B.Sc. Botany (Hons) – 2ND SEM
by Dr. Raman Kumar Ravi

Mechanism of Enzyme Action

- A chemical reaction such as A ----> P takes place because a certain fraction of the substrate possesses enough energy to attain an activated condition called the transition state.
- This transition state is at the top of the energy barrier separating the reactants and products.
- The rate of a given chemical reaction is proportional to the concentration of this transition state species.
- **The energy of activation** is the amount of energy required to bring all the molecules in 1 mole of a substance at a given temperature to the transition state.
- Enzymes combine transiently with the substrate to produce a transition state intermediate having a lower energy of activation than the uncatalysed reaction.

Thus, they accelerate chemical reactions by **lowering the energy of activation**

Example

H_2O_2 ---------> H_2O + (O)

Catalase

Reaction condition	Activation energy (KCal mol-1)
Uncatalysed	18
Catalysed by colloidal Pt	13
Catalysed by catalase	7

It is generally believed that the catalytic reactions occur in at least two steps.

Step 1: A molecule of enzyme (E) and a molecule of substrate(S) collide and react to form an intermediate called the enzyme-substrate complex (ES).

Step 2: The decomposition of ES complex to give product(s) and the active enzyme

[S] + [E] ----------> [ES] ---------> P+ [E]

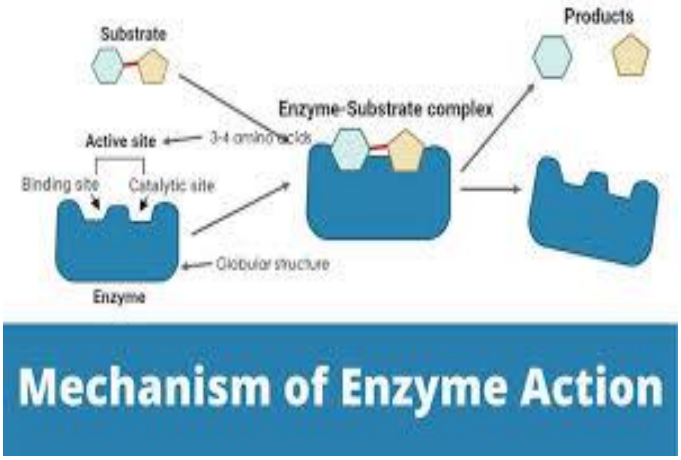
The formation of an ES complex affords a lower activation energy.

Active site

- The substrate binding site in the enzyme is referred as active site.
- The functional groups that are essential for the formation of ES complex occur at a specific location on the surface of the enzyme molecule.

This section of enzyme where substrate binding and transformation of substrate to product occurs is called as active site.

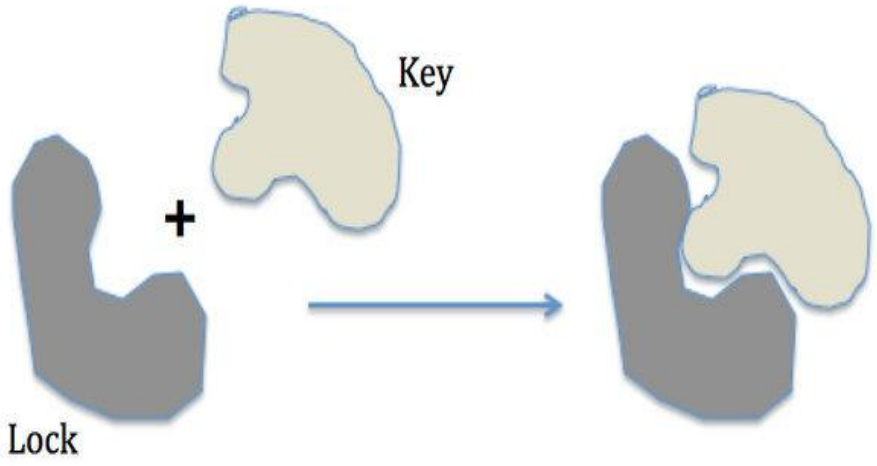
- Many attempts have been made to implicate **specific amino acid residues (side chain or R groups) as being part of the active site of various enzymes.**
- Some of the amino acids occurring at the active site of enzymes are hydroxyl group of serine, sulfhydryl group of cysteine, imidazole group of histidine and carboxyl group of aspartic acid.



Two theories were proposed to explain the mechanism of enzyme action.

1. Fischer's lock and key theory (Rigid template model)

- During 1890, **Emil Fischer** proposed this theory
- According to this, the **active site possesses a unique conformation which is complementary to the structure of the substrate** thus enabling the two molecules to fit together in much the same way as a key fits into a lock
- An unfortunate feature of this model is the **implied rigidity of the catalytic site**.



2. Koshland's induced-fit theory

- Koshland had advocated a theory **to account for the specificity of enzymes**.
- He postulated that the essential functional groups on the active site of the free enzyme are not in their optimal positions for promoting catalysis.
- When the substrate molecule is bound by the enzyme, **the catalytic groups assume favourable geometrical position to form the transition state.**
- The enzyme molecule is unstable in this active conformation and tends to revert to its free form in the absence of substrate.
- In the induced fit model, the substrate induces a conformational change in the enzyme which aligns the amino acid residues or other groups for substrate binding, catalysis or both.