

3.2 Factors that affect enzyme action

Name: _____ Class: _____ Date: _____

Total: 17 marks

KEY WORDS michaelis–menten constant • competitive • inhibitor
• competitive inhibitor • non-competitive

Objective

Build the skills to answer exam questions on the **factors that affect enzyme action** – temperature, pH, enzyme and substrate concentration, **inhibitors**, the **Michaelis–Menten constant**, and **immobilised enzymes**.

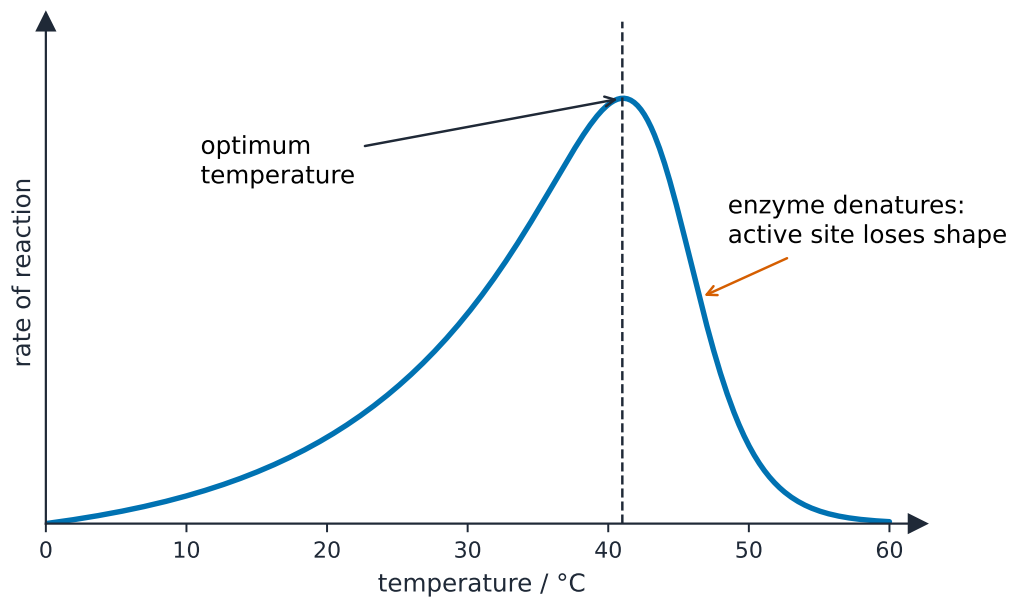
You must be able to:

- explain the effect of temperature, pH, enzyme concentration and substrate concentration on rate
- explain $V_{\max}$ and K_m and use K_m to compare affinity
- explain competitive and non-competitive inhibition, and state the advantages of immobilised enzymes

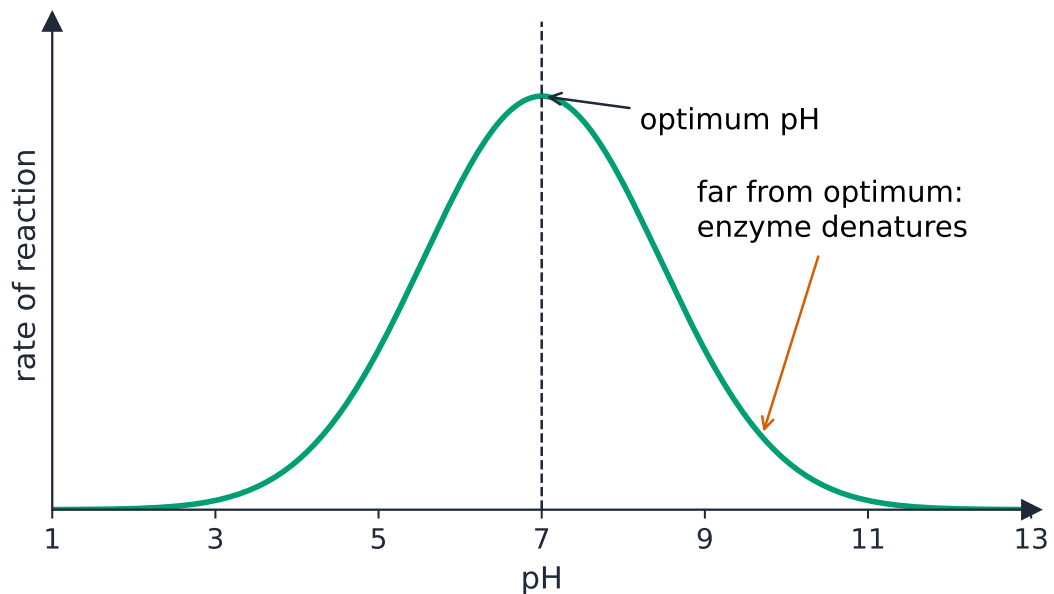
1 Key knowledge and worked examples

■ Temperature and pH

Rate rises with temperature (more **kinetic energy**, more collisions) up to the **optimum**; above it the enzyme **denatures** – bonds holding its shape break, the active site changes, and rate falls fast. Each enzyme also has an optimum pH; far from it the enzyme denatures.



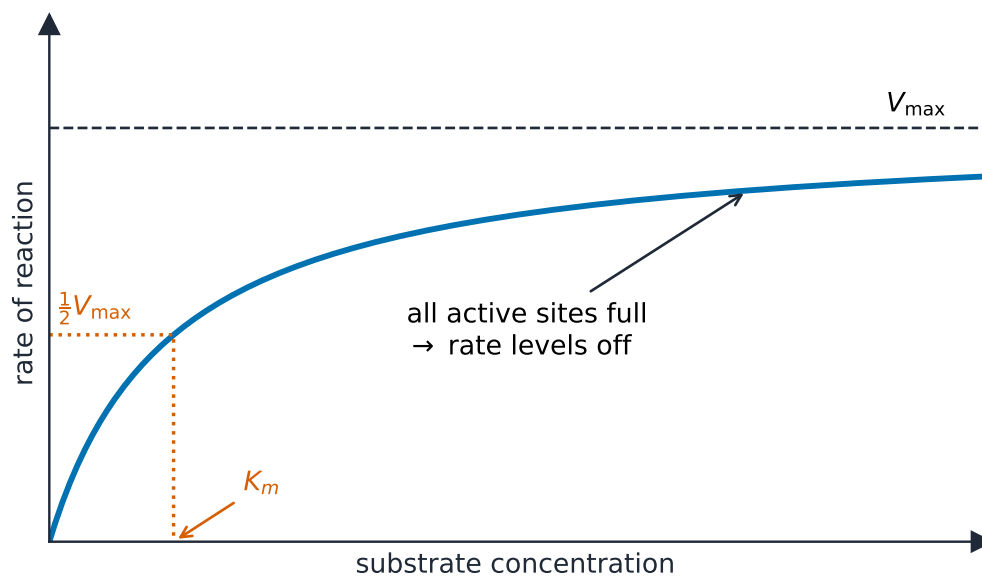
Rate rises to the optimum, then falls fast as the enzyme denatures



The rate peaks at the optimum pH and falls away on either side

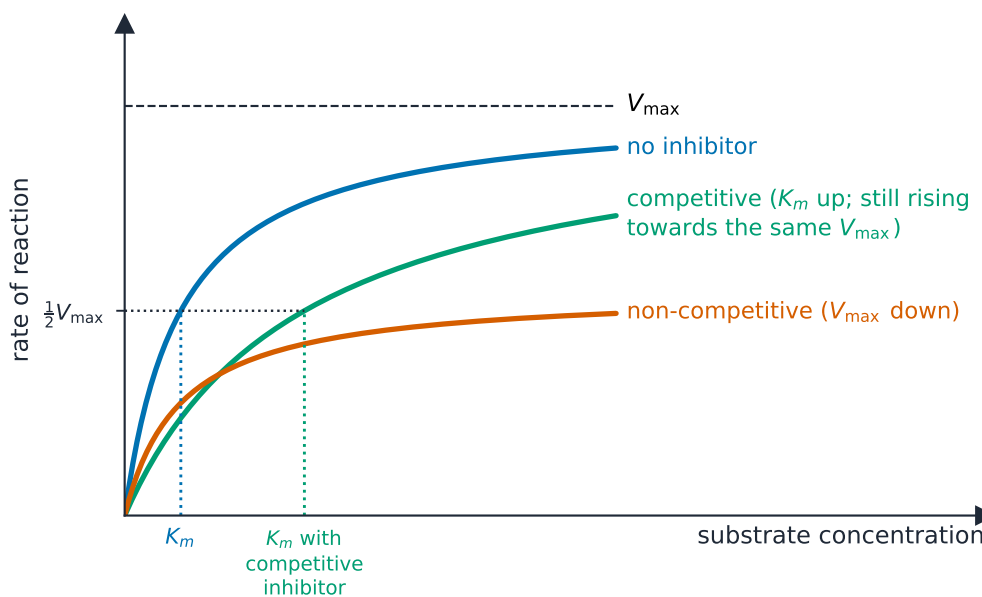
■ Substrate concentration, $V_{\max}$ and K_m

Adding substrate speeds the reaction until every active site is busy; then rate levels off at the maximum, $V_{\max}$. The **Michaelis–Menten constant** K_m is the substrate concentration that gives **half** of $V_{\max}$. A **low** K_m = **high affinity** (reaches half-speed at low substrate).



K_m is the substrate concentration giving half $V_{\max}$ – a lower K_m means higher affinity

■ Reversible inhibitors

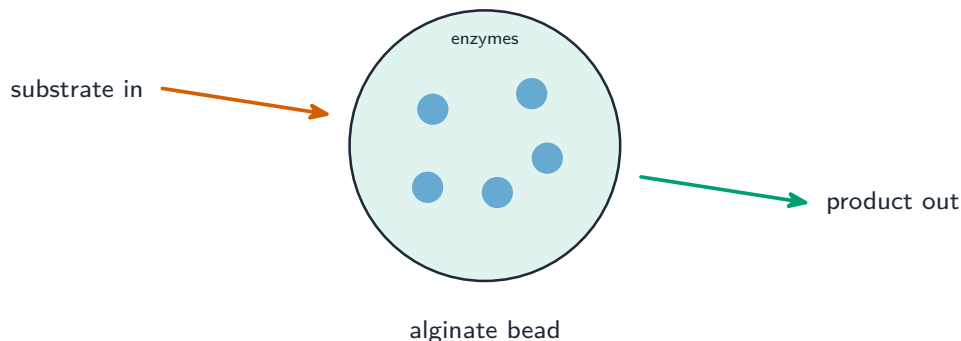


Competitive inhibition raises K_m (more substrate overcomes it); non-competitive lowers $V_{\max}$

- **competitive** : binds the active site (similar shape to substrate); more substrate overcomes it → $V_{\max}$ unchanged, K_m rises.
- **non-competitive** : binds elsewhere, changing the active site; more substrate does not help → $V_{\max}$ falls.

■ Immobilised enzymes

An **immobilised enzyme** is fixed in place (e.g. trapped in **alginate** beads).



Enzymes stay trapped while substrate flows in and product out – so they are not washed away

Advantages: re-used many times; pure product; more stable to temperature/pH; can run continuously.

2 Practice

2.1 Explain why the rate of an enzyme reaction falls above the optimum temperature. [3]

2.2 State **two** advantages of using an immobilised enzyme rather than a free one. [2]

3 Exam-style questions

3.1 A competitive inhibitor is added to an enzyme reaction. Compared with no inhibitor, what happens to $V_{\max}$ and K_m ? [1]

- ☐ A $V_{\max}$ unchanged; K_m increases
B $V_{\max}$ decreases; K_m unchanged
C both increase
D both decrease

3.2 Enzyme Y has a lower K_m than enzyme Z for the same substrate. This means that enzyme Y: [1]

- ☐ **A** has a higher affinity for the substrate
B has a higher V_{max}
C is denatured more easily
D works at a higher optimum pH

3.3 A student investigates how temperature affects the rate at which catalase breaks down hydrogen peroxide. She measures the volume of oxygen produced in the first minute at five temperatures.

(a) State **two** variables she must control to make this a fair test. [2]

(b) Describe and explain the results she would expect between 10 °C and 60 °C. [4]

(c) Explain why a buffer solution would be used in a similar experiment that varied pH. [2]

3.4 The graph of rate against substrate concentration for an enzyme levels off at high substrate concentration. Explain why. [2]
