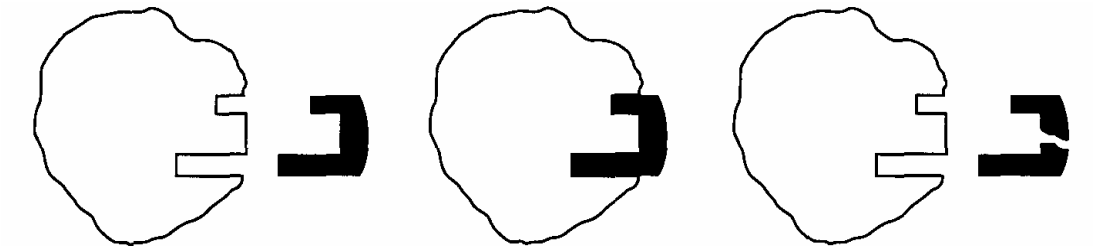
Enzymes — in action

Enzymes are **protein** molecules, made by living cells, which act as **catalysts** and speed up the rate of metabolic reactions, by lowering the **activation energy** required. In the absence of enzymes, the **anabolic** and **catabolic** reactions that make up **metabolism** would be far too slow to maintain life. The activation energy is the energy needed to increase the rate of the reaction; glucose has to be made more reactive before it will react with oxygen in respiration.

ACTION OF ENZYMES

Enzymes are large molecules. Each has its own special shape, with an area, the **active site,** on to which the substrate molecules bind, forming an **enzyme-substrate complex.** The reaction then takes place, an **enzyme-product complex** being formed. This splits, releasing the product and the enzyme, which is available to form another complex with another substrate molecule.
Enzyme molecules are **specific,** catalysing one, or one type of, reaction and it is suggested that this is due to the particular configuration of the active site into which the substrate molecules fit like a key, giving rise to the **lock and key hypothesis.** This hypothesis has been modified to the **induced fit hypothesis,** where it is thought that when a Substrate combines with an enzyme, it induces the enzyme structure to fit, moulding the amino acids of the active site into the right configuration in order to carry out the reaction.



Cofactors

Most enzymes need another non-protein **cofactor** to be present. A cofactor can be an **inorganic ion**, a **prosthetic group or a coenzyme.** Inorganic ions are known as enzyme **activators,** and a good example is shown by the increased activity of salivary amylase in the presence of chloride ions. A prosthetic group is an organic molecule, such as **haem** in the **erythrocytes,** which binds the oxygen. Coenzymes like **NAD** shuttle between one enzyme system and another - most such are formed from dietary components called vitamins (e.g. NAD is formed from a B-vitamin-complex).

Factors affecting enzyme activity

There are a great many factors which affect the activity of enzymes.

- They are **denatured by high temperatures** and extremes of **pH,** both of which alter the structure of the active site, preventing the substrate from binding with the enzyme.
- The presence of **inhibitors** can also have an effect on enzyme reactions, causing them to slow down or stop altogether. Inhibitors may be:
  - **competitive,** where the inhibitor molecule has a similar shape to the normal substrate molecule and competes for the active site of the enzyme; or
  - **non-competitive,** where the inhibitor molecule can either block the active site or cause an alteration in the shape of the enzyme molecule by attaching at some other site (e.g. it may attach to prosthetic group).
- Most enzymes can work in either direction and as metabolic reactions are **reversible,** the direction in which the reaction proceeds depends on the relative concentrations of substrate and product.
- In some metabolic pathways, the end-product of the pathway may act as an inhibitor. This is known as **end-product inhibition**, and it is an example of a **negative feedback mechanism,** preventing the unnecessary accumulation of a metabolite. A good example is shown in aerobic respiration, where the accumulation of ATP inhibits one of the respiratory enzymes in the pathway. In this way the further production of ATP is under control.

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