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Chemical nature of enzyme

* All enzymes are globular proteins composed of one or several polypeptide chains with the exception of recently discovered RNA enzymes.

* Some enzymes may additionally contain a non-protein group. According to this there are two type of enzymes. (1) Simple (2) Conjugated

Simple enzymes :- It is wholly made up of protein. eg. Pepsin, Trypsin, Urease

Conjugated enzymes :- It is formed of two parts

Holoenzyme

① A protein part (Apoenzyme) ② A non-protein part (Co-factor)

* Active site is formed jointly by apoenzyme & cofactor.
* Co-factor is small, heat stable and dialysable part of conjugated enzyme.
* Three types of cofactors may be identified. (1) Prosthetic Group (2) Co-enzyme (3) Metal Ions.

* Prosthetic Group :→ They are organic compounds & are tightly bound to the apo-enzyme

Example - Peroxidas and Catalase, which catalyses the breakdown of $H_2O_2 \longrightarrow H_2O + O_2$, Haem is the prosthetic grp & it is the part of the active site of the enzyme.

* Co-enzyme :- The are also organic compound but their association with apoenzyme is only transient, usually occur during the course of catalysis. The essential chemical components of many coenzyme are vitamins

eg. Coenzyme nicotinamide adenine dinucleotide (NAD) and NADP contain the vitamin Niacin

- FMN, FAD contain riboflavin
- TPP contain thiamine

* Metal ions :- A number of enzyme require metal ions for their activity which forms co-ordination bonds with side chains at the active site and at the same time form one or more cordination bond with the substrate.

Example :→ Zn is cofactor for the proteolytic enzyme "Carboxy peptidase"

Cl^- stimulate activity of salivary amylase

Classification and Nomenclature of Enzymes :-

* Thousands of enzymes have been discovered, isolated and studied. Most of these enzymes have been classified into different groups based on the type of reactions they catalyse.

The modern system of enzyme classification was introduced by International Union of Biochemistry (IUB) in 1961. Enzymes are divided into 6 classes each with 4-13 subclasses and named accordingly by a four-digit number.

1. Oxido reductases or Dehydrogenases : Enzymes which catalyse oxidoreduction between two substrates S and S' eg

S reduced + S' oxidised ⟶ S oxidised + S' reduced

2. Transferases :→ Enzymes catalysing a transfer of a group, G (other than hydrogen) between a pair of substrate S and S' eg.

$S\text{-}G + S' \longrightarrow S + S'\text{-}G$

3. Hydrolases :→ Enzymes catalysing hydrolysis of ester, ether, peptide, glycosidic, C-C, C-halide or P-N bonds. Digestive enzymes belongs to this group.

4. Lysases :- Enzymes that catalyse removal of groups from substrates by mechanism other than hydrolysis leaving double bonds. eg. Aldolase

X Y
C-C ⟶ X-Y + C=C

5. Isomerases :- Including all enzymes catalysing interconversion of optical, geometric or positional isomers.

6. Ligases :- Enzymes catalysing the linking together of 2 compounds eg enzymes which catalyses joining of C-O, C-S, C-N, P-O etc. bonds.

Properties of Enzymes :→

1. Enzymes are mostly protein in nature & generally globular proteins
2. They are colloidal in nature.
3. Enzyme do not start a chemical reaction but increase the rate of chemical reaction.
4. Enzymes are highly specific in their action.
5. All enzymes are heat sensitive or thermolabile
6. They get inhibited by inhibitors.

Factors Affecting enzyme Activity :→

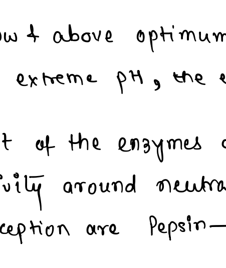
* The activity of an enzyme can be affected by a change in the conditions which can alter 3°-structure of the protein. These include
- Temperature
- pH
- Substrate concentration
- Binding of specific chemicals that regulate its activity.

1. Temperature :- The enzyme is active with in a narrow range of temperature. The temperature at which enzyme shows its highest activity is called optimum temperature.

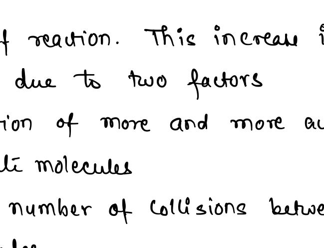
In Human it is 37°C.

* Enzyme becomes inactive below this temperature ∴ It is used in preservation of foods inside cold.
* Low temperature tnt inside cold storage prevents spoilage of food.

* High temperature destroys enzymes by causing their denaturation. This occur at 50°C or so.



2. pH = Enzyme shows its highest activity at a particular pH called optimum pH.



Below + above optimum pH, enzyme activity is lowered, and extreme pH, the enzymes become totally inactive.

* Most of the enzymes of higher organism shows optimum activity around neutral pH (6-8).
* Exception are Pepsin → 2.0 Trypsin → 8.5

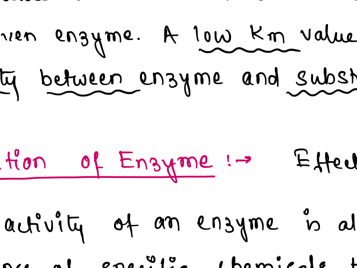
* Substrate Concentration :→ ↑es substrate concentration ↑es the rate of reaction. This increase in velocity of reaction is due to two factors

(i) occupation of more and more active sites by substrate molecules

(ii) Higher number of collisions between the substrate molecules.

If graph is plotted for substrate concentration versus reaction velocity, it appears to be hyperbolic curve

The reaction ultimately reaches a maximum velocity (Vmax) which is not exceeded by any further rise in substrate concentration. This is because the enzyme molecules are fewer than the substrate molecules and after saturation of these molecules, there are no free enzyme molecules to bind with additional substrate molecules.



Michaelis Constant (Km) :→ It is a mathematical constant which indicates the substrate concentration at which the chemical reaction catalysed by an enzyme attain half its maximum velocity.

Michaelis Menten Constant generally lies between 10^{-1} to 10^{-6} M.

* Km value is a constant and a characteristic feature of given enzyme. A low Km value indicates a strong affinity between enzyme and substrate

Inhibition of Enzyme :→ Effect of inhibitor

* The activity of an enzyme is also sensitive to the presence of specific chemicals that bind to the enzyme. when binding of enzyme shuts off enzyme activity, the process is called inhibition and the chemical is called inhibitor

⇒ There are three broad categories of enzyme inhibition

1. Reversible inhibition
2. Irreversible inhibition
3. Allosteric inhibition

1. Reversible inhibition :→ The inhibitor binds non-covalently with enzyme and the enzyme inhibition can be reversed if the inhibitor is removed. This inhibition further devided into following types.

(i) Competitive inhibition
(ii) Non-competitive inhibition.

(i) Competitive inhibition :→ when the inhibitor closely resembles the substrate in its molecular structure and inhibits the activity of enzyme. The inhibitor competes with substrate and binds at the active site of the enzyme but does not undergo any catalysis.

** The relative concentration of the substrate and inhibitor (substrate analogue or competitive inhibitor) and their affinity with enzyme determines the degree of competitive inhibition. The inhibition could be overcome by a high substrate concentration.

In competitive inhibition, the Km Value increases where as Vmax remains unchanged.
↓ means affinity for substrate decreases.

example :→ Inhibition of succinic dehydrogenase (SDH) by malonic acid (malonate), glutaric acid and oxalic acid.

- Bacterial pathogens has been affected through competitive inhibition. Sulpha drugs (sulphanilamide) inhibits the synthesis of folic acid in bacteria by competing with p-amino benzoic acid (PABA) for the active site of enzyme. Preformed folic acid is obtained by animal cells. Therefore, sulpha drugs do not harm them.

* ethanol can be used in the treatment of methanol poisoning. Competes for Alcohol dehydrogenase (ADH)

(ii) Non-Competitive inhibition :→ The inhibitor binds at a site other than active site on the enzyme surface. The binding impairs the enzyme function. The inhibitor has no structural resemblance with substrate. In fact, the inhibitor does not interfere with enzyme-substrate binding. But the catalysis is prevented, possibly due to a distortion in the enzyme conformation.

The inhibitor generally binds with the enzyme as well as the ES complex.

$$E+S \rightleftharpoons E{\cdot}S \longrightarrow E+P$$
$$+ \quad\quad\quad + $$
$$I \quad\quad\quad I$$
$$\upharpoonleft\downharpoonright \quad\quad \upharpoonleft\downharpoonright$$
$$EI+S \quad\quad EIS$$

** For non-competitive inhibition, the Km value is unchanged while Vmax is lowered.

* Heavy metal ions (Ag^+, Pb^{2+}, Hg^{2+} etc) can non-competitively inhibit the enzymes by binding with cysteinyl sulphydryl groups.
* Cyanide ion inhibit cytochrome oxidase. [cytochrome c oxidase]

(2) Irreversible inhibition :→ The inhibitor bind covalently with the enzymes and inactive them, which is reversible. These inhibitors are usually toxic poisonous substances.

eg. Disulfiram is a drug used in the treatment of alcoholism. It irreversibly inhibits the enzyme aldehyde dehydrogenase. Alcohol addicts, when treated with disulfiram become sick due to the accumulation of acetaldehyde

* The penicillin antibiotics act as irreversible inhibitors of serine-containing enzymes, and block the bacterial cell wall synthesis.

(3) Allosteric inhibition or Modulation :→

* Some enzyme possess additional sites known as allosteric site besides the active site. Such enzymes are known as allosteric enzyme.

* Allosteric effectors :- Certain substances referred to as allosteric modulators bind at the allosteric site and regulate enzyme activity.

Activity ↑es ⟶ when +ve allosteric effector binds at the allosteric site k/a Activator

Activity ↓es ⟶ when -ve allosteric effector binds at the allosteric site k/a inhibitor

* Class of allosteric enzyme

K-class ⟶ Km → change Vmax → same

V-class ⟶ Km → Same Vmax → change

eg. Inhibition of glucokinase by G-6-P

Proenzyme :→ It is the inactive precursor of enzyme. The term zymogen is often used for inactive precursor of proteolytic enzyme.

Isoenzyme :→ The multiple molecular forms of an enzyme occuring in the same organism and having a similar substrate activity are called Isoenzymes.

** Biomolecules have hierarchy of structures – 1°, 2°, 3°, 4°
** only three biomacromolecules i.e. Proteins, nucleic acids and polysaccharides are found in living systems.

Minerals :→