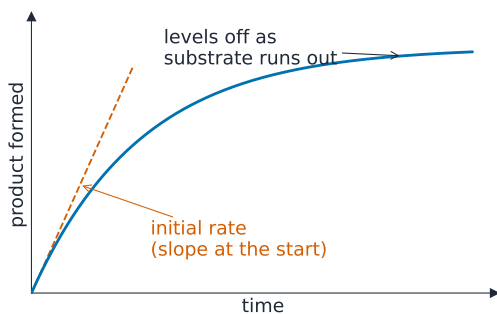
Lowering activation energy



Every reaction needs an **activation energy** 活化能 to start.

An enzyme **lowers** it, so the reaction runs fast at the cell's normal temperature – no high heat needed.

Measuring the rate



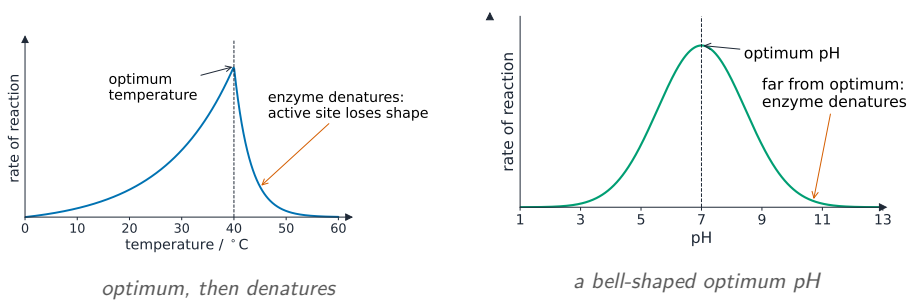
Follow product made or substrate used (a **colorimeter** 比色计 makes it exact).

Product builds fastest at the start, so the **initial rate** 初速率 (slope at time zero) is the fairest value to compare.

2 Factors

Enzymes
└ Factors

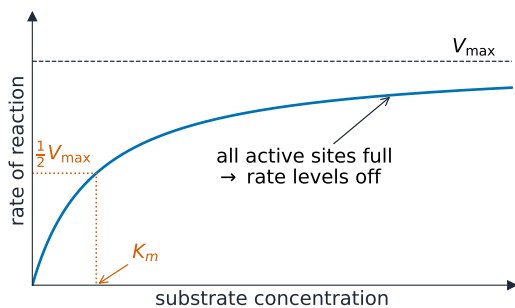
Temperature and pH



Past the **optimum** 最适温度, heat or wrong pH **denatures** 变性 the enzyme – the active site changes and no longer fits.

Enzymes
└ Factors

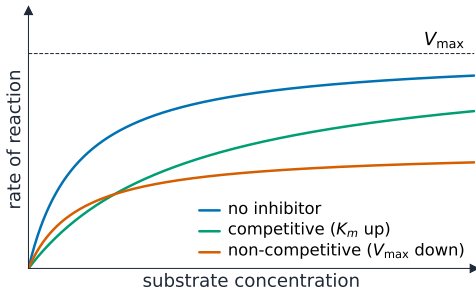
$V_{\max}$ and the Michaelis–Menten constant



Rate climbs to $V_{\max}$ once all active sites are full.

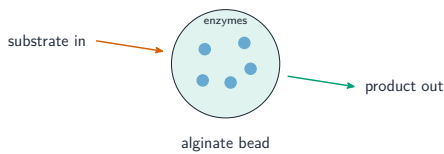
K_m (**Michaelis–Menten constant** 米氏常数) is the substrate concentration giving half $V_{\max}$ – a **low** K_m means high **affinity** 亲和力.

Reversible inhibitors



- **competitive** 竞争性抑制剂 – binds the active site; more substrate overcomes it ($K_m \uparrow$, V_{max} same)
- **non-competitive** 非竞争性抑制剂 – binds elsewhere; substrate can't help ($V_{max} \downarrow$, K_m same)

Immobilised enzymes



An **immobilised enzyme** 固定化酶 is fixed in beads while substrate flows past.

- not washed away – reused
- pure product; more stable; runs continuously

Used in **biological washing powders** 生物洗衣粉.

3

Recap

Worked example – estimating a rate

In the first 20 s of a catalase reaction, 16 cm³ of oxygen is collected. Estimate the rate.

- Rate = $\frac{\text{volume of product}}{\text{time}} = \frac{16}{20} = 0.8 \text{ cm}^3 \text{ s}^{-1}$
- This is the **average** over the first 20 s.
- The true **initial** rate is higher: the curve is steepest at $t = 0$ and flattens as substrate runs out.
- For an initial rate, draw a **tangent at the origin** and take its gradient.

Use the **initial** rate to compare conditions – at $t = 0$ substrate is not yet limiting, so the difference you see is the variable you changed.

Topic 3 – key takeaways

1 Active site

substrate fits; induced fit gives specificity

2 Activation energy

enzymes lower it to speed reactions

3 Factors

optimum temp & pH; denatures past them

4 Inhibitors

competitive raises K_m ; non-comp. lowers V_{max}

Check yourself

- Which hypothesis says the active site moulds round the substrate?
- What does an enzyme do to activation energy?
- Above the optimum temperature, what happens to the enzyme?
- A competitive inhibitor changes which constant?



Answers 1. induced fit 2. lowers it 3. it denatures 4. raises K_m (V_{max} unchanged)