Al-Mustaqbal University

College of Engineering & Technology

Biomedical Engineering Department

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Lecture Title: [Enzyme]

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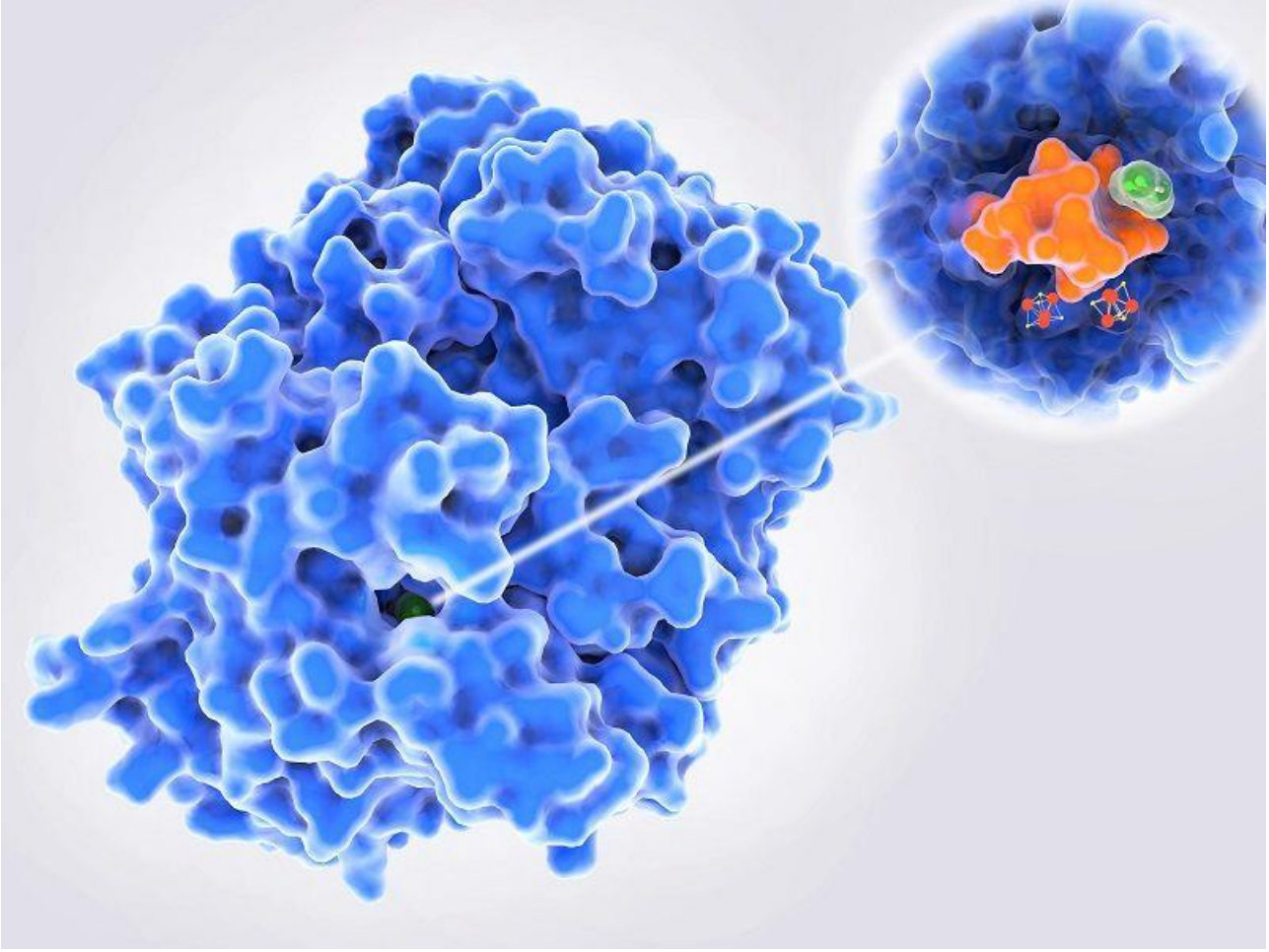
Enzymes



Enzymes are a proteins that synthesized by living cells and act as biological catalysts that speed up biochemical reactions without appearing in the net final equation.

Substrates: - a reactants in biochemical reaction upon which enzymes act to give product.

Characteristics of Enzymes

1. They enter the biochemical reaction in small quantity without changing in its chemical structure.

2. Catalysis occurs in a region within the enzyme known as the active site.

3. Enzymes convert the substrate to product in high efficient with high reaction rates where the rates of enzymatically catalyzed reactions are typically 10^6 to 10^{12} greater than those uncatalyzed reactions.

4. Unlike other catalysts, Enzymes have a greater degree of specificity; that is, enzymatic reactions rarely have side products.

5. The catalytic activity of many enzymes depends on the presence of small non-protein molecules inside them termed ***cofactors***. Cofactors can be subdivided into two groups: *metals ions* (Cu^{+2}, Fe^{+2}, Ni^{+2}…etc.) *and small organic molecules* called **coenzyme**. For example the enzyme carbonic anhydrase requires Zn^{+2} for its activity. Enzyme without its cofactor is called an *apoenzyme* (inactive enzyme); the complete active enzyme is called a *holoenzyme*.

Apoenzyme + cofactor = holoenzyme

Enzyme unit (or activity):- amount of enzyme which convert one Micro-mole (10^{-6} mole) of substrate to product in one minute under determined measurement condition.

Turnover number: - The number of moles of the substrate that converted to the product per one mole of the enzyme in one minute.

Specific activity: - enzyme units per milligram of protein. It consider a measure of the enzyme purity, thus increases with purification.

Factors affecting on the rate of enzyme-catalysed reactions

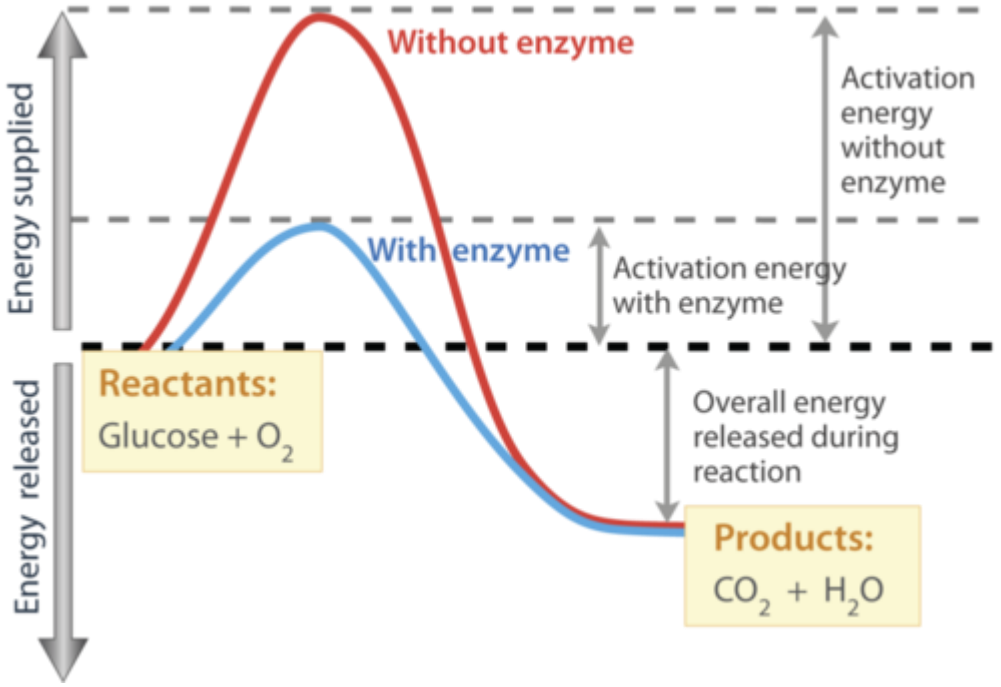
1. Enzyme concentration
2. Substrate concentration
3. product concentration
4. Temperature
5. pH
6. presence of inhibitors or activators
7. Time
8. Light and radiation

[Note] The optimum temperature for most human enzymes is between 35 and 40°C. Human enzymes start to denature at temperatures above 40°C, but thermophilic bacteria found in the hot springs have optimum temperatures of 70°C.

Enzymes and energy of reaction

Enzymes as any catalysts speed up the biochemical reaction by lowering the activation energy of reaction. Therefore, the number of reactants that have activation energy will increase.

Activation energy is the minimum energy required for the molecules to cause a chemical reaction.



Enzyme Classification

Enzymes can be classified into six distinct classes. These are:

Group Name	Type of Reaction Catalyzed
Oxidoreductases	Oxidation–reduction reactions
Transferases	Transfer of functional groups
Hydrolases	Hydrolysis reactions
Lyases	Addition to double bonds or the reverse of that reaction
Isomerases	Isomerization reactions
Ligases	Formation of bonds with ATP cleavage[a]

How substrate binds to the enzyme's active side

Active side: - a region in the enzyme at which the substrate binds to the enzyme, it consist of amino acids residues which participate in the catalysis.

There are two theories to explain how the enzyme binds to substrate

1. "Lock and key" theory.

In this model, the substrate has a specific shape match the active site of enzyme, like a lock and key [figure (1)]. The limitation of this theory is the rigidity of active side related to the substrate. However, this theory is applied on the number of simple kinetics enzyme

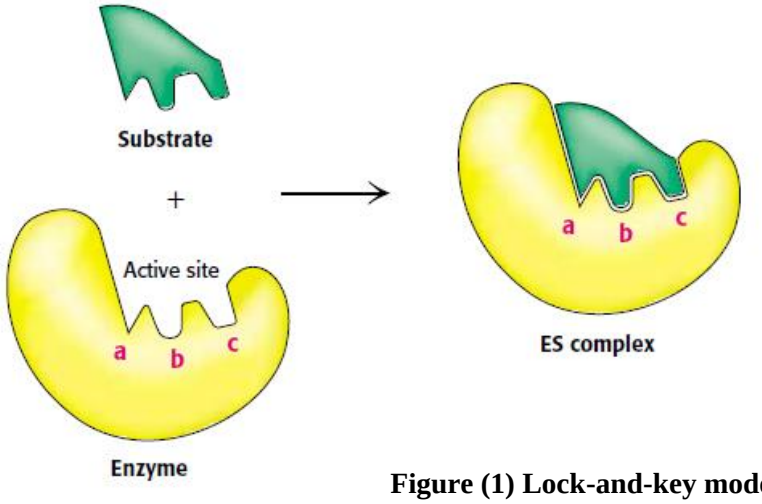


Figure (1) Lock-and-key model of enzyme–substrate binding. In this model, the active site of the unbound enzyme is complementary in shape to the substrate.