Enzyme Catalysis

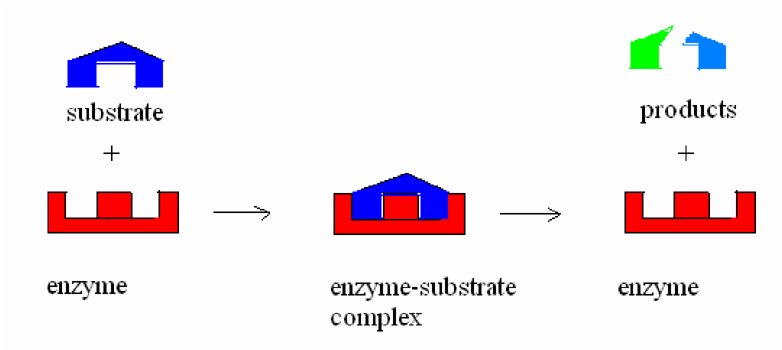
Chemical reactions not only take place in inanimate objects but also in animate as well. Almost all the chemical reactions taking place in the human body and in other living organisms are slow and hence are catalyzed by certain protein molecules, which are known as enzymes. Therefore, ***enzymes** are biological catalysts and can be classified as homogeneous catalysts.* There are two important qualities of enzymes:

- they are very specific (they act on a certain part of the molecule leaving the rest of the molecule intact)
- they increase the rate of biochemical reactions by factors of 10^6 to 10^{18}

Due to their specificity, a reactant in enzyme-catalyzed reaction is usually labeled as the *substrate.* Since enzymes and substrates are present in the same aqueous solution (single phase), they can be classified as *homogeneous catalysts*.

Enzyme Action

Even though an enzyme is a large protein molecule, it contains only few *active sites* where the interaction between enzyme and substrates take place. These active sites are structurally flexible and can adopt the structure that fits perfectly into the structure of the substrate just like a key fits into the lock, and hence it is known as "lock-key" model, which is displayed below.



Keep in mind that the same enzyme can catalyze more than one reaction because the active sites can adopt different conformations due their flexibility.

The kinetics of enzyme is quite complex, but we can represent it in a simplified manner. Let us assume that reaction takes place when enzyme E and substrate S combine and form the complex ES, which can then be decomposed in two ways, going forward to produce E and the product or backward to form again E and S:

$$E + S \overset{K}{\rightleftharpoons} ES \xrightarrow{k} E + P$$

Where k is the rate constant and K is equilibrium constant that is given by

$$K = \frac{[ES]}{[E][S]}$$

Here rate determining step is the formation of the product, and the rate of reaction is proportional to [ES], and hence [E] [S]. The rate can be expressed either as the rate of formation P or the rate of disappearance of S. Thus

$$rate = \frac{\Delta[P]}{\Delta t} = -\frac{\Delta[S]}{\Delta t} = k[ES] = kK[E][S]$$

Thus, the rate is directly proportional to the concentration of enzyme as well as substrate.
