CHEMICAL NATURE AND PROPERTIES OF ENZYMES

All the enzymes are invariably proteins. Each enzyme has its own tertiary structure and specific conformation which is very essential for its catalytic activity.

ACTIVE SITE

The active site (or active center) of an enzyme represents as the small region at which the substrate(s) binds and participates in the catalysis.

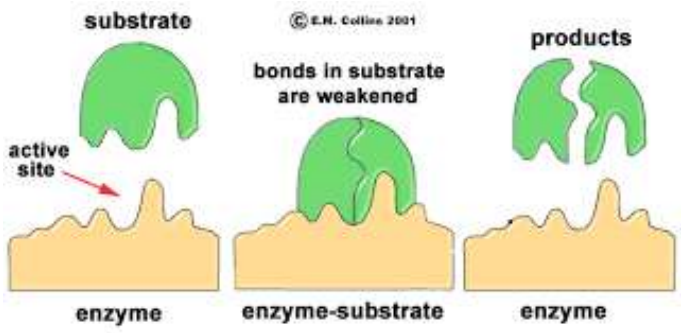

Figure (2-1): mechanism of enzyme- substrate complex formation

COENZYMES

The protein part of the enzyme, on its own, is not always adequate to bring about the catalytic activity. Many enzymes require certain nonprotein small additional factors, collectively referred to as cofactors for catalysis. The cofactors may be organic or inorganic in nature.

The non-protein, organic, low molecular weight and dialysable substance associated with enzyme function is known as **coenzyme**

The term **cofactor** is referred to the inorganic (like Ca2+, Mg2+, Mn2+ etc.) necessary to enhance enzyme activity.

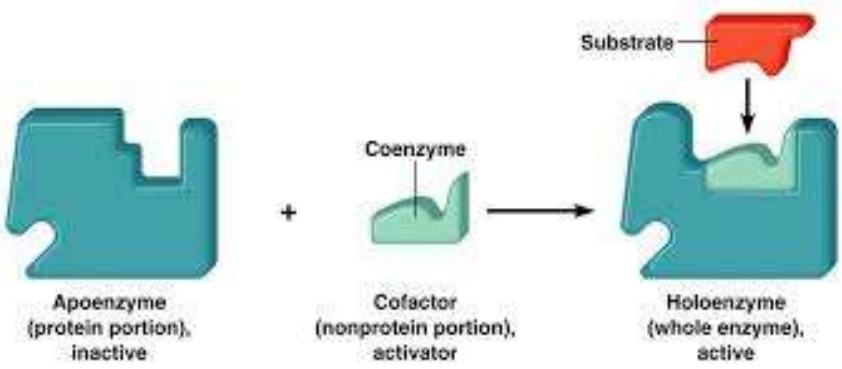

Figure (2-2): the functional unit of enzyme

The functional unit of the enzyme is known as **holoenzyme** which is often made up of **apoenzyme** (the protein part) and a **coenzyme** (non-protein organic part).

Holoenzyme ⟶ Apoenzyme + Coenzyme
(active enzyme) (protein part) (non-protein part)

HOW ENZYMES WORK

The mechanism of enzyme action can be viewed from two different perspectives. The first treats catalysis in terms of energy changes that occur during the reaction, that is, enzymes provide an alternate, energetically favorable reaction pathway different from the uncatalyzed reaction. The second perspective describes how the active site chemically facilitates catalysis.

A-Energy changes occurring during the reaction

Virtually all chemical reactions have an energy barrier separating the reactants and the products. This barrier, called the free energy of activation, is the energy difference between that of the reactants and a high-energy intermediate that occurs during the formation of product. For example, Figure

(2-3) shows the changes in energy during the conversion of a molecule of reactant A to product B as it proceeds through the transition state (high-energy intermediate), T*:

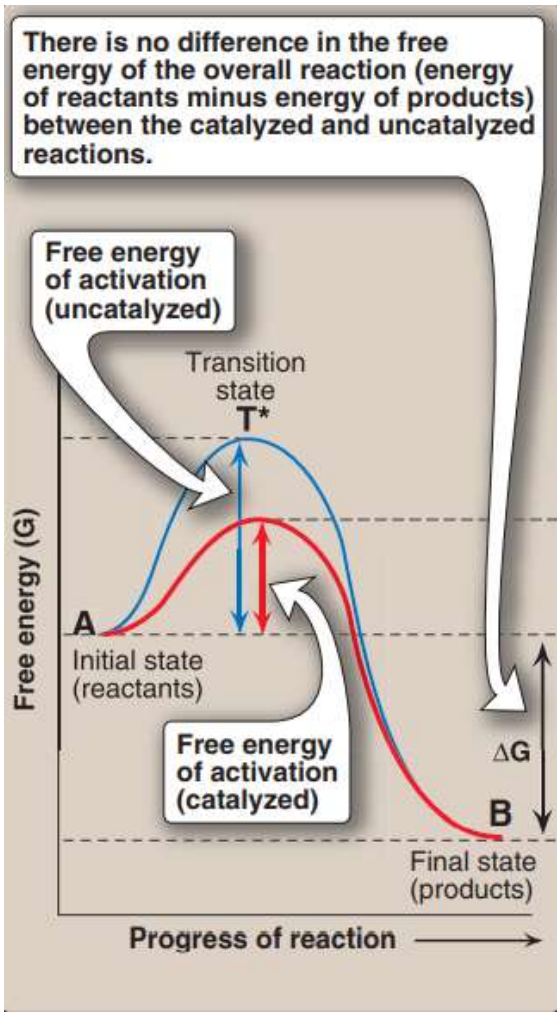

Figure (2-3) : Effect of an enzyme on the activation energy of a reaction.

1-Free energy of activation:

The peak of energy in Figure (2-3) is the difference in free energy between the reactant and T*, where the high-energy intermediate is formed during the conversion of reactant to product. Because of the high free energy of activation, the rates of uncatalyzed chemical reactions are often slow.

2-Rate of reaction:

For molecules to react, they must contain sufficient energy to overcome the energy barrier of the transition state. In the absence of an enzyme, only a small proportion of a population of molecules may possess enough energy to achieve the transition state between reactant and product. The rate of reaction is determined by the number of such energized molecules. In general, the lower the free energy of activation, the more molecules have sufficient energy to pass through the transition state, and, thus, the faster the rate of the reaction

B. Chemistry of the active site

The active site is not a passive receptacle for binding the substrate, but rather is a complex molecular machine employing a diversity of chemical mechanisms to facilitate the conversion of substrate to product. A number of factors are responsible for the catalytic efficiency of enzymes, including the following:

1-Transition-state stabilization:

The active site often acts as a flexible molecular template that binds the substrate and initiates its conversion to the transition state, a structure in which the bonds are not like those in the substrate or the product (see T* at the top of the curve in Figure 2-3). By stabilizing the transition state, the enzyme greatly increases the concentration of the reactive intermediate that can be converted to product and, thus, accelerates the reaction.

2-Other mechanisms:

The active site can provide catalytic groups that enhance the probability that the transition state is formed. In some enzymes, these groups can participate in general acidbase catalysis in which amino acid residues provide or accept protons.