Course -M.Sc. Botany Part-II, Paper-IX

(Group-“B”)

Topic-Enzymes (Bio-Chemistry)

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Enzymes

Enzymes are a biological catalysts. It is an action of saliva on the conservation of starch into sugars and action of gastric juice on digestion of meat gave birth to the idea of the presence of catalysts in biological system .These biological catalysts were named as ferments on account of the fermentation of sugar into alcohol by yeast. First time these ferments named enzymes by Louis Pasteur in 1860 .Edward Buchner (1897) who first extracted the enzymes from yeast ,which could , still , induce fermentation of sugar.

Properties of enzymes

(1)Enzymes are complex macromolecules with high molecular weight.

(2) They catalyse biochemical reactions in a cell. They help in the breakdown of large molecules into smaller molecules or bring together two smaller molecules to form a larger molecule.

(3) Enzymes do not start a reaction. However, they help in accelerating it.

(4) Enzymes affect the rate of biochemical reaction and not the direction of the reaction.

(5) Most of the enzymes have a high turnover number. Turnover number of an enzyme is the number of molecules of a substance that is acted upon by an enzyme per minute under saturated substrate concentration. High turnover number of enzymes increases the efficiency of the reaction.

(6) Enzymes are specific in action.

(7) Enzymatic activity decreases with increase in temperature and all enzymes show maximum activity at an optimum of 30-40oC.

(8) They show maximum activity at an optimum pH of 6 – 8.

(9) The velocity of enzyme increases with increase in substrate concentration and then, ultimately reaches maximum velocity.

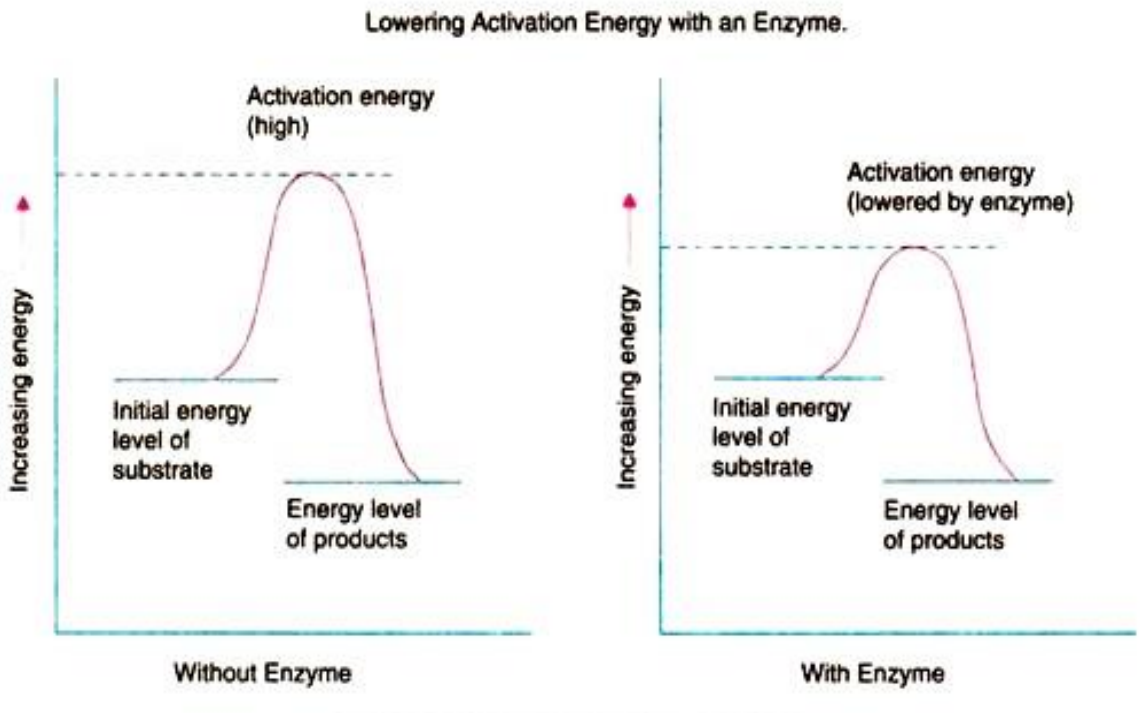
(10) One of the characteristic properties of enzymes is that they act over specific substrate. The specificity may be broad such as group specificity or absolute such as optical specificity.

Mechanism of Enzyme Action:

For certain substrates to undergo chemical reaction, they have to be provided with enough of free energy to attain an activated state called transition energy. This energy of activation acts as energy barrier and in its absence reaction fails to occur. Energy barrier is of different magnitude in different reaction .If energy barrier is low, large number of molecules will be in activated state, which means that the reaction rate is fast. Conversely, if the energy barrier is higher, smaller number of molecules is in activated state and thus the reaction is lower.

Enzyme is active in catalytic action of biochemical reaction. They act on substrate and forms a complex after interactions with the enzyme is called active center. The enzyme and substrate forms a complex at the active centre.

This binding action makes both enzyme and substrate stable. The interaction between substrate and enzyme may be either ionic bonds and hydrogen bonds or Van der Waal forces. The active sites of enzyme have some special groups such as NH2 COOH, -SH etc. which bind the substrate though above bonds to form a transitional (intermediate) compound called enzyme-substrate complex (ES).



Mode of enzyme action

Types of Mechanisms of Enzymes:

There are two types of mechanisms involved to explain substrate-enzyme complex formation:

(i) Lock and Key Theory:

In 1894 Emil Fischer explained the specific action of an enzyme with a single substrate using a theory of Lock and Key analog. According to this theory, reaction of sub-state and enzyme is analogous to lock and key.

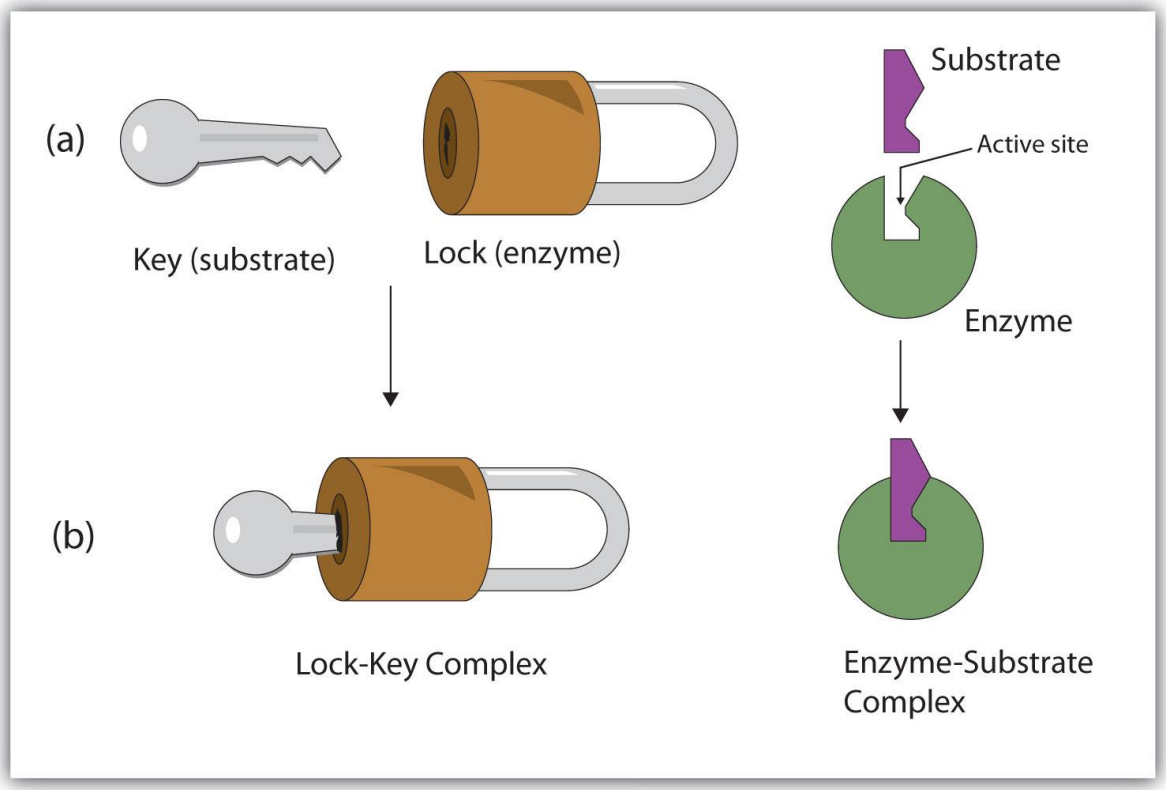
Enzyme is analogous to key, where the geometrical configuration of socket is fixed. Similarly substrate has also got fixed geometrical configuration like that of key. A particular lock can be opened or closed by a particular key. According to the particular substrate can be found at active site of particular enzyme forming substrate-enzyme complex.

Enzyme -substrate complex remains in tight fitting and active sites of enzymes are complementary to substrate molecules. Subsequently, enzyme-substrate complexes result in the transformation of substrate into the product formation due to activity of reaction sites.

Since product has lower free energy, it is released. Enzymes are fixed to receive another molecule of substrate and thus enzyme activity continues. In this analogy, the lock is the substrate and the key is the enzyme. Only the correctly sized key (substrate) fits into the key hole(active site) of the lock (enzyme).

Smaller keys, larger keys, or incorrectly positioned teeth on keys (incorrectly s

haped or sized substrate molecules) do not fit into the lock (enzyme).



(ii) Induced Fit Theory:

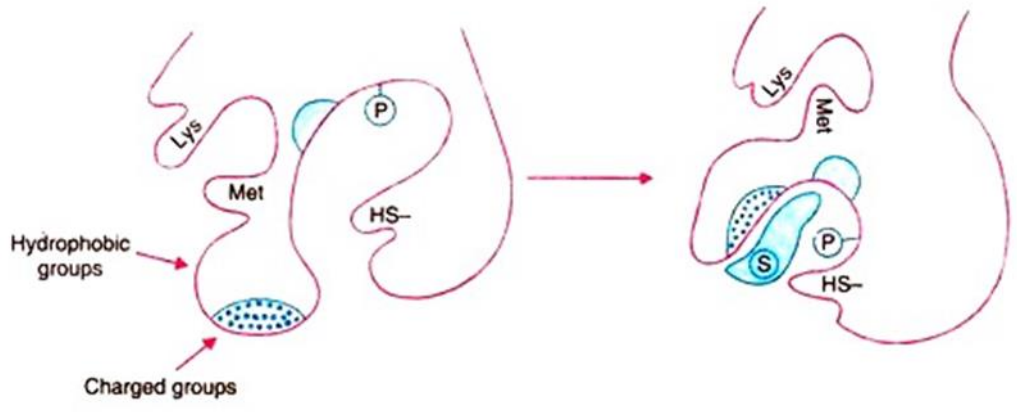
In 1958, Koshland modified the Fischer's model for the formation of an enzyme-substrate complex to explain the enzyme property more efficiently. According the Fischer's model the nature of the active site of enzyme is rigid, but it is able to be pre-shaped to fit the substrate.

Koshland explains that the enzyme molecule does not retain its original shape and structure, but the contact of the substrate induces some geometrical changes in the active site of the enzyme molecule. The enzyme molecule is made to fit completely the configuration and active centres of the substrate. At the same time, other amino acid residues may become buried in the interior of the molecule.

This theory can be explained by a hypothetical illustration as shown in Fig. The hydrophobic and charged group both are involved in substrate binding. A phospho serine (-P) and SH group of cysteine residue are involved in catalysis.

Residue of the other amino acid such as lysine (Lys) and methionine (Met) are not involved in either binding or catalysis. In the absence of substrate, the substrate binding group and catalytic group are far apart from each other.

But the contact of the substrate induces a conformational changes in the enzyme molecule and aligns both the groups for substrate binding and catalysis. Simultaneously, the spatial orientation of the other region also changed. This causes the lysine and methionine much closer.



Conformational Changes brought about by induced fit in an enzyme molecule.