Topic: Nature and Properties of Enzyme

B.Sc. Botany (Sub.) II

Group: C

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Nature and Properties of Enzyme

An enzyme is a biological catalyst that can accelerate a specific chemical reaction by lowering the activation energy but remain unaltered in the process. Most enzymes are proteins. Some are nucleic acids (RNA) like ribozymes. Enzymes have enormous catalytic power. They greatly increase the rate at which specific chemical reactions take place.

Enzymes have following components: Globular part, active site, cofactors, and coenzymes:

Globular part

The main body of enzyme is composed of globular protein. It has a large number of amino acids. These amino acids are linked by peptide bonds. Enzyme body shows tertiary protein configuration. In this case, polypeptide chain folds upon itself to form globular protein; Polypeptide chain of tertiary structure is held by disulphide Bridge or hydrophobic interaction. Globular structure of enzyme is very important for its proper * Functioning. Loss of globular structure destroys enzyme.

Active site

The globular structure of enzyme has at least one surface region. This region has a crevice or pocket. This crevice occupies only a small portion of the surface of enzymes. It is known as the enzyme's active site. Active site has a specific shape. Therefore, a substrate molecule fits into it in a very specific way. Weak chemical forces like hydrogen bonds keep this substrate in place.

The active site of the enzymes is made up of two regions-

i. Binding site: It recognizes the specific substrate and forms enzyme substrate complex. This reaction activates the catalytic site.

ii. Catalytic site: The activated catalytic site changes the substrate into products.

The Two models are given about the activity of active site-

(a) Key and lock model

Emil fischer proposed the lock and key model in 1890. According to this model a specific enzyme can transform only specific substrate into products. According to this model, the active site is a rigid structure. It cannot be changed during any step of the reaction. Later studies have not supported this model in all the reactions.

(b) Induced fit model

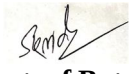
This model was proposed by Koshland in 1959. He proposed this model on the basis of new evidences. He describes that when a substrate combines with an enzyme, it induces changes in the active site. These changes enable the enzyme to perform its catalytic activity.

Cofactors

The metal ions which are loosely attached with the enzymes are called co factors. These metal ions are Ca^{-2}, Mg^{-2}, Mn^{-2}, $Cu^{—}$, and Zn^{-2}. These metal ions change a non-functioning active site to a functioning one. The attachment of a cofactor changes the shape of the protein. It allows the enzyme to combine with its substrate. The cofactors of other enzymes participate in the temporary bonds between the enzyme and its substrate during enzyme-substrate complex formation.

Coenzymes and prosthetic groups

Coenzymes are loosely attached non protein, organic molecules that participate in enzyme-catalyzed reactions. The covalently bonded non-protein part of enzyme is called prosthetic group. Coenzymes are often used in transporting electrons from one enzyme to another. These electrons are present in the form of hydrogen atoms. Many vitamins like niacin and riboflavin function as coenzymes. Or they are used to make coenzymes. Coenzymes transport energy in the form of hydrogen atoms from one enzyme to another. One of the most important coenzymes in the cell is the hydrogen acceptor nicotinamide adenine dinucleotide (NAD). It is made from vitamin B. NAD acquires a hydrogen atom from an enzyme and it reduces to NADH.



The electron of the hydrogen atom contains ‘energy. This energy is carried by NADH molecule. For example, various foods are oxidized in the cell. The cell removes electrons from the food molecules. It transfers this electron to NAD. It reduces to NADH.

Allosteric site

Some enzymes have special allosteric site. Some specific effectors can bind with this allosteric site. Allosteric enzymes change their structure in response to binding of effectors. It is called allosteric modulation. This modulation can be direct or indirect. The effector may bind directly to binding sites in the enzyme. Or effector binds to other proteins or protein subunits. This protein interacts with the allosteric enzyme and thus influences catalytic activity.

Apoenzyme and holoenzyme

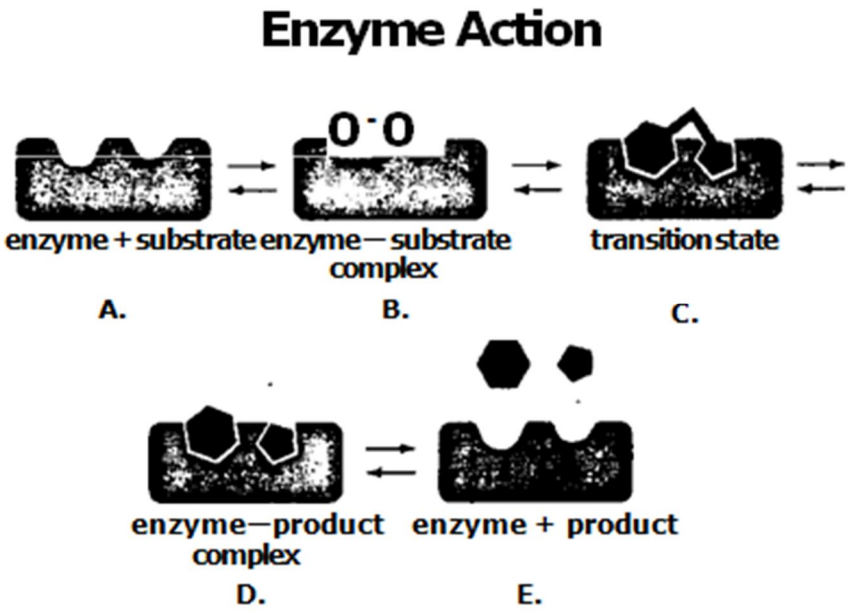
Some enzymes require prosthetic group for their normal activities. Prosthetic group is firmly bound to the enzyme. It activates the enzyme. The inactive enzyme without prosthetic group is called apoenzymc. The active enzyme with attached prosthetic group is called holoenzyme.

Types of enzymes

Enzymes are of two types:

i. Intracellular enzymes or endoenzymes: They act within the cell. The great majority of plant enzymes are endoenzymes.

ii. Extracellular enzymes or exoenzymes: They diffuse out of the cell and act on some outside medium. Exoenzymes are present in fungi and bacteria and in some of the insectivorous Plants. Endoenzymes are produced by the living protoplasm. But they do not require environment of a living cell for their action.



Properties of enzymes

There are following properties of enzymes-

- **Globular proteins**

Most of enzymes are globular protein. A few enzymes like ribo4mes are nucleic acid in nature. Globular protein of enzymes have tertiary configuration. Globular structure is very important for proper functioning of enzyme.

- **Catalytic Properties**

Enzymes influence the speed of chemical reactions. They are not utilized or consumed in the chemical reaction. So they do not appear in the end products of the reaction. An enzyme cannot start the reaction. It can only speed up the reaction. A very small quantity of the enzyme can catalyze a large quantity of the substrate and at a great speed. The effectiveness of an enzymic reaction is expressed in form of turnover number. The number of substrate molecules on which one enzyme molecule acts in one second is called turnover over number. The number for sucrose is 10^5 and for catalases 10^6.

- **Lowering the Activation of Reaction**

Activation energy is the minimum energy that is required to start a reaction. Enzyme lowers the activation of energy. The reaction can take place in the absence of enzyme. But it needs higher amount of activation energy.

- **Specificity of Enzyme Action**

Enzymes are specific in their action. The specificity of enzymes is due to their primary amino acid sequence. A given enzyme can act only on a particular substrate or a particular group of substrates. An enzyme is thus specific for both the substrate and the type of reaction that it catalyses. Thus, sucrase acts upon sucrose (cane-sugar) and lactase on milk-sugar (lactose) Sucrase will not act upon other sugars.

- **Reversibility of Enzyme Action**

The majority of reactions catalyzed by enzymes are reversible. Thus an enzyme can speed up a reaction in both directions. Thus the system attains a state of equilibrium in a short time. In the guard cells of the stomata the enzyme starch phosphorylase converts starch and inorganic phosphate into glucose monophosphate. The reaction is reversible. The same enzyme converts glucose monophosphate into starch and inorganic phosphate.

The direction of the reaction depends upon several factors. It depends on p1-1 and chemical potential of both the reactants. When the chemical potential of the products is less than that of the reactants then the reaction takes place only in one direction.

Synthesis of starch, proteins and fats are unidirectional irreversible enzymatic reactions. Such reactions have two different sets of enzymes. One enzyme is used for the synthesis of these compounds and the other is used for their breakdown.