ENZYME

- Term coined by F. W. Kuhne
- Enzymes are specific in the **reaction catalyzed.**
- Exhibit all properties of **proteins.**
- Can be denatured by changes in pH and temp.
- Enzymes are proteins specialized to catalyze biological reactions.
- Enzymes undergo physical changes during the reaction but revert to their original form at the end of the reaction.

CLASSIFICATION

- Simply named by adding the suffix **-ase** to the name of the substrate.

  E.g. **Urease** (Substrate urea), **Arginase** (Substrate arginine)

- The International Union of Biochemistry (IUB) established a commission to adopt a systematic classification and nomenclature of enzymes.

- Based on the substrate and reaction specificity.

CLASSIFICATION

IUB system classifies enzymes into six major classes (should be written in specific order only)

1. Oxidoreductases
2. Transferases
3. Hydrolases
4. Lyases
5. Isomerases
6. Ligases

CLASSIFICATION

1. **Oxidoreductases:** Enzymes catalyzing oxidation and reductions between two substrates (S)

S (reduced) + S' (oxidized) → S (oxidized) + S' (reduced)

E.g.: $CH_3\text{-}CH_2\text{-}OH + NAD \xrightarrow{\text{dehydrogenase}} CH_3\text{-}CHO + NADH + H^+$

2. **Transferase:** Enzymes catalyzing the transfer of a functional group (G) other than hydrogen between substrates.

S - G + S' ---------> S' - G + S

E.g: Phosphorylation of glucose by hexokinase.

Glucose + ATP $\xrightarrow{\text{Hexokinase}}$ **Glucose-6-Phosphate + ADP**

CLASSIFICATION

3. **Hydrolases:** Enzymes catalyzing hydrolysis of ester, peptide or glycosidic bonds.

E.g.: Acetylcholine + H2O ----------> Acetic acid + Choline

Enzyme: acetyl choline esterase

4. **Lyases:** Promote removal of substrate to leave double bond.
   - The enzyme acting on C-C, C-O, C-N bonds.

E.g: conversion of malic acid to fumaric acid by **fumarase**

COOH–CH(OH)–CH2-COOH --------> COOH – CH = CH –COOH + H2O

CLASSIFICATION

5. **Isomerases:** Enzymes catalyzing interconversion of optical, geometrical or positional isomers.

A-B-C ⇋ C-B-A

Trans-retinal ----------> cis-retinal

E.g.: Enzyme: Retinene isomerase

6. **Ligase:** Enzymes catalyzing the joining together of two compounds with the hydrolysis of a high energy compound.

E.g: Carboxylase, synthatase etc.

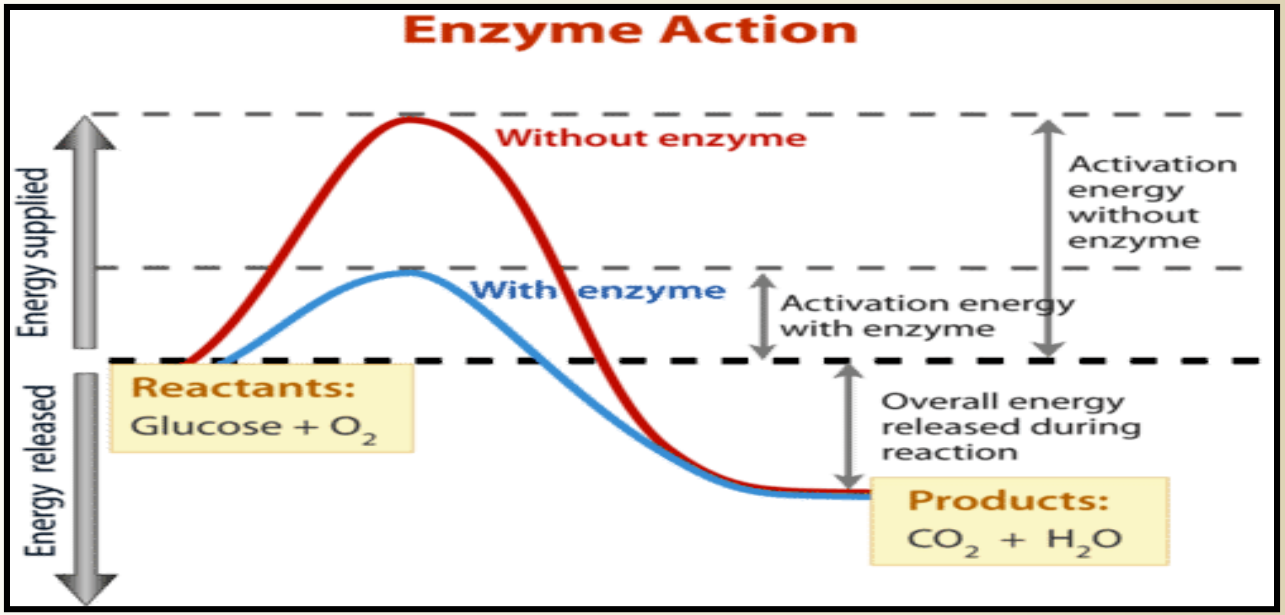
Glutamic acid + NH_3 $\xrightarrow{\text{Glutamine synthatase}}$ Glutamine

POINTS TO REMEMBER

- **Active site:** Region that bind substrate, cofactors and prosthetic group.
  - substrate binding and transformation of substrate to product occurs is called as active site.
- **Cofactors:** Nonprotein molecule. Metals are used as cofactors.
- **Substrate:** Reactant in reaction.
- **Apoenzyme:** enzyme without cofactor
- **Holoenzyme:** A complete complex of protein.
  i.e. apoenzyme + cofactor

MECHANISM OF ENZYME ACTION

- Enzyme work by weakening bonds in chemical reaction thus lowers activation energy.

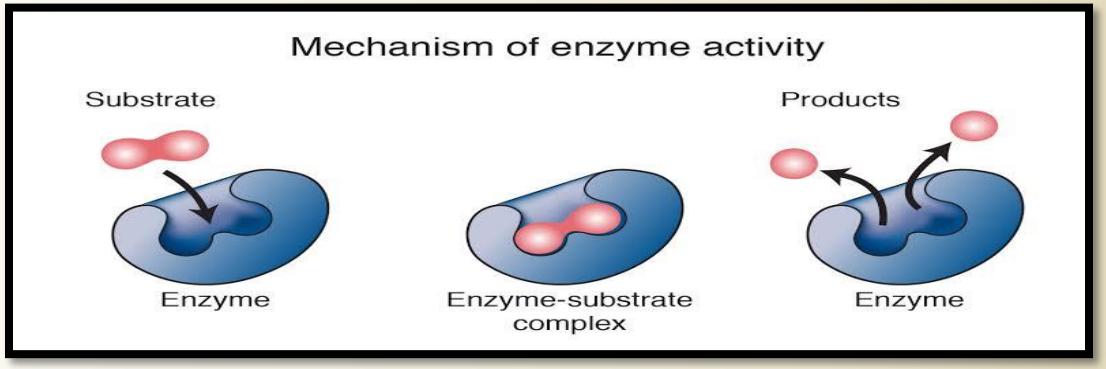


MECHANISM OF ENZYME ACTION

Catalytic reactions occur in at least two steps.

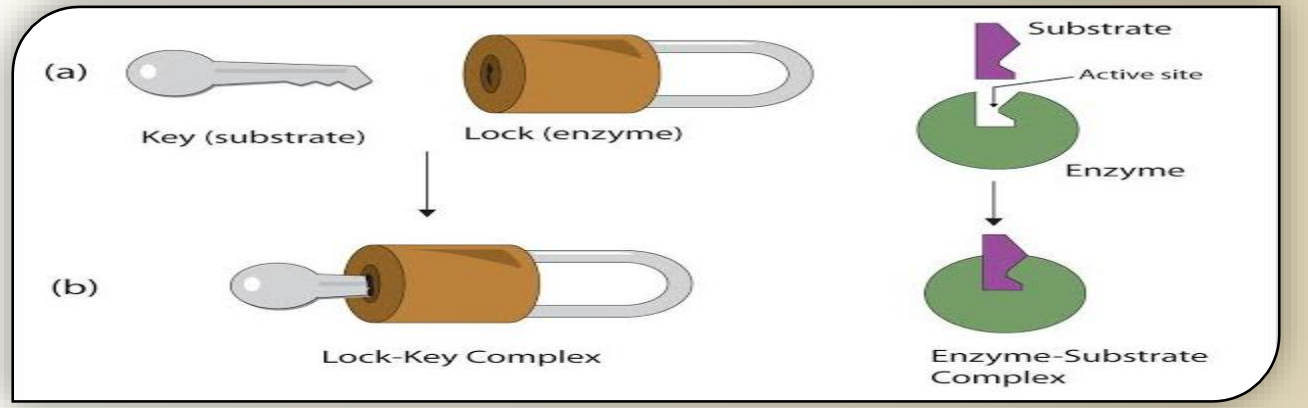
- **Step.1:** A molecule of enzyme(E) and a molecule of substrate(S) collide and react to form an intermediate called the enzyme-substrate complex (ES).
- **Step.2:** The decomposition of ES complex to give product and active enzyme.

Substrate + Enzyme → [E-S] complex → Product + Enzyme



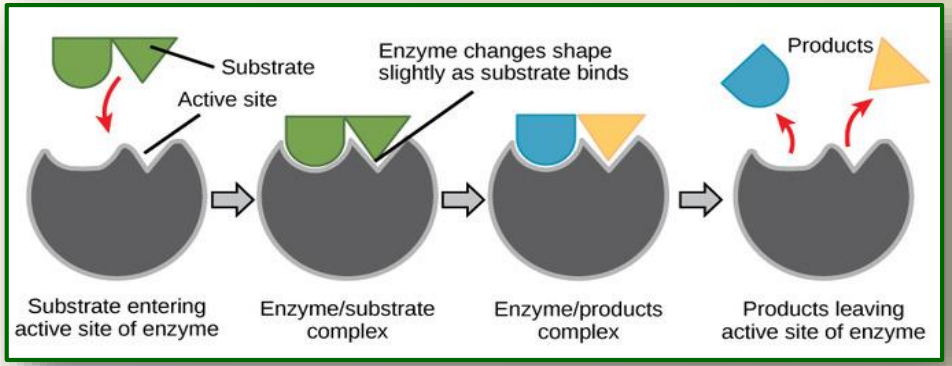
THEORIS OF ENZYME ACTION

1. **Lock and key theory:** Proposed by **Emil Fischer**
   - Active site consist of unique conformation complementary to substrate.
   - Active site of an enzyme are rigid.
   - There is no change in It before and after reaction.



THEORIS OF ENZYME ACTION

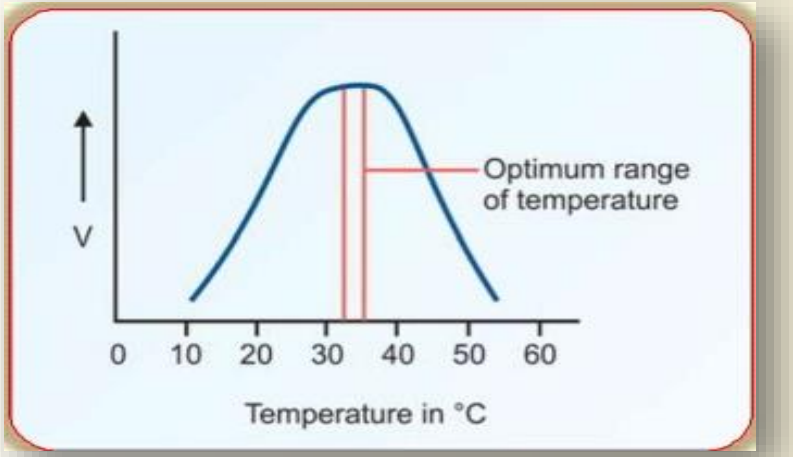
2. **Induced fit theory:** Proposed by Koshland
   - The substrate induces a conformational change in the enzyme.
   - When substrate bind to an active site both changes shape slightly, creating an ideal fit for catalysis.



ENZYME KINETICS

- It is the study of ***'rate of enzyme catalyzed reaction'.***
- It reveals the *number* and *order* of individual steps.
- Factor affecting rate of enzyme catalyzed reaction:

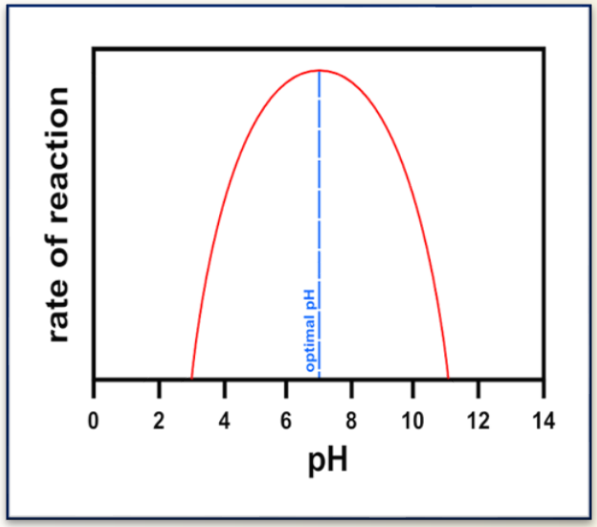
A. Temperature: Temperature coefficient (Q10).



ENZYME KINETICS

B. pH: Optimum pH ranges between 6-8.

- High or low pH value cause ionization of enzyme results denaturation.



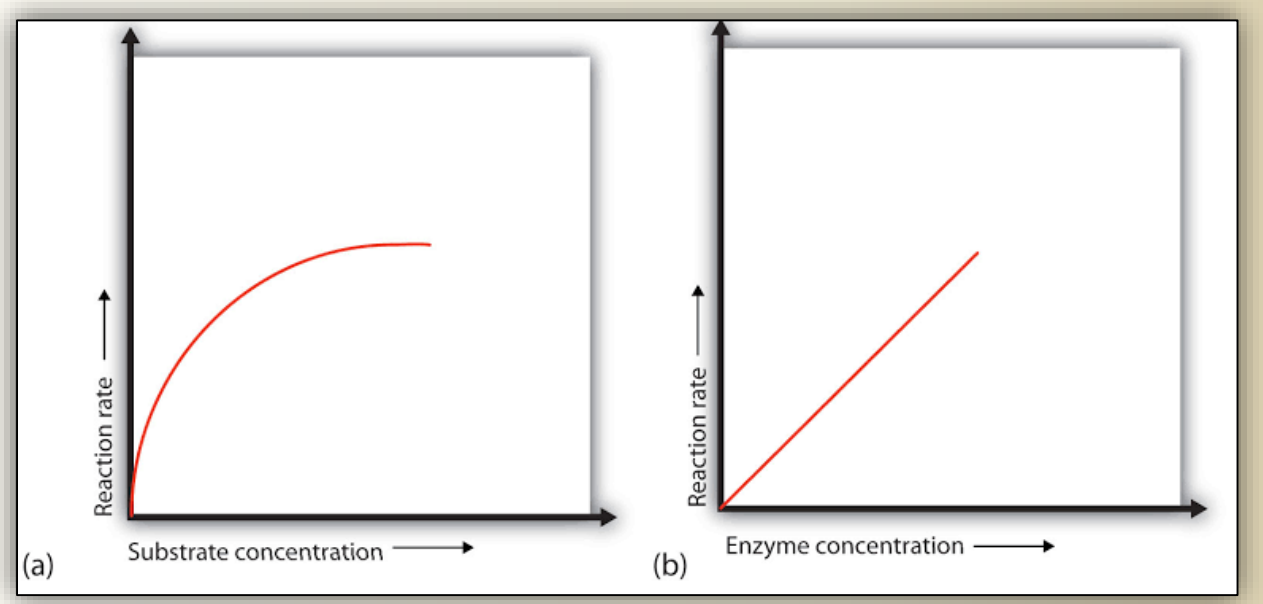
Optimum pH values of Some Common Enzymes

Enzyme	Substrate	Optimum pH	Location
Pepsin	Peptide Bond	1.5 to 2.0	Stomach
Sucrase	Sucrose	6.2	Small Intestine
Amylase	Amylose	6.7 to 7.0	Pancreas
Urease	Urea	7.0	Liver
Trypsin	Peptide Bond	7.7 to 8.0	Small Intestine
Lipase	Lipids	8.0	Pancreas

ENZYME KINETICS

B. **Substrate concentration:** Enzymatic reation increaction increases with substrate concentration until a limiting rate is reached.

C. **Enzyme concentration:** Directly proportional to enzyme activity.



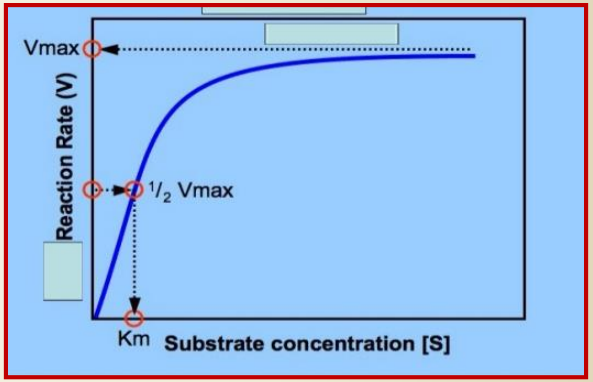
ENZYME KINETICS

- **Michaelis Menten Reaction:** Enzyme reversibly combines with substrate to form an ES complex that subsequently yield product and regenerating free enzyme.

Enzyme + Substrate ⇌ [E-S] complex → Product + Enzyme

$$Vo = \frac{V_{max}[S]}{Km + [S]}$$

V0 = Initial velocity (moles/times)
[S] = substrate concentration (molar)
V_{max}= maximum velocity
K_m = substrate concentration at half V_{max}



NOTE: The equation describe how reaction velocity varies with substrate concentration.

FACTS RELATED TO ENZYME

- Most enzyme in human body work in 37° C.

THANK YOU