PUC 1st Year-Semester-2

Unit II: Chemical constituents of living cells

Module No: 14: Enzymes-Types, properties, Action

An enzyme may be defined as a complex biological catalyst that is produced by a living organism in its cells to regulate the various physiological processes of the body

The substance on which an enzyme acts is called the substrate. A catalyst is any organic or inorganic substance that accelerates a chemical reaction without affecting the end products of the reaction and without being destroyed in the course of the reaction. All chemical reactions occurring in living cells and therefore all metabolic processes are mediated by the highly specific biological catalysts, called enzymes.

Types

There are six main classes of enzymes based on their reaction specificity as suggested by the international Union of Biochemistry

1. Oxidoreductases

These enzymes are concerned with biological oxidation and reduction- the removal or addition of hydrogen atoms. Dehydrogenases, oxidases (where O_2 acts as acceptor), oxygenases (where O_2 is partly incorporated into the molecule), and peroxidases (where H_2O_2 serves as an acceptor) are found in this class of enzymes

2. Transferases:

These are the enzymes that catalyze the transfer of a chemical group from are molecule to another. The groups may be alkyl, glycosyl, acyl, amino, aldehyde, sulphur or phosphorus. Ex: Transaminases, Transphophorylases etc.

3. Hydrolases

They breakup the complex molecules into the simple ones by the addition of water molecule. These fall into 3 categories

A. **Proteases:**(**proteolytic enzyemes**): These are the enzymes that attack the peptide bonds of proteins and peptides.
B. **Carbohydrases:** These enzymes hydrolyze the glycosidic linkages of simple glycosides, oligosaccherides and polysaccharides
C. **Esterases:** These enzymes catalyze hydrolysis of ester linkages. This catagory includes lipases. Phosphatases, nucleases etc.

4. Lyases:

These are a group of enzymes that reversibly catalyze the removal of groups from substates non hydrolytically. Ex: Fumarase, Aldolase, Decarboxylase etc.

5. Isomerases or mutases

These are the enzymes that catalyze the inter-conversion of a compound to one of its isomers by intramolecular rearrangement of various atoms or groups. Examples are phosphohexose- isomerase, phosphohexose mutase etc.

6. Ligases or Synthetases

These are the enzymes that catalyze the linking of two separate molecules; the reaction is coupled with the breaking of an energy rich bond ATP.

Ex :Succinate thiokinase, glutamine synthetase etc

General properties

1. All enzymes are proteins. Enzymes exhibit all typical properties of proteins namely, high molecular weight, colloidal behaviour, slow diffusion, inability to pass through most living membranes, and movement in response to an electric current
2. Enzymes are active in small quantities. Since the enzyme is reused, only a small quantity of an individual enzyme is required by biological systems.
3. An enzyme changes only the rate of the reaction, not the direction of the equilibrium
4. An enzyme is a catalytic agent which speeds up a reaction by lowering the activation energy
5. Being a protein, an enzyme loses its catalytic properties if subjected to agents like heat, strong acids or bases, organic solvents which denature the protein
6. The enzyme activity is influenced by temperature. pH, concentration of enzyme and substrate concentration
7. Each enzyme usually acts an a single substrate. This is known as specificity of enzyme action
8. One of the primary characteristics of enzymes is their emergence from a reaction or set of reactions in an unaltered state.
9. Certain enzymes exhbit reversibility of their action. This propertiy is very helpful in metabolism.

10. Some enzymes exist as proenzymes, which are inactive and their activation is necessary to catalyse a reaction.

Mechanism of Enzyme action

The enzyme promotes a given reaction, but itself remains unchanged at the end of the reaction. In 1913 Michaelis and Menten proposed that an intermediate enzyme- substrate complex is formed during enzyme activity

Enzyme (E)+ substrate (S) ⇌ Enzymes-stubstrate complex (ES)

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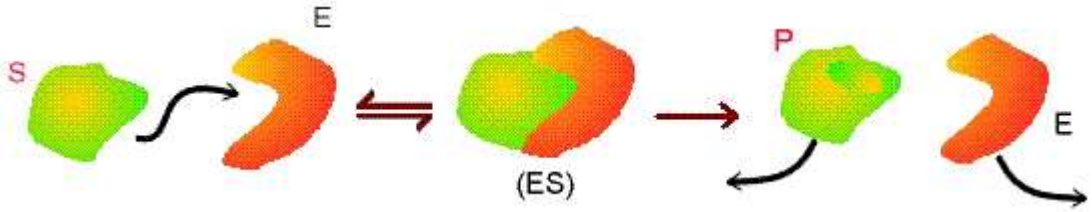
Enzyme +Products (p)



The enzyme itself remains almost passive. It merely provides a “platform” or template on which certain molecules could react with each other. Such an enzyme platform brings reacting molecules into contact much faster than chance collisions at that temperature. The result is that the reactions are accelerated.

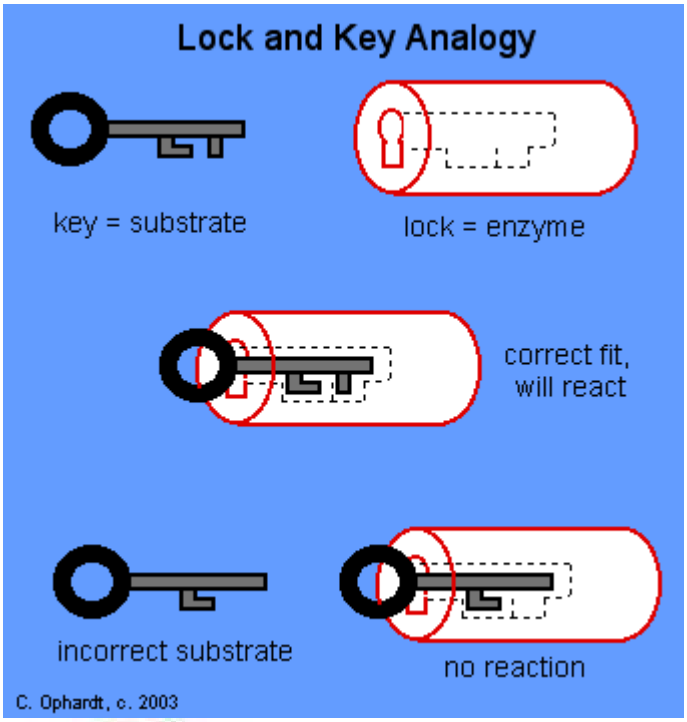
The mechanism of enzyme action has been explained by two theories.

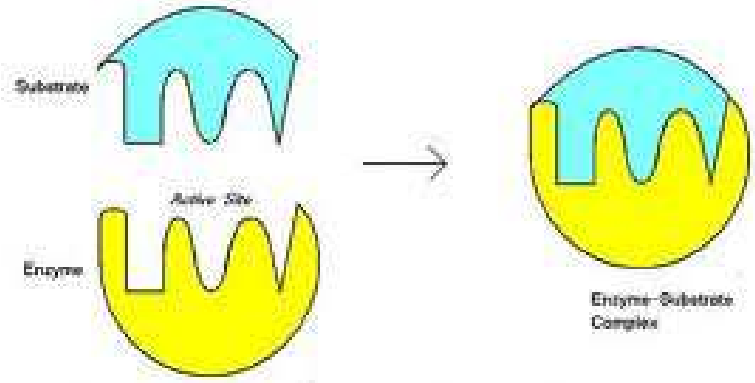
1. Lock and key theory
2. Induced fit theory

1. Lock and key theory

The lock and key theory of enzyme action was proposed by Emil Fischer in 1890. It is also called the rigid model of the catalytic site. Each enzyme has a unique shape into which a complementary substrate fits

quite easily just like a key fits into its lock. Similarly, only certain types of molecules will establish a close fit with a given type of enzyme protein. This concept was developed to explain the great specificity of enzymes. According to this concept a structurally well defined catalytic site will accept only those substrate molecules which have a matching shape and will repell others that differ structurally. In other words, the catalytic site of the enzymes by itself is complementary in shape to that of the substrate.

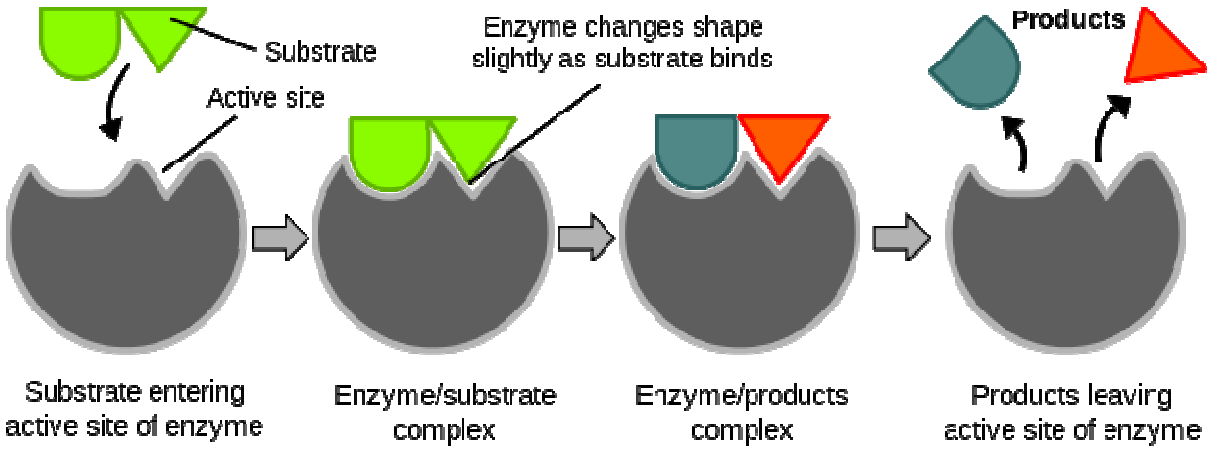




Lock-and-key Model.- The substrate and enzyme active site have complementary shapes

2. Induced Fit theory

This model was given by Koshland in 1966. It is also called the flexible model of the catalytic site. According to this model the catalytic site of some enzymes are not rigid, and undergoes a conformational change when comes in contact with substrate and thus the shape of the catalytic site is modified to the formation of enzyme substrate complex possible. The theory proposes that the active site of the enzyme does not initially exist in a shape that is complementary to the substrate, but is induced to assume the complementary shape as the substrate binds. Thus, according to the induced fit model, the enzyme (or its active site) is flexible



Questions

1. Describe the different types of enzymes and explain their general properties
2. Explain the mechanism of enzyme action