1.4 ENZYMES

- Enzymes are proteins in tertiary or quaternary structure with complex conformations

- Enzymes act as catalysts
    - **Catalyst** = is a substance that speeds up a chemical reaction without being consumed in the process.

- The catalyst does not affect the overall free energy change of a reaction (ΔG)

- Catalysts can only speed up reactions that would normally take place anyway
    - It speeds up both the forward and reverse reactions equally
    - An enzyme does not affect the position of equilibrium, only the speed at which equilibrium is reached (it will be reached faster)

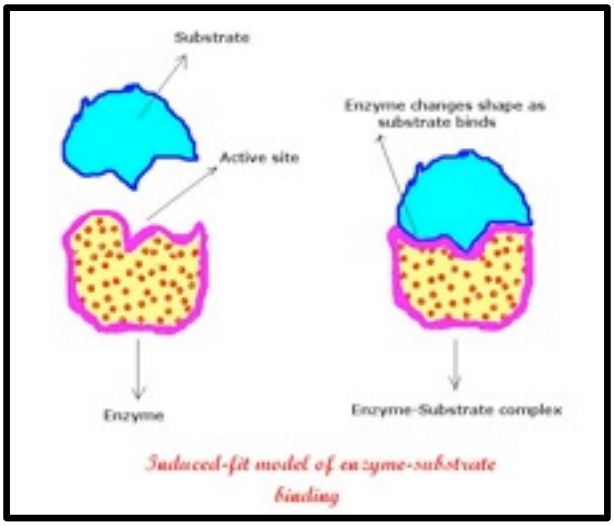
- **Substrate** = the reactant that an enzyme acts on when it catalyzes a reaction

    - the substrate binds to a specific site on the enzyme who which it is attracted – this is called the **ACTIVE SITE**

    - enzymes are VERY SPECIFIC for the substrate to which they bind (many will not bind isomers)

    - the substrate and the active site must possess compatible shapes for binding to occur

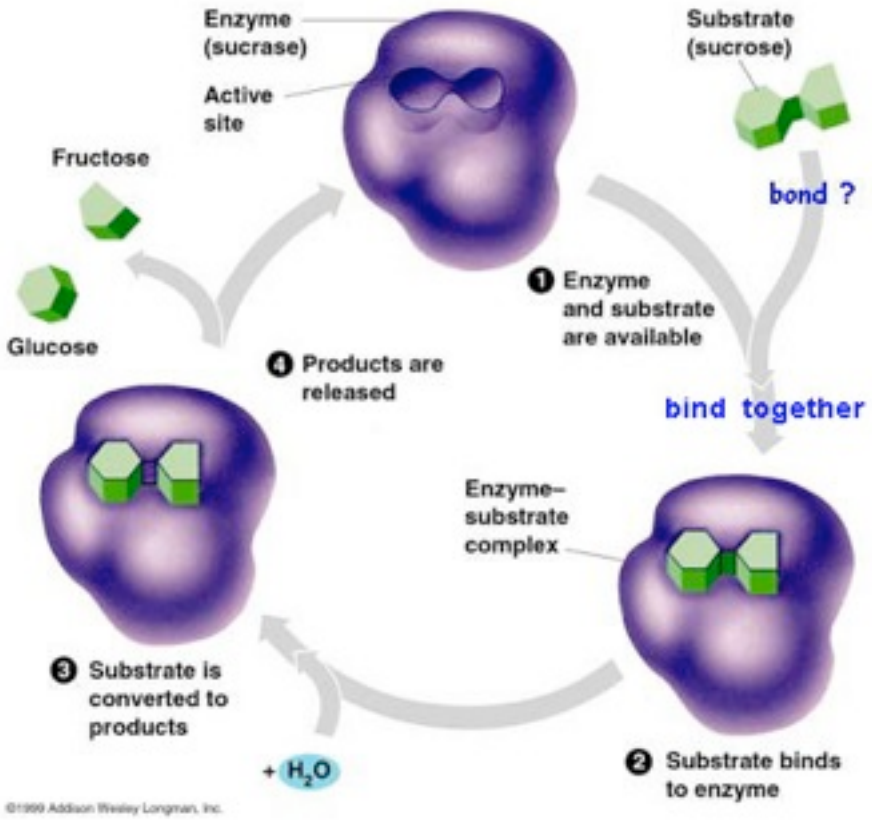
    - as the substrate enters the active site, its functional groups come close to the functional groups of amino acids in the enzyme – this causes the enzyme to change shape, thereby accommodating the substrate



This is called the **INDUCED-FIT MODEL** of enzyme-substrate interaction.

Example:

The enzyme **SUCRASE** catalyzes the hydrolysis of sucrose into two separate glucose and fructose molecules:



- Enzyme-catalyzed reactions can be saturated
    - Ie: there are a limited number of specific enzyme molecules in a cell at any one time
    - Increasing the substrate concentration with therefore only speed up the reaction to a certain point until all enzymes are saturated

- **<u>Factors that affect enzyme activity</u>**:
    - Temperature
    - pH
    - substrate concentration
    - enzyme concentration

- enzymes sometimes also require the use of **COFACTORS** (often minerals) or **COENZYMES** (often vitamins) before they can work properly

- Cofactors and Coenzymes are needed for some enzymes to function optimally, many of them shuttle molecules from one enzyme to another

- NAD+ is an example of a coenzyme that acts as an electron carrier in cellular respiration

- NADP+ performs a similar role in photosynthesis

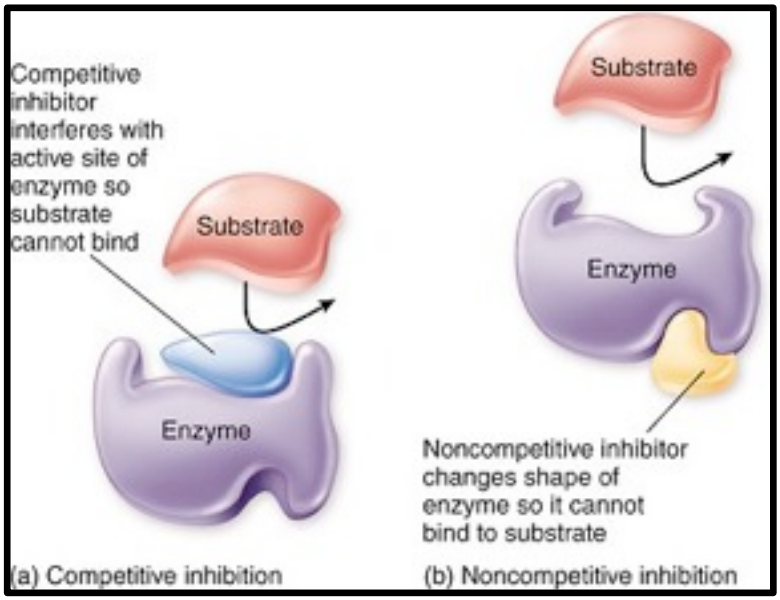
<u>Enzyme Inhibition</u>

- a variety of substances inhibit enzyme activity

- this can sometimes be very dangerous or can be a method used by the cell to regulate enzyme activity

- There are two types of inhibitors:
    - **<u>COMPETITIVE INHIBITORS</u>** – substances that compete with the substrate for an enzyme's active site

    - **<u>NONCOMPETITIVE INHIBITORS</u>** – substances that attach to a site other than the active site and cause a change in the enzyme's shape, making it lose affinity for its substrate

- 

competitive inhibition is reversible

        - it can be overcome by increasing the concentration of the enzyme's substrate allowing it to compete favourably with the inhibitor

Allosteric Regulation

- cells must control enzyme activity to coordinate cellular activities

- there are two main ways to control enzyme activity:
    - 1) by restricting the production of a particular enzyme
    - 2) by inhibiting the action of an already produced enzyme

- some enzymes posses receptor sites other than the active site called **ALLOSTERIC SITES**
        - = sites that bind substances that may **inhibit or stimulate** an enzyme's activity

- binding an ACTIVATOR will result in the stabilization of the enzyme's shape, which keeps all active sites available to substrates

- binding an ALLOSTERIC INHIBITOR will stabilize the inactive form of the enzyme.
        - Non-competitive inhibitors attach to the allosteric sites of certain enzymes

NOTE The binding of an activator or an inhibitor to one allosteric site will affect the activity of all the active sites on the enzyme.