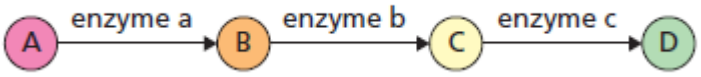
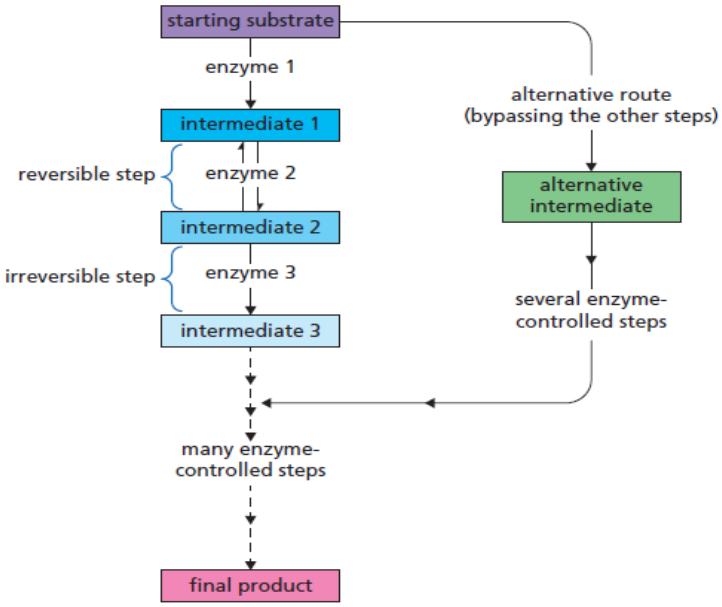
Unit 2 Metabolism & Survival

Key Area 1: Metabolic Pathways

Metabolic Pathways are integrated and controlled pathways of **enzyme-catalysed** reactions within a cell.



Metabolic Pathways can have **reversible steps**, **irreversible steps** and **alternative routes**.

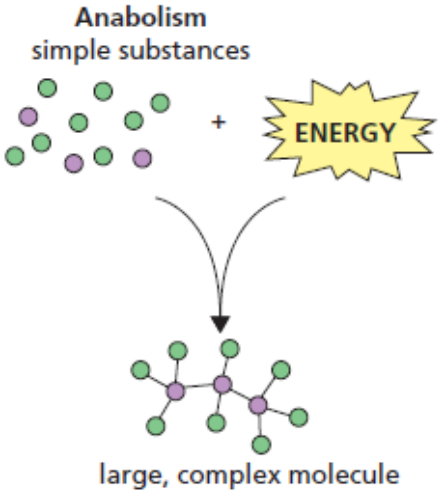


Catabolic and Anabolic Reactions

Reactions within metabolic pathways can be anabolic or catabolic.

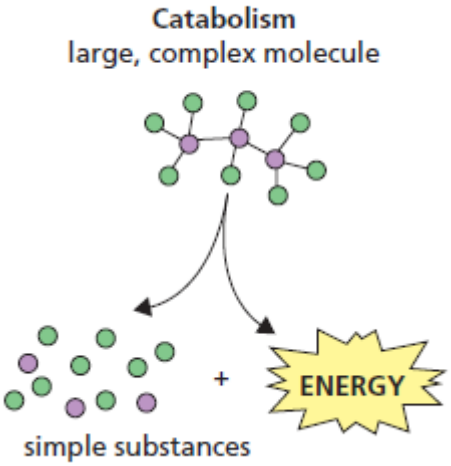
Anabolic Reactions

Anabolism **build up large molecules from small molecules and require energy**.



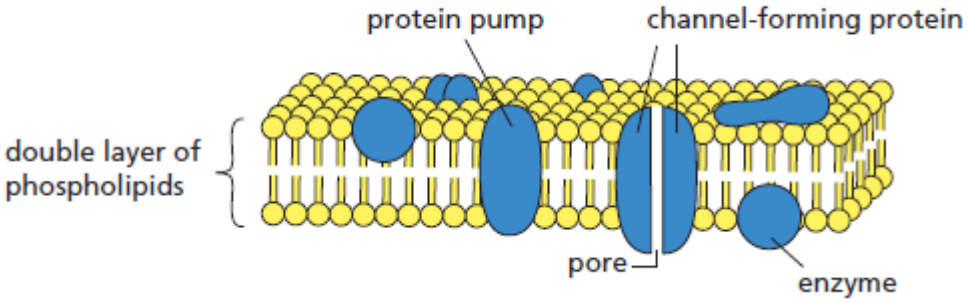
Catabolic Reactions

Catabolic reactions **break down large molecules into smaller molecules and release energy**.



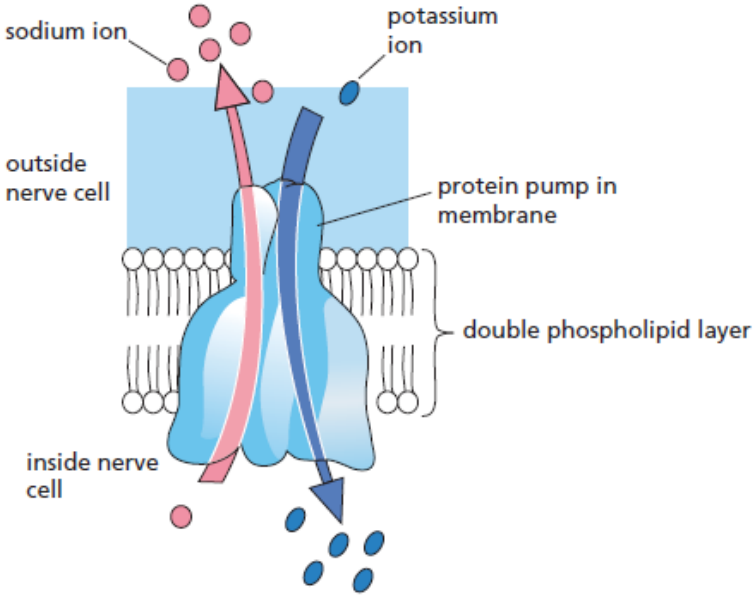
Protein pores, pumps and enzymes are embedded in membranes.

Membranes consist of proteins and phospholipids. The phospholipids create a bilayer and are constantly moving. This gives the membrane flexibility.



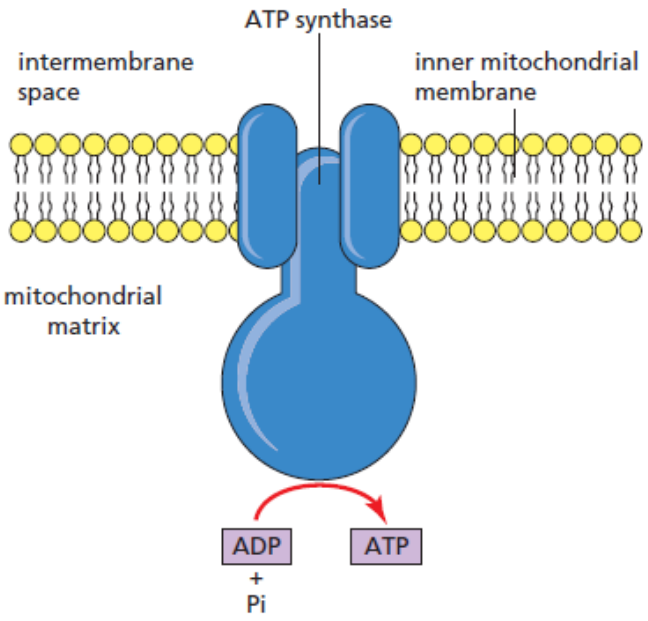
Channel-forming proteins create **pores** which control the **diffusion** of small molecules across the cell. Diffusion= movement of molecules from an area of high concentration to an area of low concentration.

Active transport = movement of molecules from an area of low concentration to an area of high concentration and requires energy in the form of ATP. This ATP is generated during aerobic respiration.



The Sodium-Potassium pump is an example of a carrier protein involved in active transport. Details of this is not required.

Some of the proteins embedded in the membranes of mitochondria and chloroplasts act as **enzymes**. ATP Synthase is an example of an membrane embedded enzyme which produces ATP from ADP + Pi.



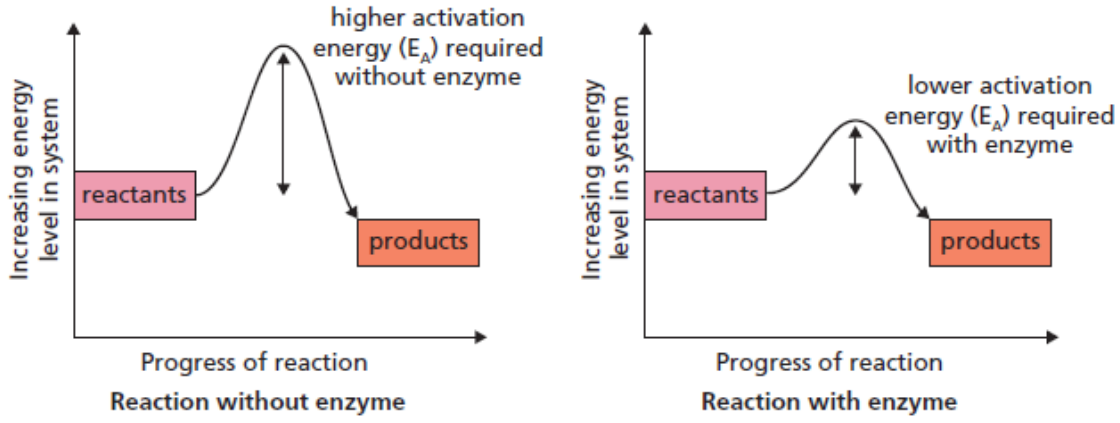
Role of Enzymes in Metabolic Pathways

Metabolic pathways are controlled by the presence or absence of particular enzymes and the regulation of the rate of reaction of key enzymes.

Activation Energy

The energy required to initiate a chemical reaction is known as the activation energy.

Enzymes **lower the activation energy** required for a reaction to take place.



Affinity

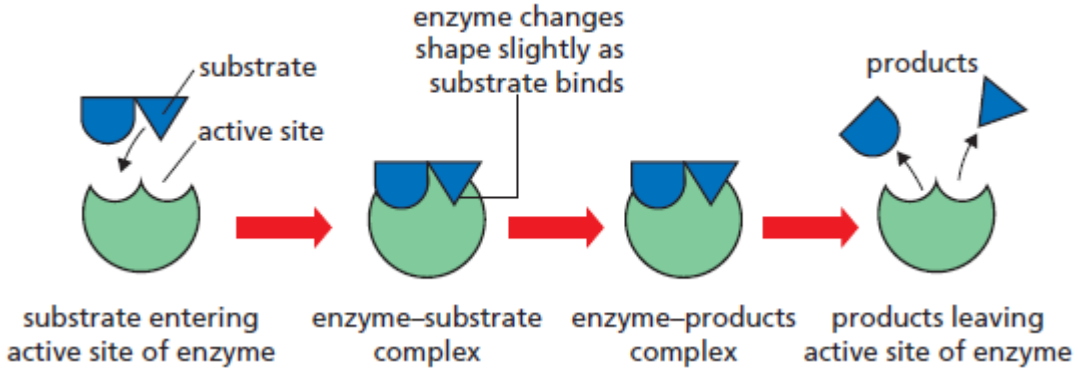
The activity of enzymes depends on their flexible and dynamic shape.

Substrate molecules have **high affinity** for the **active site** of an enzyme (bind readily).

Products of enzyme reactions have a **low affinity** for the **active site** of an enzyme, allowing them to leave the active.

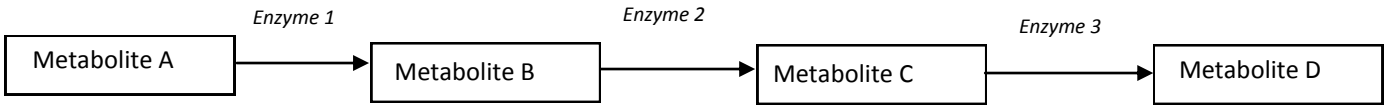
Induced Fit

The enzyme is flexible and the **substrate can induce the active site to change shape** to **better fit the substrate** after the substrate binds. This is known as **INDUCED FIT**.



Direction of enzyme-controlled reactions

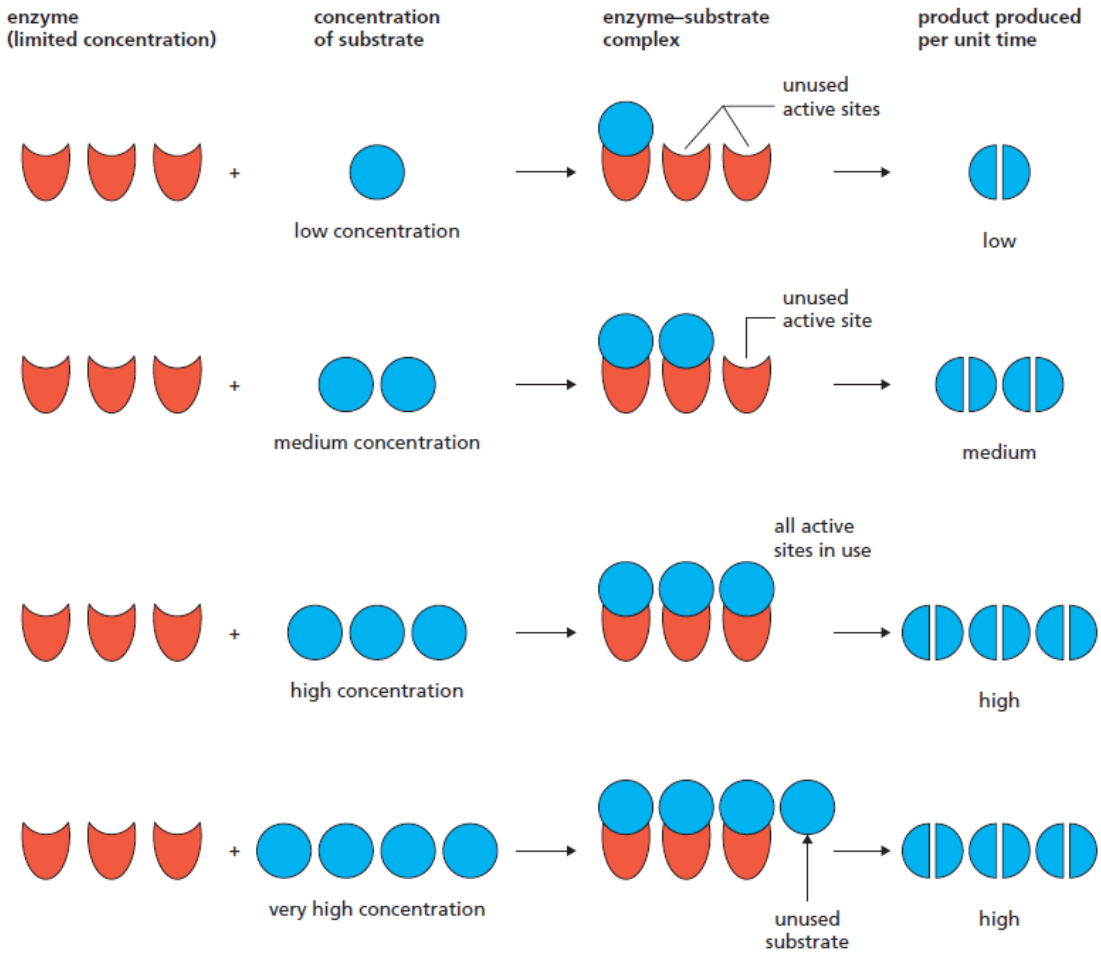
Some metabolic reactions are **reversible** and the presence of a substrate or the removal of a product will drive a sequence of reactions in a particular direction.



In the above example, the presence of Metabolite A activates Enzyme 1 and metabolite A is then converted to metabolite B. An increase in metabolite B then activates enzyme 2 and metabolite B is converted to metabolite C etc. Most enzymes can also work in reverse. If, for example, Metabolite C levels were to increase to an unusually high level whilst Metabolite B levels were low, enzyme 2 would work in reverse to convert Metabolite C back into Metabolite B.

Effect od Substrate and Enzyme Concentration

As the concentration of Substrate or Enzyme increases, the rate of an enzyme-controlled reation increases since more active sites will be occupied by substrate and therefore more enzyme-substrate complexes will be formed. If however**, either enzyme or substrate concentration is limited, the rate reaction will only increase up to a point**. Beyond this point, the rate of reaction remains **Constant** because either active sites will remain unoccupied (if substrate concentration is limited) or substrate molecules will have no active sites to occupy (if enzyme concentration is limited).



Enzyme Inhibition

An Inhibitor is a substance which reduces the rate of an enzyme controlled reaction.

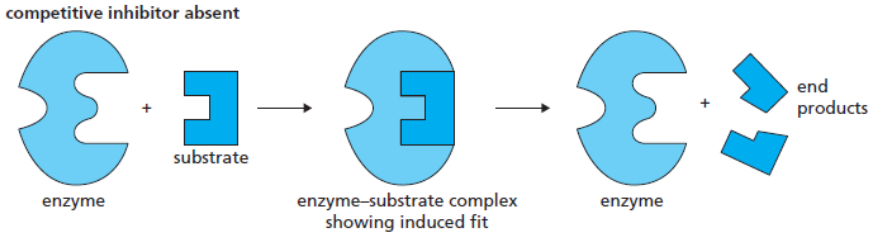
There are 2 main types of inhibitor :

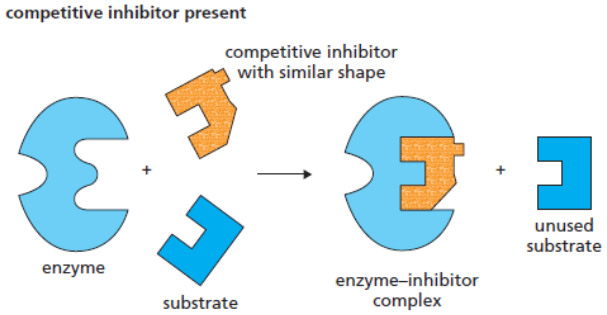
- Competitive
- Non-competitive

Competitive Inhibitors

Competitive inhibitors **bind at the active site** of the enzyme, **preventing the substrate from binding**.

Competitive inhibition **can be reversed** by **increasing substrate concentration**.

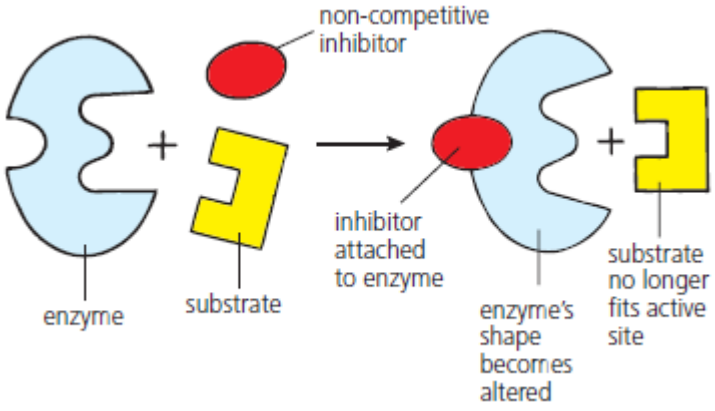




Non-competitive Inhibitors

Non-competitive inhibitors **bind away from the active site** (at an **allosteric site**) but **change the shape of the active site**, **preventing the substrate from binding**.

Non-competitive inhibition **cannot be reversed** by increasing substrate concentration.



Feedback Inhibition

Feed back inhibition occurs when the **end-product** in the metabolic pathway reaches a **critical concentration**.

The end-product then **inhibits an earlier enzyme**, blocking the pathway and so **prevents further synthesis of the end-product**.