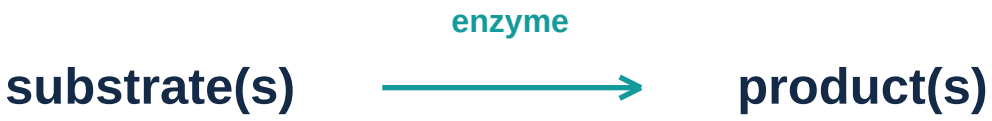
Speed up reactions, remain reusable

An enzyme is a biological catalyst: it increases reaction rate without being used up in the overall reaction. Enzymes allow the chemistry of life to proceed rapidly under suitable biological conditions.

THE ENZYME IS NOT A CONSUMED REACTANT



The substrate changes. The enzyme is regenerated.

A substrate is a reactant on which an enzyme acts. Products are formed by the reaction. Writing an enzyme above the arrow shows its catalytic role, rather than implying it is converted into the products.

1. GLOBULAR PROTEIN STRUCTURE

The enzymes studied here are globular proteins: amino acid chains fold into a compact three-dimensional shape. That folded structure creates an active site able to interact with suitable substrates.

2. REUSABLE DOES NOT MEAN INDESTRUCTIBLE

At the end of a normal catalytic cycle, the enzyme can act again. It may change temporarily during catalysis, but is not used up overall. Enzymes can still be damaged, denatured or broken down over time.

Scope note: most enzymes are proteins; catalytic RNA is an exception outside this lesson. Detailed active-site models and activation energy follow in Lesson 3.1.2.

Supporting reading: OpenStax Biology 2e, 6.5: Enzymes.

Scope: Cambridge Biology 9700 syllabus, section 3.1, outcome 1, p. 20.

Classify by where the enzyme acts

Both intracellular and extracellular enzymes are made by cells. The distinction is the location of the catalysed reaction, not whether the enzyme was originally produced in a cell.

THE PLASMA MEMBRANE IS THE KEY BOUNDARY



Simplified location diagram; the secretion machinery is not shown.

1. INTRACELLULAR: REACTIONS WITHIN CELLS

Examples include enzymes involved in respiration and DNA replication. Enzymes may act in the cytoplasm or inside organelles. A reaction inside a mitochondrion or lysosome is still inside the cell.

2. EXTRACELLULAR: SECRETED TO WORK OUTSIDE

Digestive enzymes released into saliva or the gut lumen catalyse reactions beyond the secreting cell's plasma membrane. The lumen is the space within the digestive tract, not the cytoplasm of its lining cells.

Outside a cell does not necessarily mean outside the body. Use the cell boundary, not the skin or body outline, to classify enzyme action.

Supporting reading: OpenStax Biology 2e, 6.5: Enzymes.

Scope: Cambridge Biology 9700 syllabus, section 3.1, outcome 1, p. 20.

Two examples, the same principle

Catalase and amylase act on different substrates and can work in different locations. Both illustrate catalysis: substrate is converted to product while the enzyme remains available for another cycle.

1. CATALASE IN A LIVER CELL: INTRACELLULAR

Hydrogen peroxide can form during cellular metabolism and can damage cell components. Catalase breaks it down into water and oxygen, helping protect the cell.

catalase

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

The coefficients balance the atoms. Catalase is written above the arrow: it is not one of the products and is not consumed by this overall reaction.

2. SALIVARY AMYLASE: EXTRACELLULAR

Salivary glands secrete amylase into the mouth. There, outside the gland cells, it begins hydrolysing starch into smaller carbohydrates, including maltose and short chains.

amylase

starch + water → smaller carbohydrates

Word summary, not a balanced molecular equation. Other digestive enzymes complete conversion to glucose for absorption. Amylase itself does not simply become glucose.

An enzyme is a molecule, not a living organism. It can catalyse reactions outside a living cell if substrates and suitable conditions are present.

Supporting reading: RCSB PDB-101: Alpha-amylase.
Supporting reading: RCSB PDB-101: Catalase.

Scope: Cambridge Biology 9700 syllabus, section 3.1, outcome 1, p. 20.