ENZYME

1. A cell is a site for various biochemical activities. It forms the new tissues, replace the old tissues. 2. The energy changing process and disposal of waste substance occurs continuously in cell. These biochemical occuring in cell requires the catalyst which is known as enzymes. 3. These catalyst or enzymes speeds up the rate of reactions.

4. Many biochemical reactions would not occur without enzymes.

5. So the enzymes are responsible for supporting almost all the biochemical reactions that maintain tendency in living organism.

Eg:- Catalase enzyme takes part in decomposition of Hydrogen peroxide.

$$2H_2O_2 \xrightarrow{\text{Catalase}} 2H_2O + O_2$$

HISTORY OF ENZYMES DISCOVERY

1. The enzyme was first discovered by Anselme Payen(1833).
2. Later Louis Pasteur studied fermentation (Breakdown of a substance) of sugar to alcohol by yeast and told that vital force in yeast known as ferments.
3. Edward Buchner named the enzyme zymase that brought about the fermentation of sucrose.
4. Following the Buchners example, enzymes were usually named according to the reaction.
5. The suffix -ase is combined with the name of the substrate.

Eg:- Lactase is the enzyme that decompose lactose.

STRUCTURE OF ENZYME

On the basis of their structure the enzymes are of following types :-

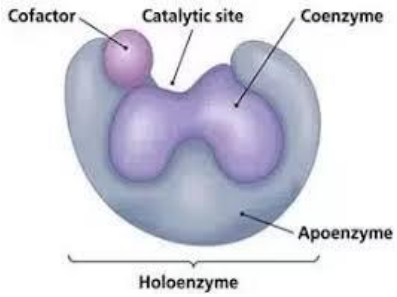
I. Holoenzyme
II. Apozyme
III. Prosthetic group
IV. Cofactors
V. Coenzymes

I. HOLOZYME :-

1. These are the active enzymes.
2. It consist of a protein component (apoenzyme) and its coenzymes (complex organic molecules).
3. These enzymes need the help of cofactors to function.

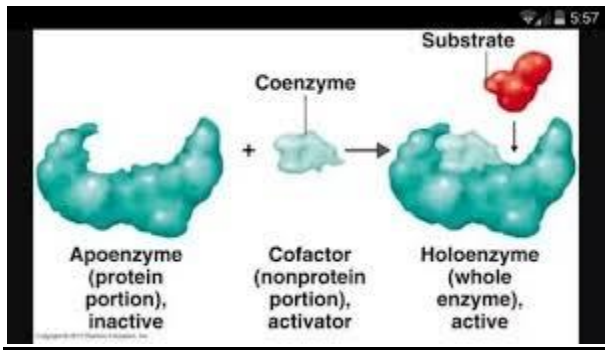
Eg :- DNA polymerase and RNA polymerase contain multiple protein subunits.

4. The protein component is known as apoenzyme, while the non-protein component is known as the cofactor.
5. The cofactor may be as simple as as a metal ion or as complex as a small non-protein organic molecule(iron, zinc, magnese, magnesium, copper, calcium, vitamins etc.).



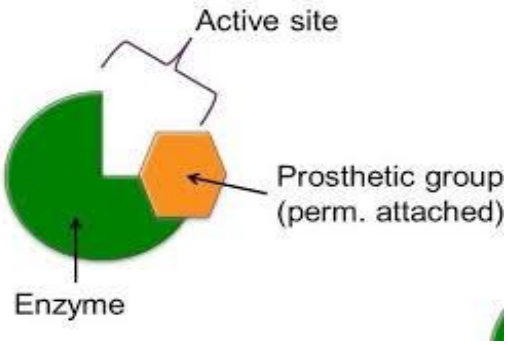
II. APOZYME :-

1. An apoenzyme is an inactive enzyme.
2. When the apoenzyme binds with an organic or inorganic factor, it becomes active.
3. An apoenzyme together with its cofactor are called holoenzyme.



III. PROSTHETIC GROUP :-

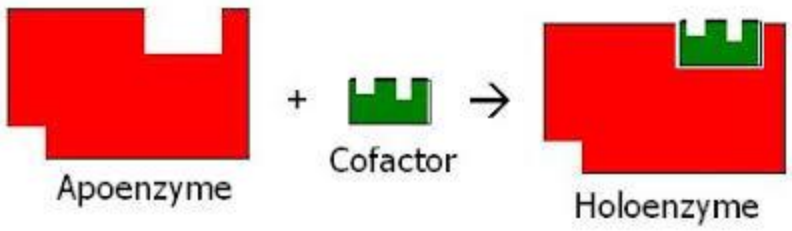
1. It is a tightly bound specific non-polypeptide unit.
2. It is required for the biological function of some proteins.
3. The prosthetic group may be organic(vitamin, sugar, lipid), or inorganic(metal ion).
4. It is a complex in which the small organic molecule is bound to the apoenzyme by covalent bond.
5. It is a dialyzable, thermostable and firmly attached to the apoenzyme portion.



IV. **COFACTORS** :-

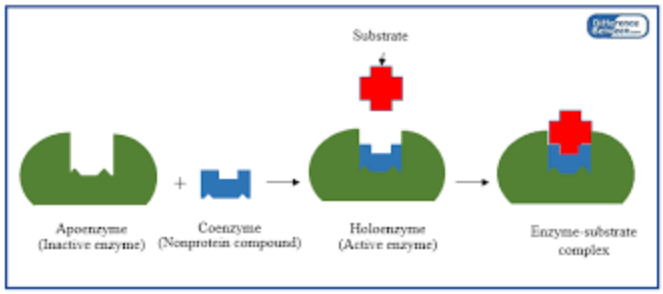
1. The cofactors are mostly ions or coenzymes.
2. The coenzymes are inorganic and organic chemicals that assists enzymes during the reactions.

3. The cofactor can be divided into two groups:- i. Coenzymes. ii. Prosthetic groups.
4. The coenzymes are small organic molecules usually obtained from the vitamins.
5. Prosthetic groups refer to tightly bound coenzymes.



V. **COENZYMES** :-

1. A coenzyme is an organic non-protein compound.
2. It binds with an enzyme to catalyse a reaction.
3. A coenmzyme cannot function alone but can be reused several times when paired with an enzyme.
4. An enzyme without a coenzyme is called an apoenzyme.
5. Without coenzymes the enzymes cannot catalyse reactions effectively.
6. When an enzyme gains a coenzyme, then it becomes a holoenzyme or active enzyme.



CLASSIFICATION OF ENZYMES

Depending on the reactions that they catalyse, the enzymes are classified into six major groups :-

I. Oxidereductases
II. Transferase
III. Hydrolases
IV. Lyases
V. Isomerases
VI. Ligases

I. OXIDEREDUCTASES :-

1. It catalyse oxidation-reduction reaction, where electrons are transferred.
2. These electrons are usually in the form of hydrogen atoms.
3. When a substrate is being oxidized, it is the hydrogen donor.
4. These include oxidases, reductases and dehydrogenases.

II. TRANSFERASE :-

1. This group transfers functional groups between donor and acceptor molecule.
2. For example glutamate-pyruvate transaminase transfer an amino group from glutamate to pyruvate.

III. HYDROLASES :-

1. It is a catalyse that involve in hydrolysis.
2. This usually involve the transfer of functional groups to water.
3. Example digesative enzymes are hydrolases.

IV. LYSASES :-

1. These enzyme react where functional groups are added to break double bonds in molecule or the reverse, when double bonds are formed by the removal of functional groups.
2. Example decarboxylase remove CO_2 from the substrate.

V. ISOMERASES :-

1. This brings about rearrangement.
2. These enzymes allow for structural within a compound.
3. They may be isomerases, epimerases and mutases.

VI. LIGASES :-

1. These catalyse reacts where two chemical groups are joined with the use of energy from ATP.
2. These joined formation are of carbon-carbon, carbon-nitrogen etc.

MECHANISM OF REACTION

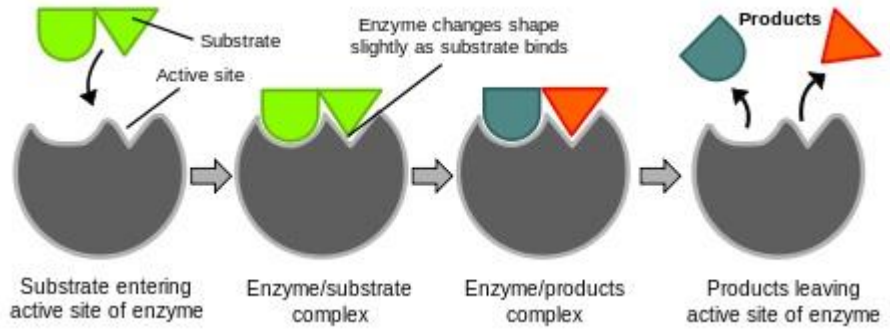
There are several theories regarding the mechanism of reaction. These are :-

I. ACTIVATION ENERGY :-

1. Some of the chemical reactions do not occur spontaneously.
2. These requires an external supply of an energy to initiate the reaction called activation energy.
3. In this reaction, an enzyme must unite with atleast one of the reactants.
4. In biochemical reaction, reactants are commonly called substrate.

II. LOCK AND KEY HYPOTHESIS :-

1. This theory was proposed by Emil Fischer.
2. According to this, the enzymes and substrate have specific shapes.
3. These enzymes are relatively large molecules and on their surface have specific sites called active sites.
4. The substrate molecule fit on this site just like a key fits into a lock.
5. The substrate molecule fits into the active site to form an enzyme-substrate complex.
6. The substrate undergo a chemical change and forms products, which are released from the enzyme.



III. INDUCED FIT THEORY :-

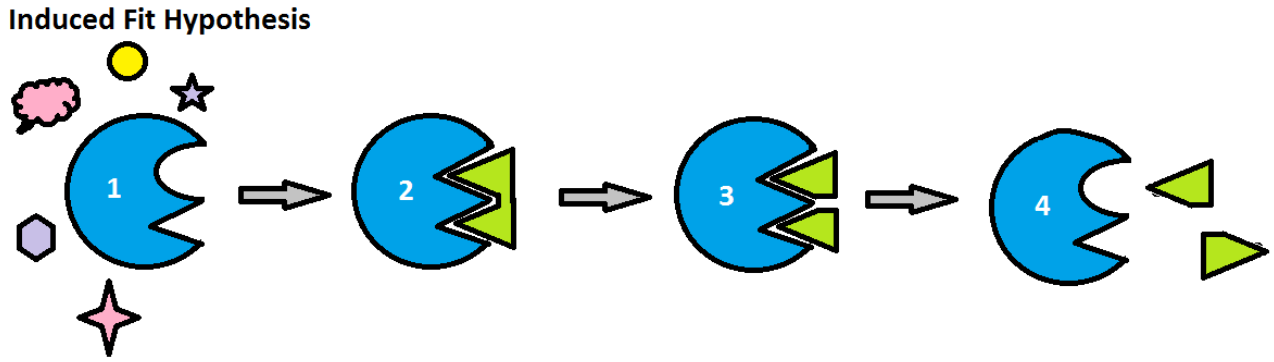
1. This theory is modification of lock and key theory.
2. It was proposed by D.E.Koshland.
3. According to this theory, contact of an enzyme with the substrate induces a change in the active site of the enzyme molecule.
4. The active site of the enzyme has two regions :-

(i). Buttressing region

(ii). Catalytic region.

(i). Buttressing region :- The buttressing region provides the attachment to the substrate.

(ii). Catalytic region :- The catalytic region is specialized to weaken bonds to break the substrate molecules and form products.



FACTORS AFFECTING ENZYME ACTIVITY :-

There are different factors which affects the enzyme activity. Such as temperature, pH, substrate concentration, enzyme concentration etc.

I. EFFECT OF TEMPERATURE ON ENZYME ACTIVITY :-

1. The activity of an enzyme increases with the temperature, to a certain temperature known as optimum.
2. After optimum, as the temperature increases further, the activity of enzyme decreases due to denaturation of the protein.
3. The increasing temperature easily breaks the hydrogen bond in the enzymes and it becomes denaturated.
4. The optimum temperature varies greatly from enzyme to enzyme.
5. They are around 25°C for plant enzymes.

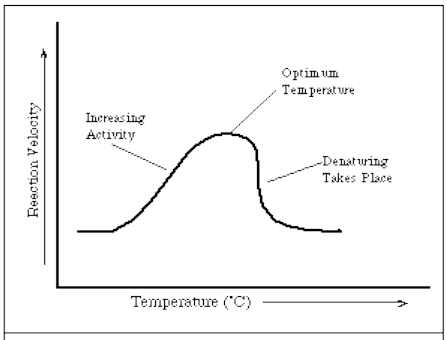


FIGURE 13
Effect of temperature on reaction rate

II. EFFECT OF pH ON ENZYME ACTIVITY :-

1. If the pH changes the enzymes are effected.
2. The changing in pH alters the state of amino acids.
3. Extremely high or low pH result in complete loss of activity for most enzymes.
4. Eg – (i). Pepsin :- It is secreted in the stomach. It works best at an acidic pH of 1-2.

(ii). Trypsin :- It is secreted by duodenum. It is inactive at low pH, but active at pH of 8.

III. SUBSTRATE CONCENTRATION :-

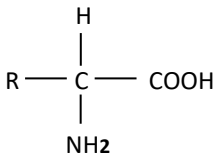
1. If the amount of enzyme is kept constant, the substrate concentration gradually increases.
2. The reaction velocity will increase until it reaches maximum.
3. After this (optimum) point, substrate concentration will not increase the velocity.

IV. ENZYME CONCENTRATION :-

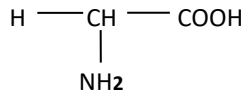
1. The enzyme of high concentration is effective on substrate of high concentration.
2. If the concentration of substrate is increased, then it becomes necessary to increase the concentration of enzyme.
3. But if the concentration of enzyme is high, and the concentration of substrate is low, then the activity of of enzyme becomes low.

PROTEINS

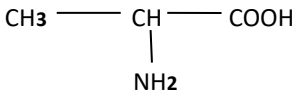
1. The amino acids are the building blocks of proteins.
2. Each amino acid are made up of carbon, Hydrogen, Oxygen and Nitrogen.
3. The sulphur may also present in some cases.
4. The general formula of an amino acid is:-



5. Each amino acid is a nitrogenous compound having an carboxylic group(-COOH) & a basic amino group(-NH_2).
6. The carbon next to the carboxylic group is called the alpha ( ) carbon.
7. R – represents the side chain that is different for each amino acid.
8. R – can be simple as a hydrogen atom or a methyl group (-CH_3), or a complex structure, which may be straight or branched or cyclic in nature.



Glycin
(H - in place of carbon)

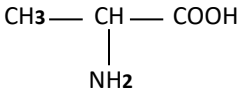


Alanine
(CH_3 in place of R)

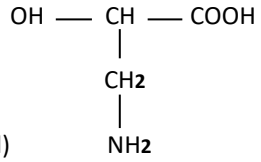
9. Since the amino acids have the acidic and basic group. So they can react with both acids and bases. So they are called amphoteric compounds.

The presence of R – group makes each amino acid unique.

1. If the R – group is of hydro-carbon chain, the amino acid is hydrophobic.
2. If the R – group has either oxygen or nitrogen, then the amino acid is hydrophilic.



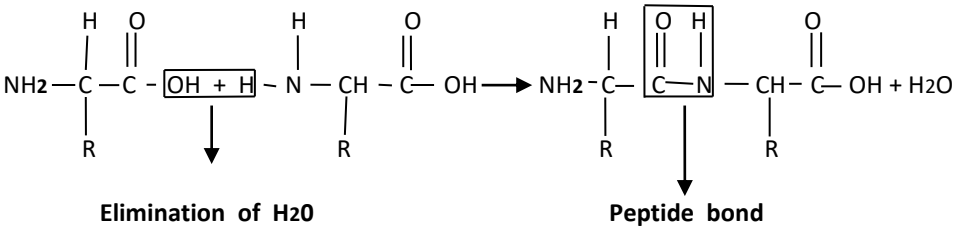
Alanine (Hydrophobic amino acid)



Serine (Hydrophilic amino acid)

PEPTIDE BOND

1. A peptide bond is formed between two amino acid molecules.
2. It is formed when the amino group (-NH_2) of one amino acid is linked with the carboxylic group (-COOH) of the other amino acid, by the elimination of water molecule.
3. Then covalent bond which is formed between the two amino acids is called peptide bond or amide bond.
4. This can be represented as - CO - NH



TYPES OF PEPTIDE BOND

The peptide bond are of following types:-

I. Dipeptide Bond

II. Oligopeptide Bond

III. Polypeptide Bond

I. Dipeptide Bond :-

The covalent bond which is formed between two amino acids is called dipeptide bond.

II.Oligopeptide Bond :-

A chain of 2-10 amino acids forms an oligopeptide bond. When there are 3 amino acids it is called tripeptide bond, If the number of amino acids are 4 it is called tetrapeptide bond and so on.

III. Polypeptide Bond :-

A chain of more than 10 amino acids is called polypeptide bond.

The peptide chain one end has a free amino group (-NH_2) called N- terminal end. The other end has a free carboxyl group (-COOH) called C- terminal end.

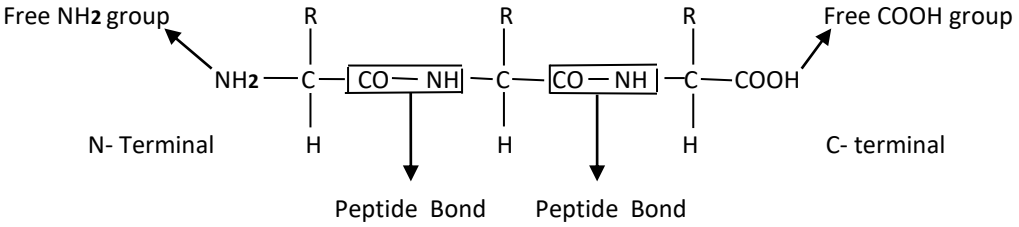


Fig :- Oligopeptide(tripeptide) with N & C terminal

LEVELS OF PROTEIN STRUCTURE

I. In proteins a large number of amino acids are linked by peptide bond to form a complex

molecule of protein.

II. There are 4 levels of protein structure :-

1. Primary Structure
2. Secondary Structure
3. Tertiary Structure
4. Quaternary Structure

1. **PRIMARY STRUCTURE** :-

i. This is the basic structure of any protein.

ii. It is determined by the sequence of amino acids in a protein.

iii. The sequence of amino acids in polypeptide chain is specific for a particular protein.

iv. Even a change in a single amino acid makes a different protein

2. **SECONDARY STRUCTURE** :-

i. The primary structure of a protein undergoes a change in structure by folding.

ii. Such formed proteins are called secondary structure protein.

3. **TERTIARY STRUCTURE** :-

i. When a compact globular shape is formed by extensive folding of the polypeptide chain, it gives rise to a tertiary structure.

4. **QUARTENARY STRUCTURE** :-

i. When two or more polypeptide chain associate with each other, it gives rise to a quaternary structure.

ii. Each chain exit in a tertiary level.