*This is the **Higher Combined** version — includes Higher Tier content. Some Separate-only details are omitted.*

Enzymes are biological catalysts — protein molecules that speed up chemical reactions in the body without being used up.

Required Practical: Investigating the effect of pH on amylase activity using starch-iodine method — timing how long it takes for starch to be fully digested at different pH values.

- Enzymes are specific: each has an active site with a specific shape that only fits one type of substrate (lock and key model).
- Substrate binds to active site → enzyme-substrate complex forms → products released → enzyme unchanged and reused.

★ **HT** Induced fit model: active site is NOT rigid — it changes shape slightly to accommodate the substrate more precisely.

- Effect of temperature: as temperature rises, rate increases (more kinetic energy, more collisions). At OPTIMUM temperature, rate is maximum. Above optimum, enzyme DENATURES — active site permanently changes shape. Cannot be reversed.
- Effect of pH: each enzyme has an optimum pH. Extreme pH denatures the enzyme. E.g. pepsin: optimum pH 2 (stomach). Amylase: optimum pH 7 (mouth).

★ **HT** Denaturation vs inhibition: denaturation is permanent (high temp/extreme pH breaks bonds holding protein shape). Inhibitors may be reversible or irreversible.

- Digestive enzymes: amylase → starch to sugars; protease → proteins to amino acids; lipase → fats to fatty acids + glycerol.

Key Terms

Enzyme	A biological catalyst — a protein that speeds up chemical reactions without being used up
Active site	The region of the enzyme where the substrate binds — has a specific complementary shape
Substrate	The molecule(s) an enzyme acts on — binds to the active site
Denaturation	Irreversible change in enzyme shape due to high temperature or extreme pH — active site destroyed
Optimum	The temperature or pH at which an enzyme works at its maximum rate
Induced fit model	The idea that the active site changes shape slightly to better fit the substrate when it binds

■ **Exam Tip:** Denaturation is PERMANENT — the enzyme cannot be "un-denatured" by cooling. At low temperatures the enzyme is just slow (not denatured). Many students confuse these. Remember: cold = slow; hot = denatured.