

3.1 Mode of action of enzymes

Name: _____ Class: _____ Date: _____

Total: 14 marks

KEY WORDS enzyme 酶 • substrate 底物 • colorimeter 比色计
 • induced-fit hypothesis 诱导契合学说 • active site 活性位点

Objective

Build the skills to answer exam questions on the **mode of action of enzymes** — the **active site** 活性位点, the **enzyme–substrate complex** 酶底物复合物, lowering of **activation energy** 活化能, **specificity** 专一性, and measuring reaction rate.

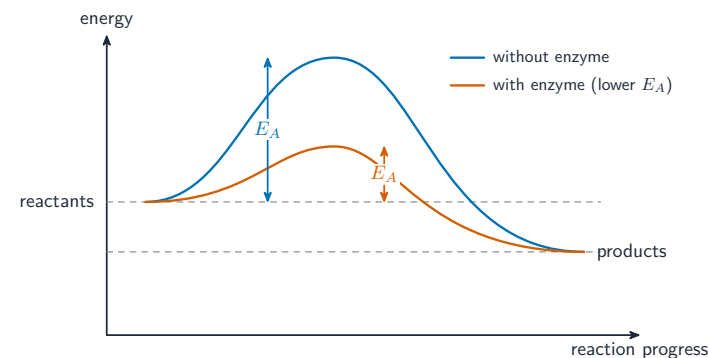
You must be able to:

- explain how an enzyme works using active site, enzyme–substrate complex and lowering of activation energy
- compare the lock-and-key and induced-fit hypotheses
- describe how to follow a reaction (catalase, amylase, colorimeter) and calculate an initial rate

1 Worked examples

■ How enzymes lower activation energy

Every reaction needs a “push” of energy to start — the **activation energy** (E_A). An enzyme provides a route with a **lower** E_A , so the reaction goes quickly at the cell's normal temperature.

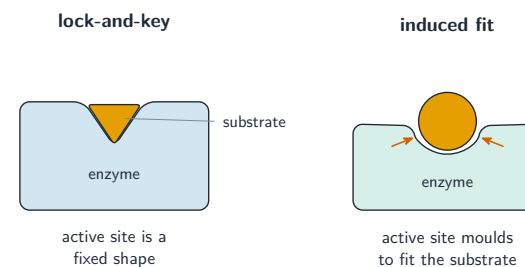


The enzyme route has a lower E_A , so more molecules have enough energy to react

The **substrate** 底物 binds in the active site to form an **enzyme–substrate complex**; the reaction happens, the **products** 产物 leave, and the active site is free again.

■ Specificity: lock-and-key vs induced fit

An enzyme is **specific** — its active site is **complementary** 互补 to only one substrate.

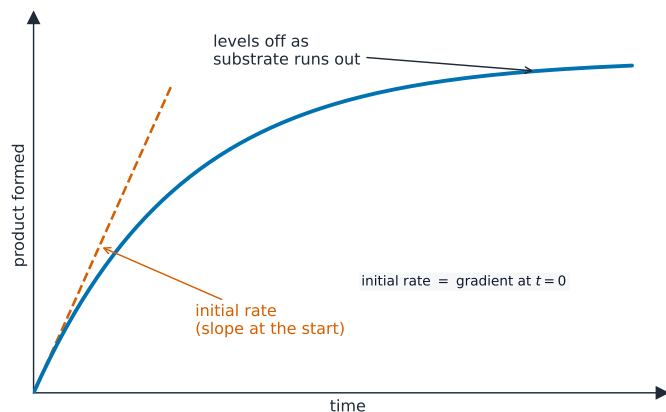


Lock-and-key: a fixed active site. Induced fit: the active site changes shape to grip the substrate

The **induced-fit** hypothesis fits the evidence better: the active site changes shape slightly as the substrate binds.

■ Measuring rate — the initial rate

Follow product made (e.g. O_2 from **catalase** 过氧化氢酶) or substrate lost (e.g. starch with **amylase** 淀粉酶, using the iodine test or a **colorimeter** 比色计). The reaction is fastest at the start, so the **initial rate** (slope of the tangent at time zero) is the fairest value to compare.



Product builds fastest at the start; the initial rate is the slope of the tangent at time zero

2 Practice

2.1 Put these steps of enzyme action in order: products leave · substrate enters the active site · enzyme-substrate complex forms · reaction occurs. [2]

2.2 State **one** reason the induced-fit hypothesis is preferred to the lock-and-key hypothesis. [1]

3 Exam-style questions

3.1 An enzyme lowers the activation energy of a reaction. This means that: [1]

- ☐ A more product is made overall
☐ B the reaction releases more energy
☐ C the reaction can proceed faster at a given temperature
☐ D the enzyme is used up in the reaction

3.2 Why does one type of enzyme catalyse only one reaction? [1]

- ☐ A there is only one enzyme in each cell
☐ B the active site is complementary to only one substrate
☐ C enzymes are used up after one reaction
☐ D the substrate lowers the activation energy

3.3 Catalase breaks down hydrogen peroxide into water and oxygen. A student collects the oxygen given off.

time / s	0	30	60	90
volume of O ₂ / cm ³	0	12	18	20

(a) Calculate the mean rate of oxygen production during the first 30 s. Give the unit. [2]

(b) The rate between 60 s and 90 s is lower than during the first 30 s. Explain why. [2]

(c) Explain why the **initial rate** is the fairest measurement to use when comparing reactions. [2]

3.4 Describe how a colorimeter could be used to follow the breakdown of starch by amylase. [3]
