Enzymes

Definition : enzymes are biological catalysts which bring about chemical reaction in the living cell.

. produced by the living organism in small amounts.

. Functions: digestion, breathing, synthesis and break down of CHOS, proteins, fats

. enzymes acts upon substance called substrate.

. enzymes convert substrate into product. Ex: lactose **lactase** → galactose + glucose

. 16% of weight is nitrogen.

physical properties: **1**. Heat labile **2**. Soluble in water

3. Precipitate by precipitating agent (ammonium sulphate or trichloroacetic acid).

General properties of enzymes:

1. all enzymes are proteins.

2. enzymes accelerate the reaction but:

a. do not alter the reaction equilibrium

b. not consumed in overall reaction **c**. required in very small quantities.

3. enzymes are highly specific for their substrate.

4. enzymes possess active site, at which interaction with substrate take place.

Sources of enzymes:

Endoenzymes: enzymes that function within the cells, most of enzymes are these types.
Ex: metabolic oxidase.

Exoenzymes: enzymes that are liberated by cells and catalyze reactions outside the cell.
Ex: digestive enzymes (amylase, lipase, protease).

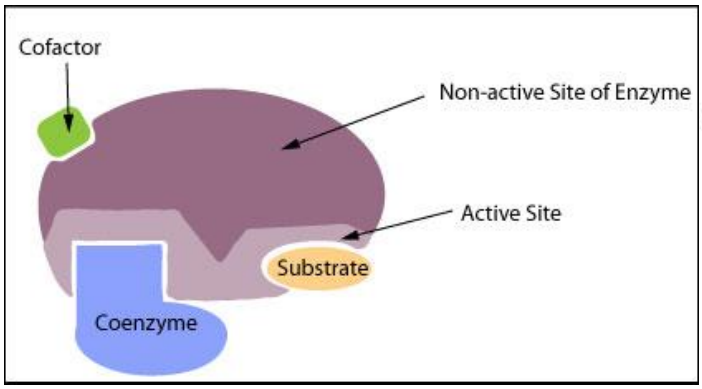
Chemical composition of enzymes:

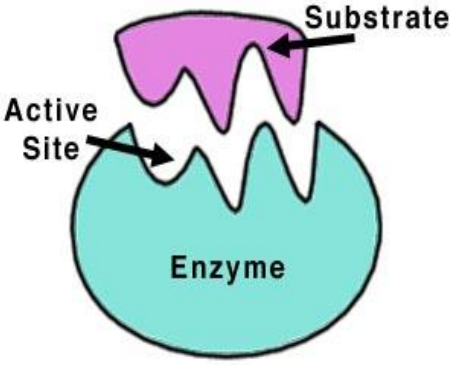
Enzymes classified according to their chemical composition into.

1. Enzyme consist of only protein.

Ex: pepsin, trypsin (amino acids binding peptide bonds).

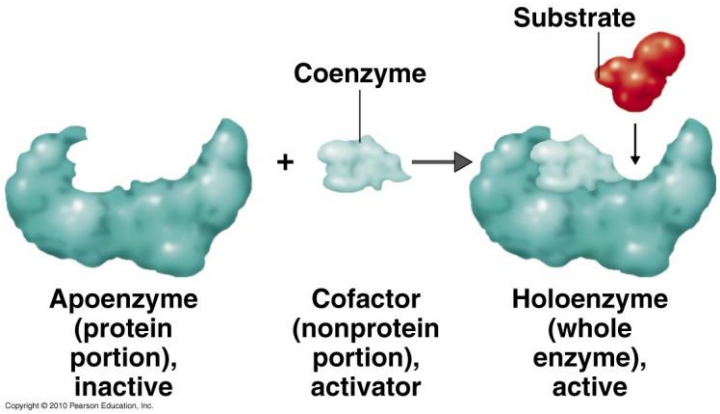
2. Enzyme consist of : protein (enzyme) + Co - Enzyme = **Holoenzyme**
(apoenzyme**)**





3. Enzyme consist of:

Protein (enzyme) + prosthetic group (Co – factor) = **Holoenzyme**



Coenzymes : are typically organic molecules, used by enzymes to help catalyse reactions, contain functionalities not found in proteins,

cofactors : are catalytically essential molecules or ions that are covalently bound to the enzyme

Holoenzyme : enzyme consist of Apoenzyme + prosthetic group

Apoenzyme : term refers to the protein part of enzyme.

Active site of enzyme: the point in the enzyme which interaction with substrate, co-enzyme, inhibitor take place.

Zymogen: the active form of enzyme.

Ex: pepsinogen —**Hcl**→ pepsin (active)

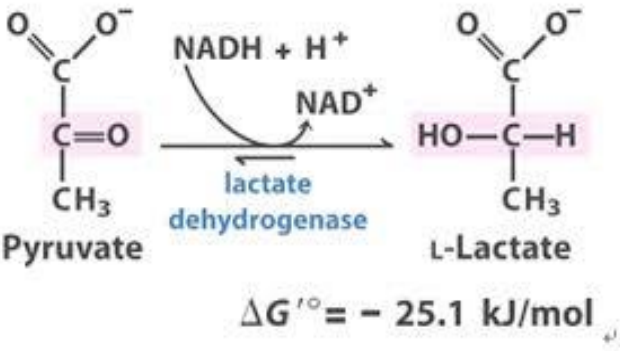
Ex: trypsinogen —**enterokinase**→ trypsin (active)

The difference between Co-enzymes and Co- factors:

Co-enzymes	Co - factors
1. binds loosely and can easily separated from enzyme by dialysis.	**1**.conjugated with protein(enzyme)
2. organic compounds (ex: water soluble vitamins such as Vit C and B	**2**. metallic ions (Fe, Mn, Cu,Mg)
4. non protein.	**3**. has low molecular weight
5. heat resistance.	
6. their function as co-substrate.	

Classification of enzymes:

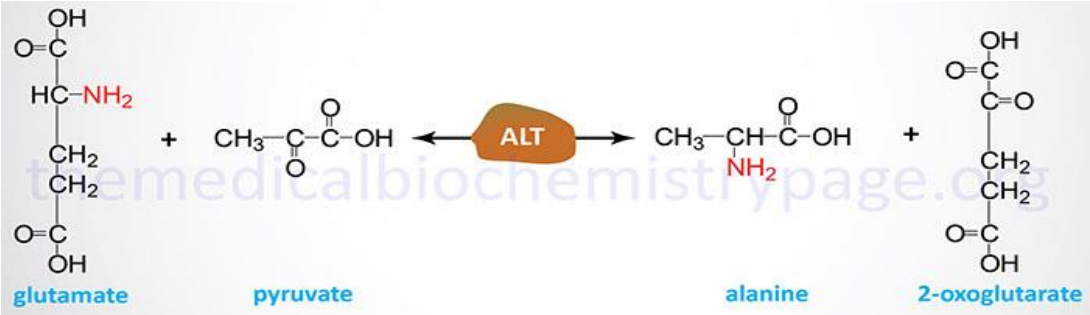
1. Oxidoreductases: one compound oxidized, another reduced. Ex: lactate dehydrogenase, tyrosinase,



2. Transferase:

Enzyme transfer group containing C, N or S, from one substrate to another substrate.

Ex: **Transaminase** (glutamate oxaloacetate transaminase(**GOT**) or Aspartate transaminase (**AST**). and glutamate pyruvate transaminase(**GPT**), alanine transaminase(**ALT**)
(transfer of amine group)

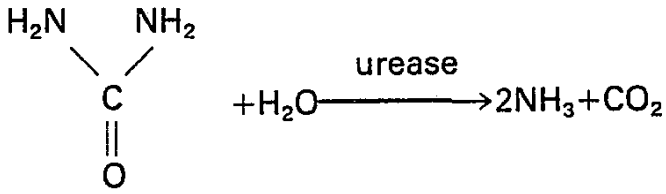


3. Hydrolyase:

Catalyse hydrolysis of ester, peptide or glycoside bound by addition of H2O across the bond.

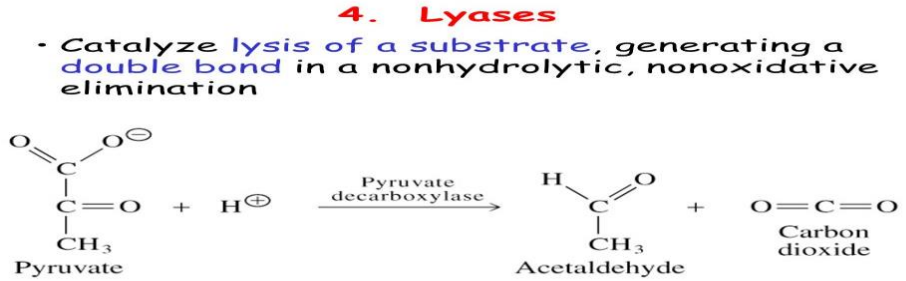
Urea + H2O ——urease——> 2NH3 + CO2

Maltose + H2O ——maltase——> glucose + glucose



4. Lyasis:

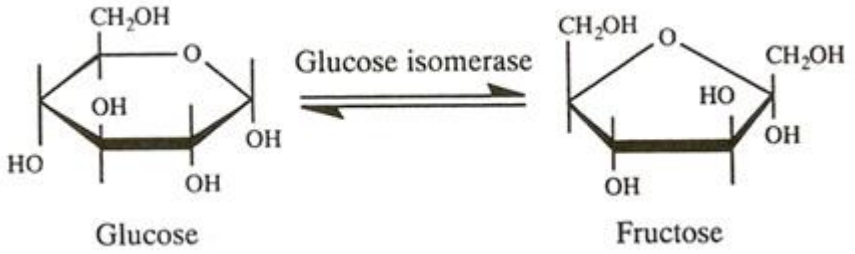
Additional or removal of group without hydrolysis, oxidation, reduction producing double Bond.



5. Isomerase:

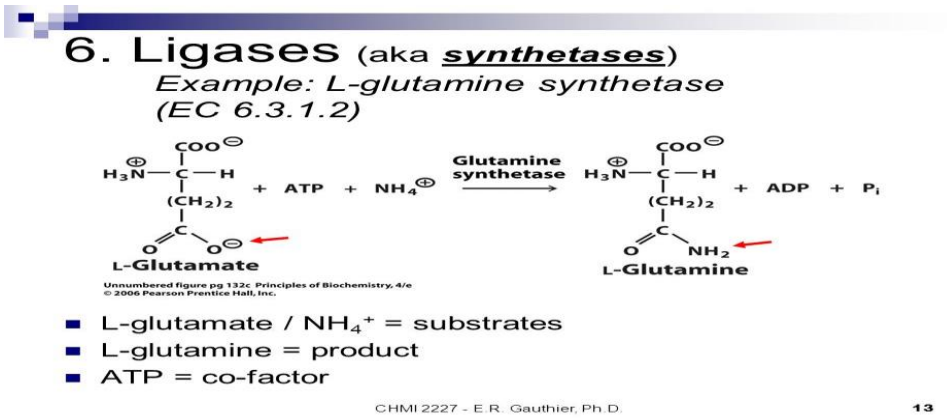
Produce optical, geometric or position isomer of substrates by intermolecular rearrangement.

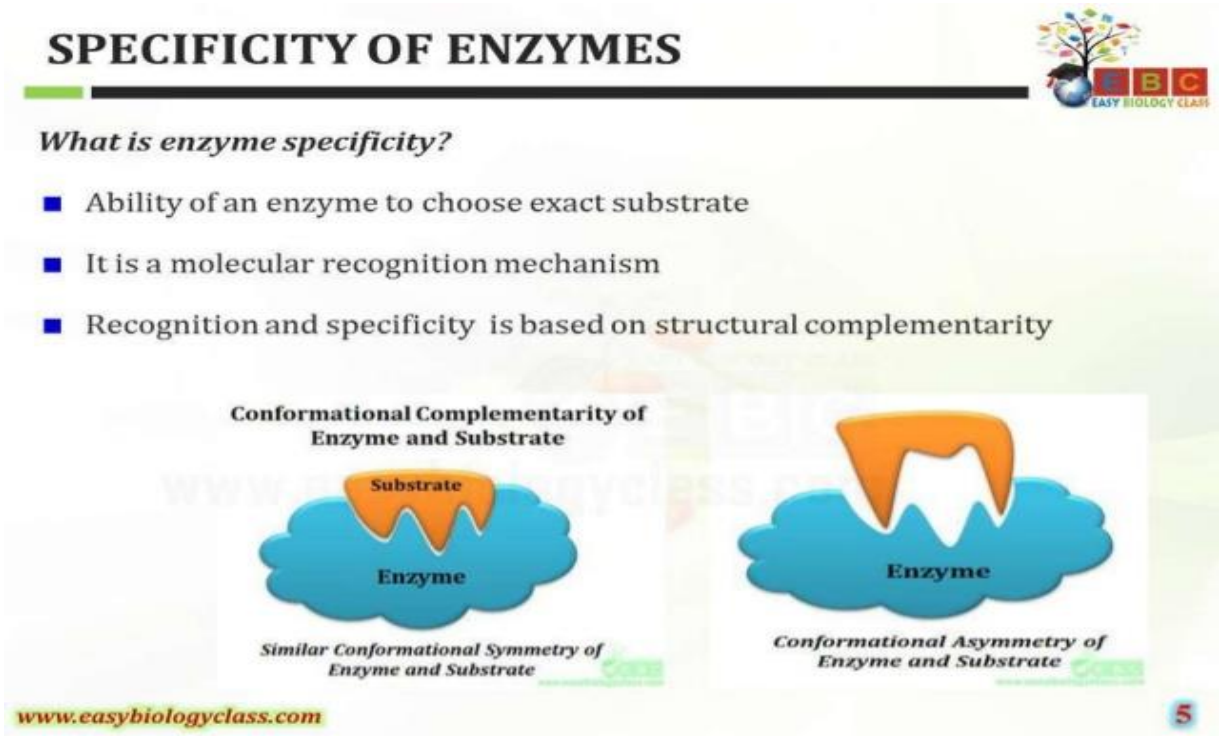
Ex: D- alanine racemase **L – alanine**



6. Ligases or synthetase:

link two substrate together usually by pyrophosphate bound.



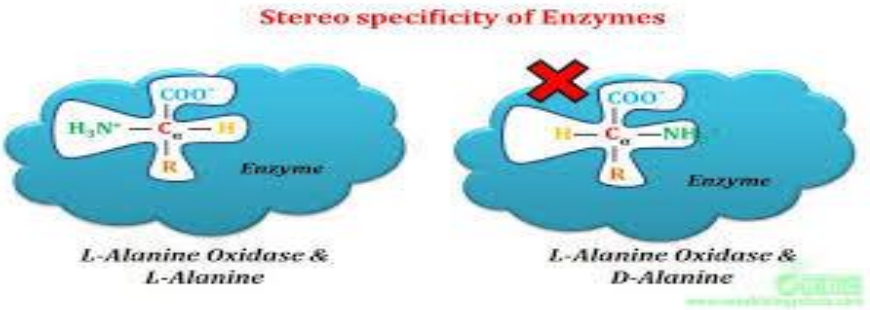


Three types of specificity:

1.Steriospecificity: enzyme show specificities with only one specific group of substrate.

Ex: Urease catalysis the hydrolysis of urea **only**

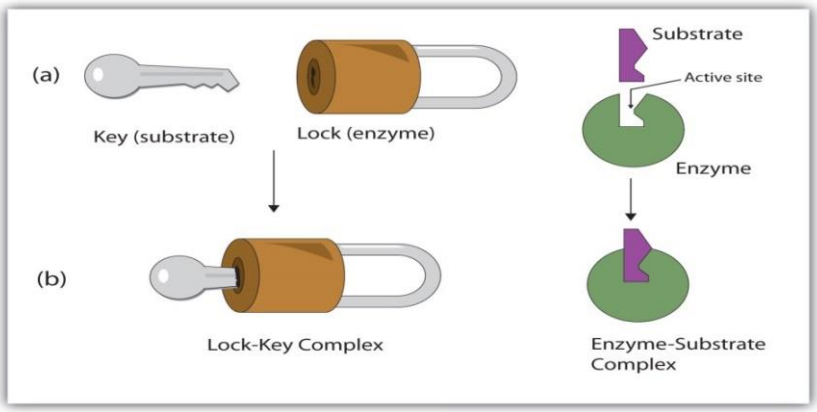
L- amino oxidase for L-alanine substrate.

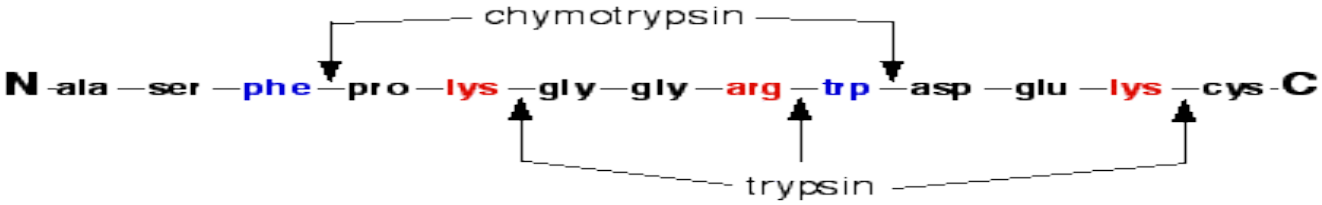


2. substrate specificity: enzyme catalyze reaction with specific substrate, cannot acts on other substrate. They are Like lock and key model. **Ex:** Trypsin, Chymotrypsin

trypsin: hydrolyze peptide bonds involving carboxyl group of **basic amino acids (arginine and lysine).**

Chymotrypsin hydrolyze peptide bonds of **aromatic amino acids (phenylalanine ,tyrosine).**



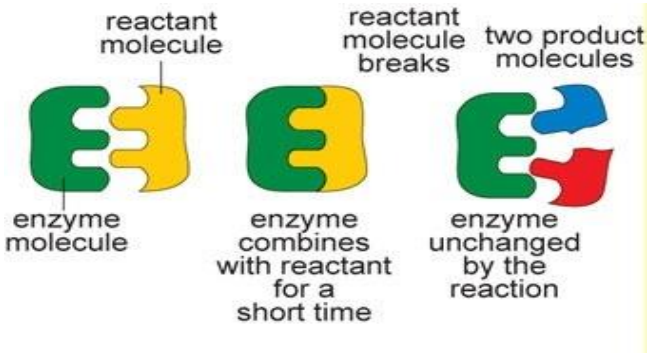


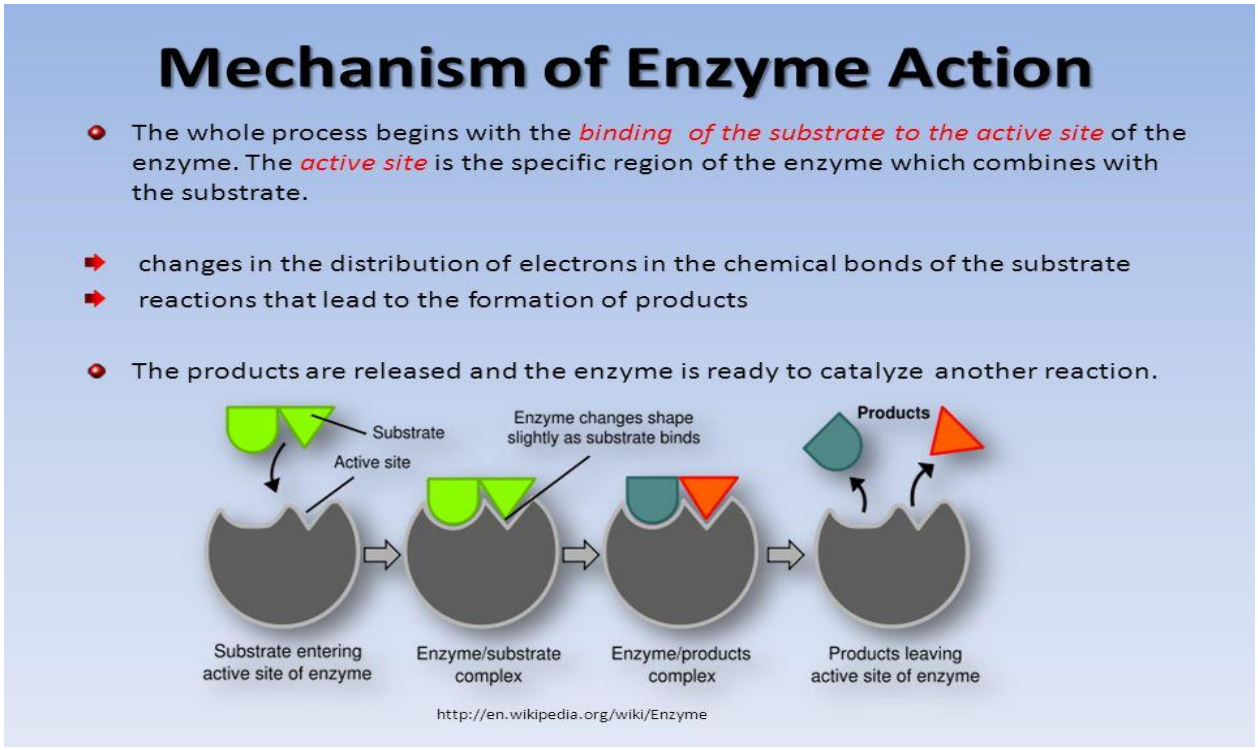
3.reaction specificity: substrate can undergo many reactions, but each reaction catalyzed by different enzyme. **Ex:** Oxalic acid undergo different reactions.

Mechanism of enzyme action: According to Michaels and Menton equation.

Enzyme + Substrate ⟶ Enzyme – substrate ⟶ Enzyme + product

Substrate: define as organic compound convert by enzyme to the product.





Factors affecting enzyme activity:

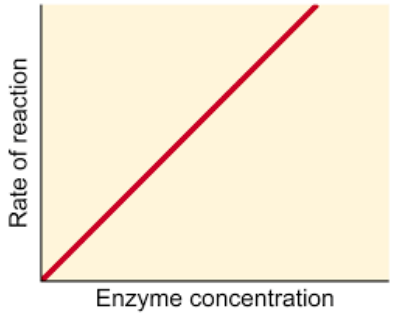
1. Enzyme concentration.

a. The rate of reaction depends directly on the amount of enzyme present.

b. At a specific time.

c. Unlimited substrate concentration.

If the amount of enzyme is increased by two fold, the reaction rate is doubled.

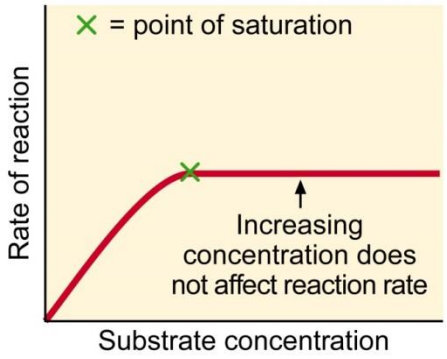


2. Substrate concentration.

a. The rate of reaction is directly proportional to the substrate avalible.

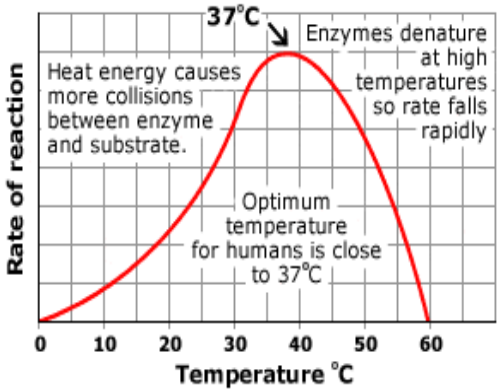
b. If the enzyme concentration is kept constant, and the amount of substrate is Increased.

c. Further increase in the substrate, does not increase the rate of the reaction any more.



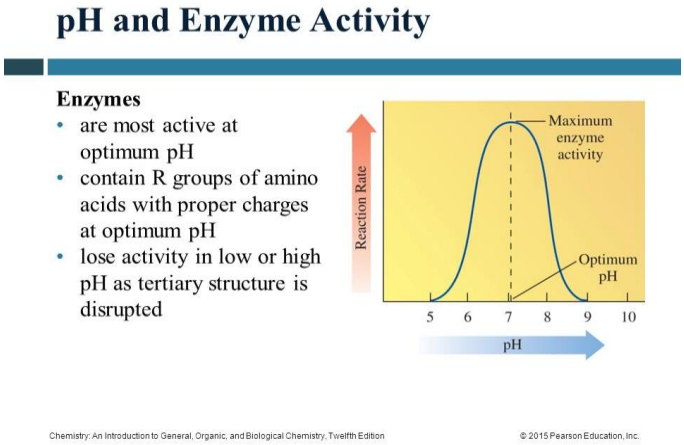
3. Temperature

a**. The rate of enzyme may increase with increase in temperature** but up to a certain limit.
b. All enzymes can work at their maximum rate at optimum temperature.
c. For enzymes of human body 37°C is the optimum temperature.
d. Enzymes denature at high temperatures.



4. Value of PH.

a. Enzymes have specific range of PH at which will work.
b. loose activity in low or high PH.
c. Enzyme denature (change shape and become ineffective). (in temperature and PH).



Enzyme inhibition:

Inhibitors : a chemical substance, can react in place of substrate with the enzyme but is not transformed into product(s). the process called enzyme inhibition.

The Inhibitors : poisons, like cyanide, antibiotics, anti-metabolites and some drugs.

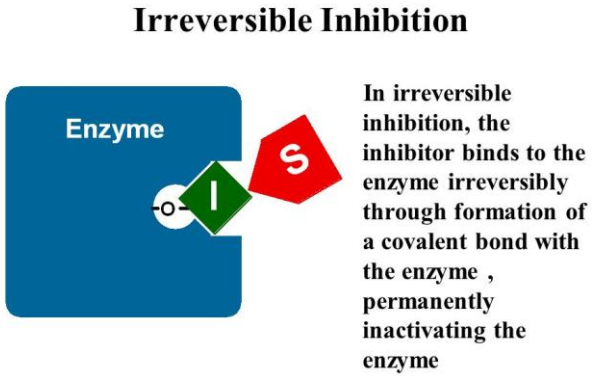
Classification of inhibitors:

Inhibitors can be divided into two types: **(i) Irreversible (ii) Reversible**

Irreversible inhibitors:

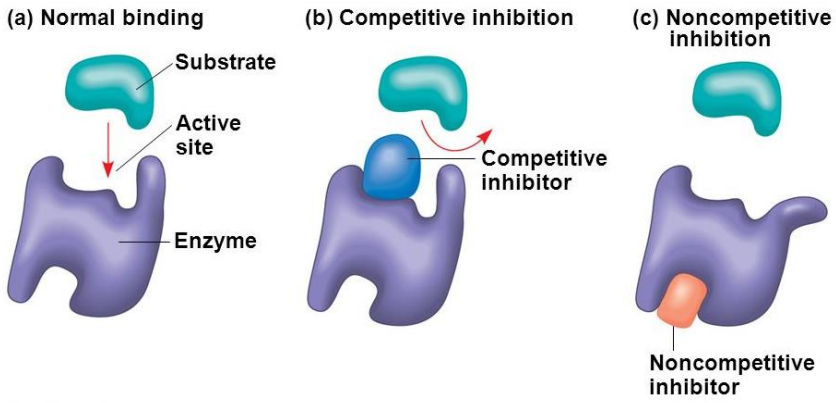
1. The inhibitor occupying the **active sites** by forming covalent bonds or they may physically block the **active sites.**

2. The inhibitor destroying the globular structure.



Reversible Inhibitors:

Reversible inhibitors attach to enzymes with non-covalent interactions such as hydrogen bonds, hydrophobic interactions and ionic bonds. Inhibitors form weak linkages with the enzyme.



Diagnostic value of plasma enzyme:

When a tissue is injured some cell of that tissue are destroyed and their content including enzyme are released in to the blood stream. The increasing of enzyme in blood will indicate the disease.

Enzymes	Increase in disease
1. Aspartate transaminase (GOT) (previously)(AST)	myocardial infarction
2. Alanine transaminase (GPT)(Previously) (ALT)	liver disease especially with liver cell damage
3. Amylase	Acute pancreatitis

4. Acid phosphatase(ACP)	Prostatic carcinoma
5. Alkaline phosphatase(ALP)	Liver disease, bone disease (rickets)
6.Lactate Dehydrogenase(LDH)	myocardial infarction, liver disease, Blood disease
7. Creatine Kinase(CK)	myocardial infarction , skeletal muscle disease (Muscle dystrophy)
8. Glutamyl transferase (GT)	liver disease, biliary obstruction

All these enzymes are seen in blood:

1. Normal level of (GOT) in blood. (5 to 40 units / liter)

Found in high concentrations in liver, heart, skeletal muscle and kidney, in both cytoplasm and mitochondria.

Elevated in serum in: **myocardial infarction**, **acute liver cell damage**, **viral hepatitis** and **carbon tetrachloride poisoning.**

Moderate elevation: **muscular dystrophy, dermatomyositis, acute pancreatitis** and **crushed muscle injuries.**

2. Normal level of (GPT) (7 to 56 units / liter)

Very high levels of ALT: (more than 10 times normal) are usually due **to acute hepatitis**, sometimes due to a **viral infection.**

moderate increases in ALT: include **obstruction of bile ducts, cirrhosis, chronic hepatitis, heart damage, alcohol abuse, tumors in the liver.**

3. Enzyme phosphatase: is agroup of enzyme , hydrolysis the monophosohate ester under acidic or alkaline condition.

Type of phosphatase are: **1. Acid phosphatase ACP**

2. Alkaline phosphatase ALP

Acid phosphatase(ACP). Normal level = 0.1 – 3.5 K. A.U /100ml

Disease elevated in: **1. metastatic prostate carcinoma.**

2. carcinoma of blood.

Alkaline phosphatase(ALP). Normal level (3 – 13) K. U/ ml blood

Disease elevated in: **1. Bon disease (paget disease)**

2. Rickets 3. Liver disease

4. Enzyme amylase. Normal value: 100 – 330 IU/L

Disease elevated in: **1. Acute pancreatitis 2. Severe diabetic (ketosis and acidosis).**

3. salivary gland disorder (mumps, parotitis)

5. Lactate dehydrogenase LDH: Normal level (70 – 240IU/L)

Disease elevated in: **1.myocardial infarction (MI)**

2. pneumonia 3. Leukemia 4. Anemia