CLASS – 11

BIOLOGY

Chapter – 9

BIOMOLECULES - Enzyme

By ~Shahanshah Shahid

PGT- Biology

Chandra Public School, Mau (U.P)

Introduction

- Multiple of biochemical reaction occurs in living cells which are collectively called metabolism.
- In metabolism two type of process are found –

1. **Catabolism-** breakdown of larger molecules and their oxidation to CO2 and H2O
2. **Anabolism –** synthesis of molecules by simple substances.

- In all the biochemical reaction required a specific enzyme for their completion and the enzyme control the rate of reaction.
- Generally enzyme divided into two classes

1. **Endo-enzymes** (intracellular enzymes)

Example- Most plant enzyme

2. **Exo-enzymes** (extracellular enzymes)

Example- enzyme found in bacteria, fungi and insectivores

Characteristic of enzyme

1. **Colloidal nature**: - due to large size of the enzyme molecules posses' extremely low rate of diffusion and form colloidal system in water.
2. **Catalytic nature or catalytic efficiency:-** The rate enzyme catalyzed reaction (catalytic power of enzyme) is measure by turnover number(i.e. no. of substrate molecules converted into product per enzyme site per second)

Name of enzyme	Turnover number
Chymotrypsin	100-1ooo/sec
Trypsin	100-1000/sec
Ribonuclease	100/sec

Urease	10000/sec
Enolase	100/sec

- Rate of enzyme catalyzed reaction are affected by experimental condition i.e. temperature pH presence of specific molecules.

3. Specificity of enzyme action:-

- Each enzyme is specific in their action.

Example –

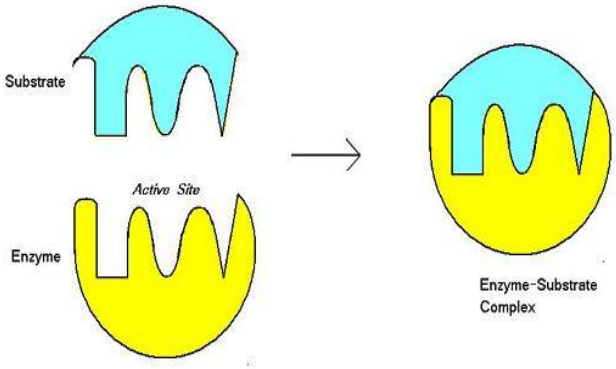
1. Urease show absolute specificity for urea
2. Alanine racemes show optical specificity (i.e. inter-conversion between L- form to D-form) for Alanine .x

4. Thermal stability (Heat sensitivity):-

- Being proteinaceous in nature enzyme are sensitive to heat .
- The rate of enzyme action increases with rise in temperature but above the 60 degree centigrade the enzyme become inactivated.

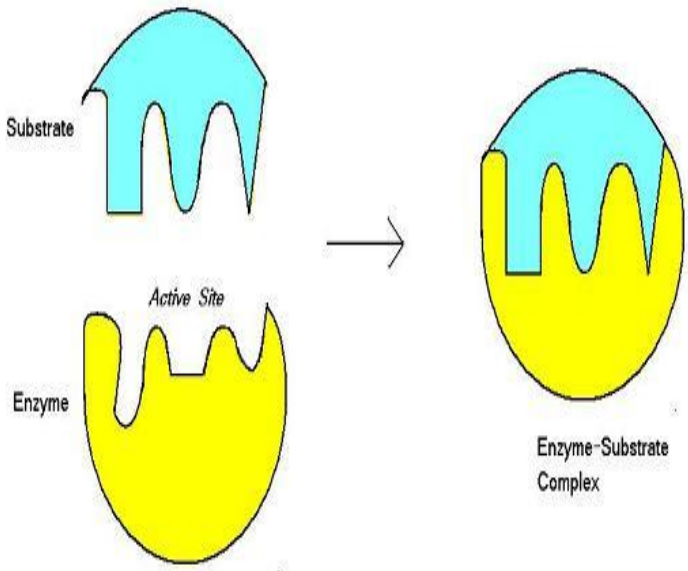
Active site

- Small portion of a enzyme where substance molecules bind and undergo a biochemical reaction.



Lock-and-key Model.- The substrate and enzyme active site have complementary shapes

- Enzyme can be denatured by high temperature or extreme pH values that mean the shape of active site change shape and does not fit its substrate molecules.



Induced-fit Model. - The enzyme active site forms a complementary shape to the substrate after binding.

Models:-

1. **lock-and-key model**
2. **Induced-fit model-**

Properties of active site

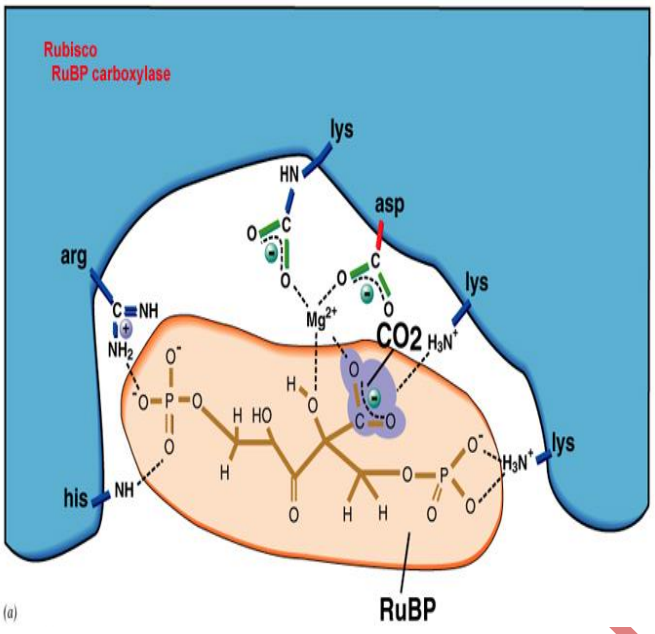
1. Flexible
2. Active site form due to tertiary structure of proteins
3. In active site the amino acid sequence are linear
4. Active site posse two site-

- Catalytic site
- Substrate binding site

5. Enzyme is specific in their nature due to existence of active site.

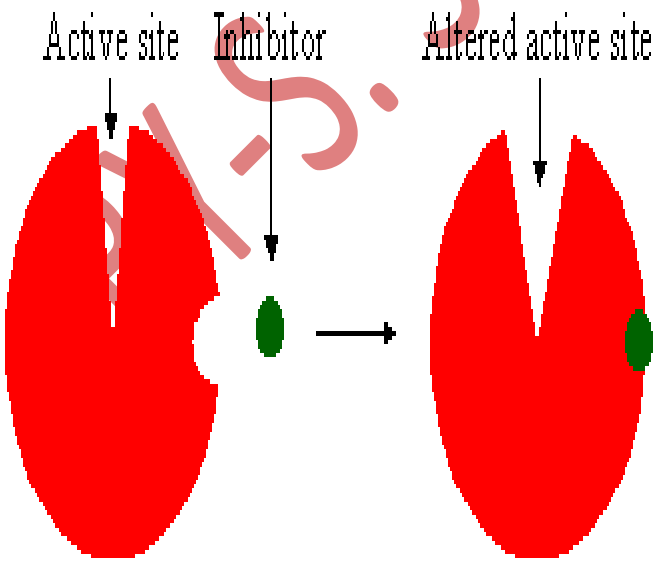
6. Out of 20 amino acid only some of them are repeatedly found at active site such as:-

Serine, Aspartate, Histidine ,Cysteine Lysine , Arginine, Glutamate, Tyrosine



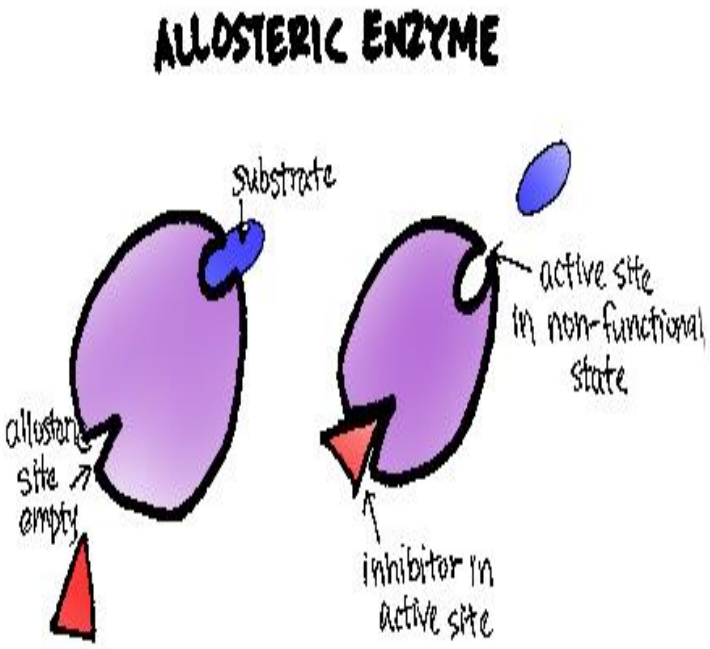
Allosteric site

- The place on an enzyme where a molecule that i s not a substrate may bind, thus changing the shape of the enzyme and influencing its ability to be active.



Allosteric regulation:-

- It is a regulation of enzyme by binding an effecter molecules at the allosteric site of enzyme .
- When an effecter enhance the activity of enzyme known as allosteric *activators.*
- when an effecter inhibit the activity of enzyme known as *allosteric inhibitors*



Co-factor

- Cofactor is non protein chemical compound that is bound to a enzyme and required for its biological activity.
- It classified into two classes
- Inorganic cofactor

Ion	Examples of enzyme
Cupric	Cytochrome oxidase
Ferrous or Ferric	Catalase
	Nitrogenase

	Hydrogenase
Magnesium	Glucose-6-phosphate Hexokinase DNA polymarase
Maganese	Arginase
Nickel Zinc	Urease Alcohol dehydrogenase Carbonic anhydrase DNA polymerase

Organic cofactor

It further divided into two group

I. Co-enzyme :-

Those cofactors which bound with enzyme loosely known as coenzyme .

Example - Vitamin (B1, B2, B6, B, Folic acid Vitamin c .

II. Prosthetic group:-

Those cofactors which bound with enzyme tightly known as prosthetic group.

Example: - Thiamine pyrophosphate (TPP), Flavin adenine dinucleotide (FAD), Biotin ,Lipoamide

Classification of enzyme

- In 1961 international union of biochemistry(I.U.B.) classified into 6 classes on of function performed by them –

Class Number	Enzyme Class	Catalysed Reaction	Example
1	Oxido-reductases	Oxidation-reduction reaction	Alcohol dehydrogenase , Catalase
2	Transferases	Transfer of functional group	Phosphorylase, Hexokinase
3	Hydrolases	Hydrolysis reaction	Lipase , Arginase ,Trypsin, Kimotripsin and all gastro intestinal enzyme
4	Lyases	Addition-elimination	Aldolase, Fumarase
5	Isomerases	Isomerization	Glucose phosphate Isomerase, Malate Isomerase
6	Ligases	Condensation	Citrate synthetase , acetyl-coA synthetase, acetyl-coA carboxylase

Modifiers of enzyme activity

- Organic or inorganic molecules which reversibly alter the catalytic activities of enzymes.
- These molecules behave two way-

1. Activator (positive modifiers) –

- These modifiers are molecules which increases the enzyme activities.
- Example:-Inorganic modifiers

2. Inhibitors (negative modifiers)-

- These modifiers are molecules which decreases the enzyme activities.
- Example:- Organic modifiers

Inorganic modifiers (Enzymes activators):

- Some enzymes required a metal ions for its activity.
- But if remove the metal ions the enzymes loss partially or totally their enzymatic activities.

Example:- K, Cu, Fe, Mg etc .

- Mg2+ participates in phosphate-transfer reactions.
- Fe, Cu participates in oxido- reduction reactions

Enzyme inhibitors

- Organic compound which converted the enzyme into inactive substance and thus adversely affected the rate of enzymetically-catalyzed reaction known as inhibitors.
- This process known as inhibition.
- These inhibitors generally recognized into two types- on the basis of whether the enzyme-inhibitor (EI) complex dissociates rapidly or very slowly.
- Reversible Enzyme Inhibition
-
- Irreversible Enzyme Inhibition

Uses of Enzyme Inhibition

- Enzyme inhibitors are important for a variety of reasons

1) They can be used to gain information about the shape on the enzyme active site and the amino acid residues in the active site.
2) They can be used to gain information about the chemical mechanism.
3) They can be used to gain information about the regulation or control of a metabolic pathway.
4) They can be very important in drug design.

Reversible Enzyme Inhibition

- In this case the inhibitor dissociates very rapidly because it bound very loosely with enzyme.
- It distinguished into three type:-

1. Competitive (substrate analogue) inhibition:-

- In this structure of inhibitors closely resembles with substrate.
- Due to analogues of substrate the inhibitor bind with enzyme and form enzyme-inhibitors complex.
- The composition between substrate and inhibitor to bind with enzyme (degree of inhibition) depend upon relative composition of the substrate and inhibitors.

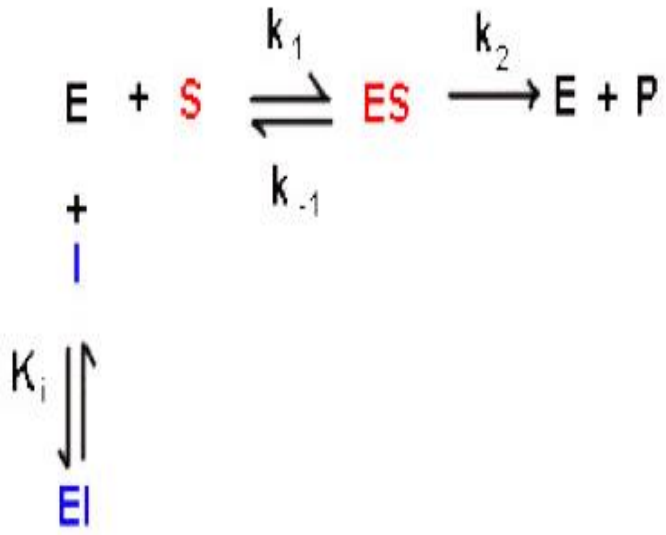
Example:-

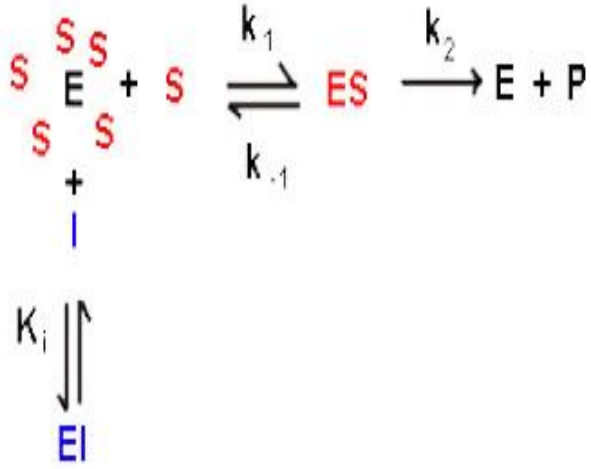
i. Catalytic action of succinic acid dehydrogenase .

ii. Competitive inhibition used in therapeutically to treat patients who ingested methanol (CH3.OH).

Competitive Inhibition

- A competitive inhibitor reduces the amount of free enzyme available for substrate binding thus increasing the Km for the substrate
- The effect of a competitive inhibitor can be overcome with high concentrations of the substrate



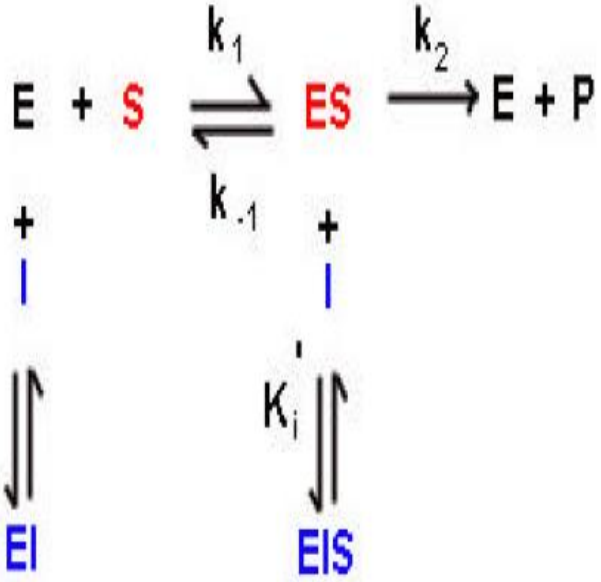


2. Non-competitive inhibition:-

- In this substrate and inhibitor bind simultaneously to a enzyme but the site of binding is different for both substrate and inhibitors .
- The inhibitor can bind to both free enzyme and the ES complex .

Example:-

- Ag, Hg, Pb inhibit the activity of various enzyme such as urease .
- Cyanide and hydrogen sulphide strongly inhibits the action of iron- containing enzymes for e.g. – catalase, peroxides .

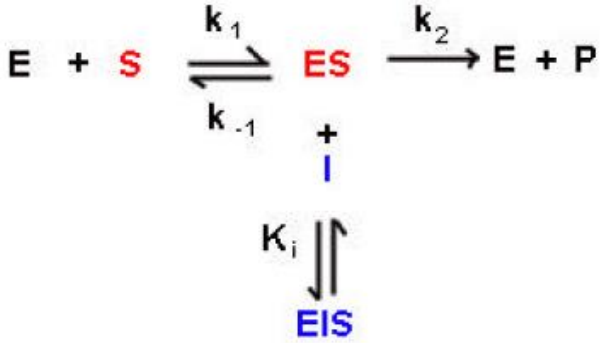


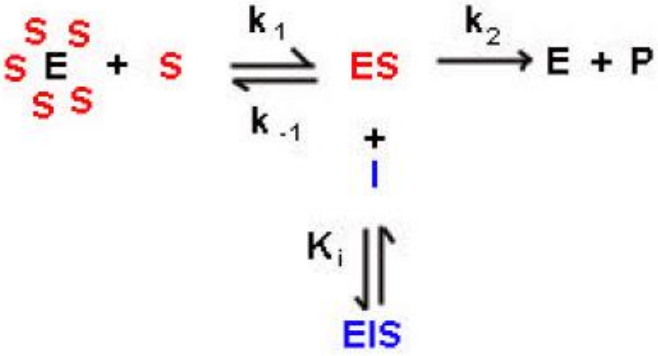
3. Uncompetitive inhibition:-

- These inhibitors bind on Allosteric site .
- An uncompetitive inhibitor binds to the enzyme substrate complex but not to free enzyme

The result is a decrease in Vmax and Km

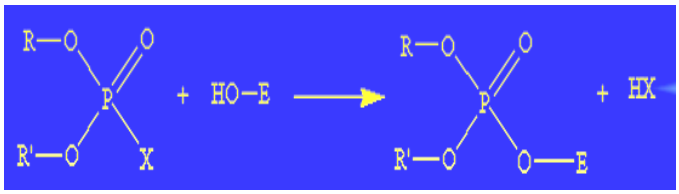
The effect of an uncompetitive inhibitor can not be overcome by high concentrations of the substrate.



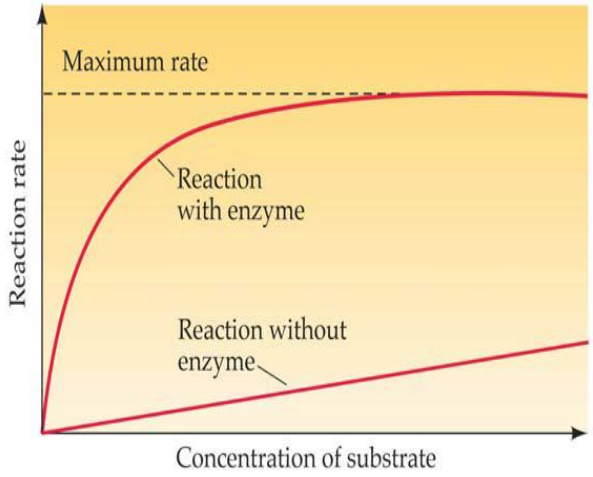


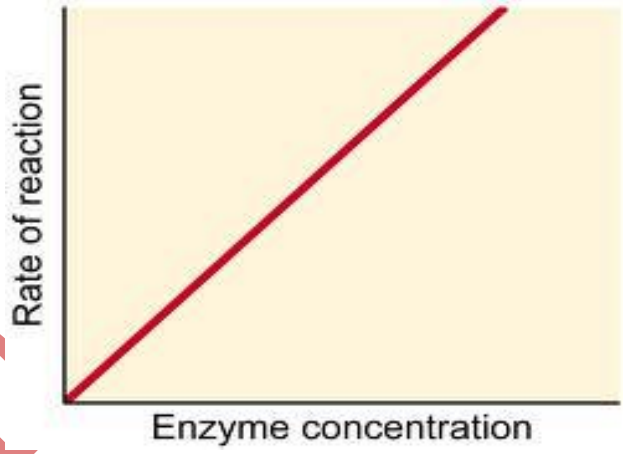
Irreversible Enzyme Inhibition

- The inhibitor combine with essential group of enzyme active center by covalent bond, resulting in enzymatic activity loss.

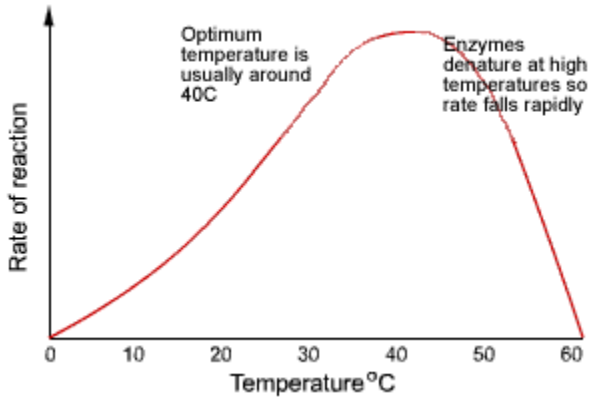


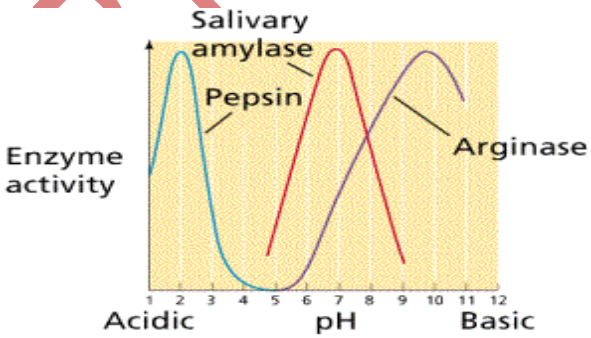
- Irreversible inhibitor dissociated very slowly from its target enzyme .
- Example:-
- Iodoacetamide (used in detection of sulfhydryl group)- irreversibly inhibits the catalytic activity by modifying cysteine and other side chain .
- Diisopropylphosphofluorideate(DIPF) – act as irreversible inhibitor on those enzyme which have active residues at catalytic sites .





Factors that Affect the Rate of Enzyme Reactions





- http://www.biologymad.com/resources/Ch%204%20-%20Enzymes.pdf
- http://en.wikipedia.org/wiki/Allosteric_regulation