General Features of Metabolic Pathways

A ⇒ B ⇒ C ⇒ D ⇒ E

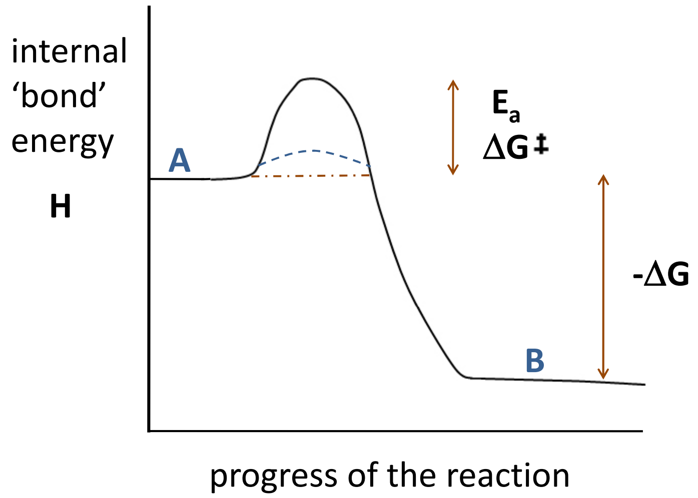
enzyme 1 enzyme 2 enzyme 3 enzyme 4

Endergonic/exergonic reactions

The **rate** of a biochemical reaction is dependent on enzyme activity

The **direction** of a reaction is dependent on the properties of the chemical molecules themselves

Endergonic/exergonic reactions



Reversible & Irreversible Steps in a Metabolic Pathway

$$A \xrightarrow{\text{enzyme 1}} B \underset{\text{enzyme 2}}{\rightleftharpoons} C \underset{\text{enzyme 3}}{\rightleftharpoons} D \xrightarrow{\text{enzyme 4}} E$$

The rate of an enzyme reaction can be regulated in several ways:

1. by altering the availability of the substrate, (e.g. by increasing the transport system into the cell)
2. by increasing the **amount** of enzyme present in the cell, by increasing the rate of transcription from the gene in DNA into mRNA)

'up regulation' or 'induction'

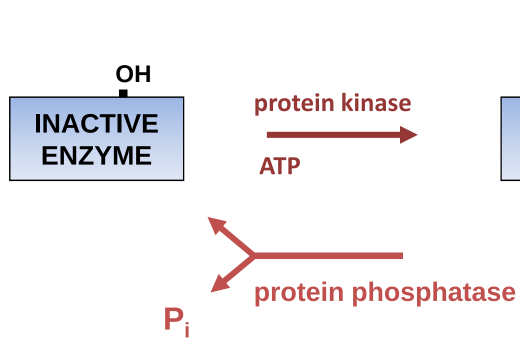
'down regulation' or 'repression'

Regulation Mechanisms for Enzymes already present in the Cell

3. Interconversion of 'active' & 'inactive' forms of key enzymes

INACTIVE ⇄ ACTIVE

Interconversion of Active & Inactive Forms of the Enzyme by Covalent Modification



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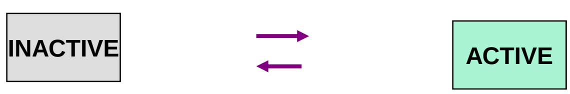
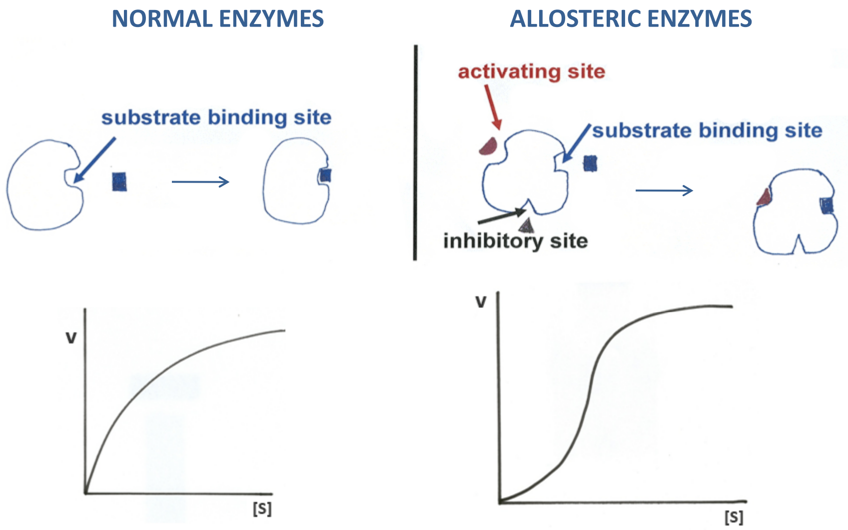


4. Allosteric regulation

Allosteric control mechanisms



Metabolic reactions require:

Fuel molecules
(substrates / Intermediates)
+
Enzyme catalysts
+
Cofactors

Activating ions
Mg^{2+} Zn^{2+}
Cl^-

Coenzymes / prosthetic group

Examples of Enzyme Cofactors

$$ATP \longrightarrow ADP + P_i$$

ATP acts as a 'high energy' cofactor for kinase enzymes

ATP breakdown releases approx 31 kJ of energy per mole

General role of ATP

ATP acts as 'high energy' cofactor in the cell for driving mechanical events such as pumps, transporters, contractile events & movement

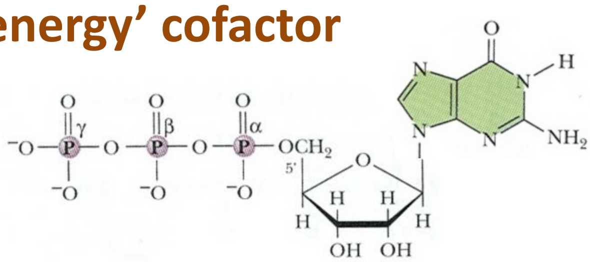
Other 'high energy' nucleotides

other 'high energy' nucleotide cofactors are used to drive specific biosynthetic reactions

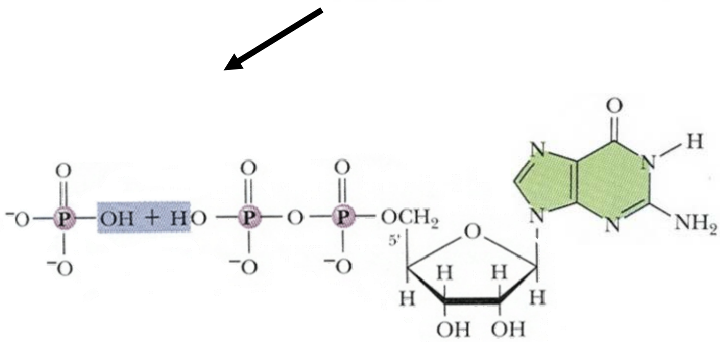
UTP drives the synthesis of complex sugars

GTP drives the synthesis of proteins

GTP as 'high energy' cofactor



GTP



P_i + GDP