ENZYMES

DEFINITION

Enzymes are biological catalysts that increase the rate of chemical reaction without being used in the process.

EXPLANATION

Nearly every chemical process that takes place in living cells is facilitated by an enzyme. The sum of all chemical reactions that a cell or larger living things carries out is its metabolism. Many activities in living things are controlled by metabolic pathways in which a series of interrelated steps are involved, each one of them facilitated by an enzyme.

DISCOVERY OF ENZYME

The name "enzymes" (Greek: En- in, zyme- yeast) literally means "in yeast". Buchner, who in 1887 discovered that yeast extract could bring about fermentation of grape juice and coined the word Zymase for the active substance in yeast extract. Later on it was given the name enzyme.

ENZYME STRUCTURE

* PROTEIN IN NATURE

Enzymes are proteins, and their function is determined by their complex structure.

* ACTIVE SITE

The reaction takes place in a small part of the enzyme called the active site. The enzymes are specific for one reaction only, as other molecules would not fit into the active site.

The active site is divided into two sites:

i) Binding Site
ii) Catalytic Site

i) BINDING SITE

The binding site forms a temporary hydrogen bond with the substrate. In some cases, it may form a covalent bond.

ii) CATALYTIC SITE

When the substrate is binded to the active site, the catalytic site is activated.

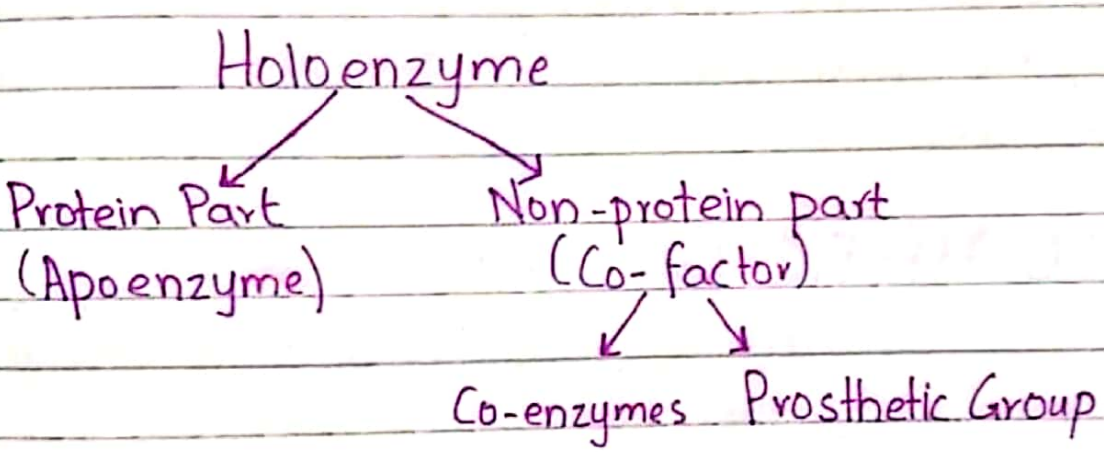
* FRAMEWORK

The protein, other than the active site, ~~acts~~ acts as a "framework". The amino

acids around the active site attach to the substrate molecule and hold it in position while the reaction takes place.

* HOLOENZYMES

A holoenzyme refers to a catallytically active enzyme that consist of both apo enzyme and cofactor.



* APOENZYME

Apoenzyme are the protein part of the holoenzyme.

~~The~~ ~~is~~ Apoenzymes are enzymes that lack their necessary cofactor(s) for proper functioning.

~~The~~ ~~binding~~ ~~of~~ Holoenzymes are the active form of apo enzyme. *

* COFACTORS

Cofactors - are atoms, groups of atoms and molecules that join with enzymes altering their shape and making them functional.

One can think of these cofactors as an "on-off" switch for activating an enzyme.

Cofactors can be metals (or coenzymes), and their primary function is to assist in enzyme activity. They are able to assist in performing certain necessary reactions the enzymes cannot perform alone.

Cofactors are divided into
i) Prosthetic Group
ii) Coenzymes

i) PROSTHETIC GROUP

If the cofactor is a non-protein like a metallic ion (i-e zin, copper, or iron) it is referred to as prosthetic group. They are often attached to enzymes by covalent bond.

ii) COENZYMES

Some cofactors are small organic molecules called coenzymes. Like enzymes they are not permanently altered in the reaction.

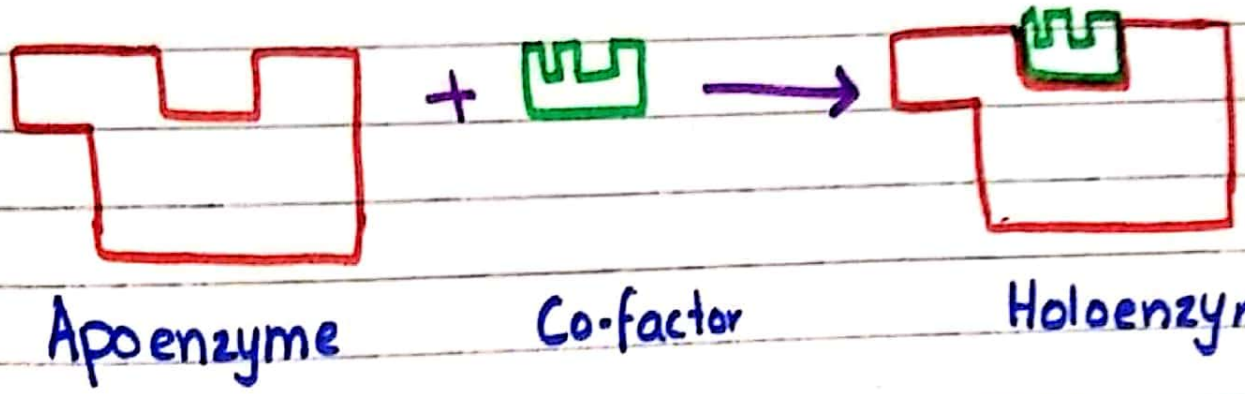
Many of these coenzymes are derived from vitamins and minerals that are essential for life. The absence of these cofactors can lead to vitamin and mineral diseases e.g lack of Vitamin B produces beriberi.

They are loosely attached to the protein part of enzyme.

Examples of coenzymes are NAD^+, FAD^+, NADP.

*APOENZYMES

Enzymes without their necessary cofactors are called apo enzymes, which are inactive form of enzyme.



ENZYME ACTIVATORS

Certain substances known as activators can enhance enzyme activity.

e.g Strawberries, blueberries and blackberries are a good source of manganese. This mineral is an enzyme activator in the body that aids in the synthesis of biotin, thiamine, Vitamin C and choline. It also helps in the metabolism of carbohydrates and proteins.

ENZYME INHIBITORS

DEFINITION

Inhibitors inhibits the activity of enzymes, reducing the rate of their reactions.

An enzyme inhibitor is a molecule that binds to an enzyme and decreases its activity.

EXPLANATION

Inhibitors are chemical substances which inhibit the activity of enzymes partially or completely depending upon the nature of the inhibitors.

Inhibitors are less effective when the concentration of the enzyme and substrate is higher.

OCCURANCE

Inhibitors are found naturally in the cells, but are also used artificially as drugs, pesticides and research tools.

MECHANISM

The binding of an inhibitor can stop a substrate from entering the enzyme's active site and/or hinder the enzyme from catalyzing its reaction.

TYPES OF INHIBITORS

1. IRREVERSIBLE INHIBITORS

Irreversible inhibitors usually react with the enzymes and change it chemically (e.g via covalent bond formation) These inhibitors modify key amino acid residues needed for enzymatic activity.

2. EXAMPLES

Poison (Cyanide), heavy metal ions (Hg, Pb etc), Insecticides etc.

2. REVERSIBLE INHIBITORS

These inhibitors temporarily block the active site of enzyme for the incoming substrate.

TYPES OF REVERSIBLE INHIBITORS

1. COMPETITIVE INHIBITOR

A competitive inhibitor molecule has a similar structure to the normal substrate molecule, and it can fit into the active site of the enzyme. It therefore competes with the substrate for the active site, so the reaction is slowed down.

EXAMPLE: Sulphonamide (Antibacterial drug)

2. NON-COMPETITIVE INHIBITOR

A non-competitive inhibitor molecule is quite different in structure from the substrate molecule and doesnot fit into the active site. It binds to another part of the enzyme molecule, called allosteric site, changing the shape of the whole enzyme, including the active site, so that it can no longer bind substrate molecules.

ALLOSTERIC SITE

The activity of some enzymes is controlled by certain molecules binding to a specific regulatory (or allosteric) site on the enzyme, distinct from the active site.

CONTROL OF REACTION RATE

Different molecules can inhibit or activate an enzyme, allowing sophisticated control of rate. Only a few enzymes can do this, and they are often at the start of a long biochemical pathway. They are generally activated by the substrate of the pathway and inhibited by the product of the pathway, thus only turning the pathway on when it is needed.

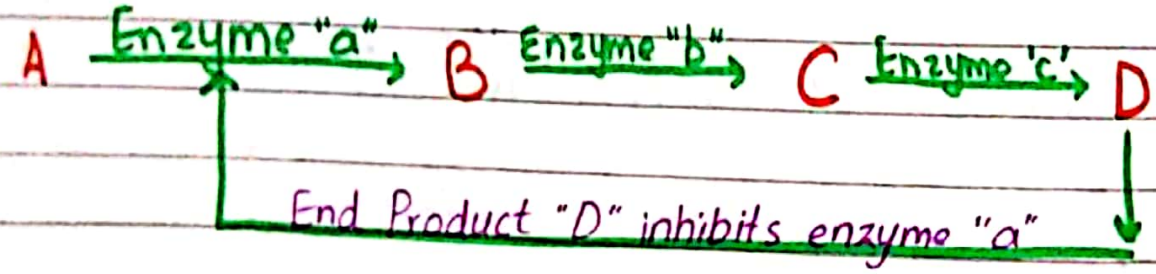
FEEDBACK INHIBITION

DEFINITION

When a product remains unreacted, they accomodate in the body and moves toward an enzyme and attach to its allosteric site.

MECHANISM

Sometimes it has been found that when a series of reactions is catalyzed by a number of enzymes in sequence the accumulation of the final end-product may cause inhibition in the activity of the first enzyme of the series.



The inhibition due to a compound (Final end-product) which is totally different in structure from the substrate of the enzyme is called as allosteric site inhibition or feed back inhibition and such an enzyme is called as allosteric enzyme. This type of inhibition takes place due to the presence of allosteric site on the surface of the allosteric enzyme away from the active site. This end product molecule (i-e D) fits in the allosteric site and brings about change in shape

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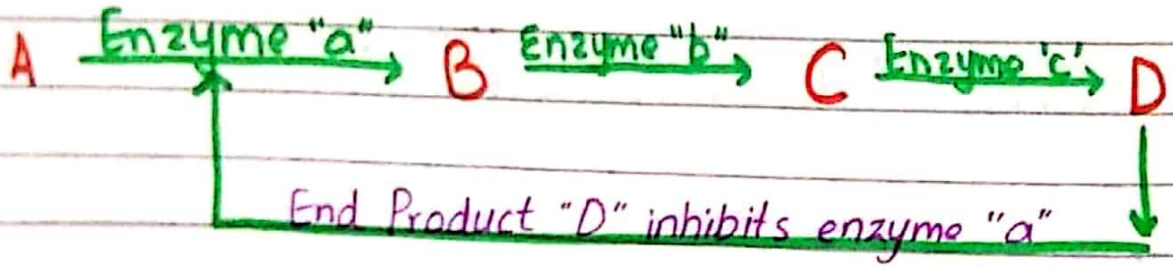

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of the enzymes so that the active site of the enzyme becomes nonfit for reaction.

REVERSIBLE INHIBITION

The allosteric inhibition is reversible. When the concentration of the final end-product in the cell falls, it leaves the allosteric site, and the activity of the allosteric enzyme is restored.

Uses Of Inhibitors

1. Pencillin

Pencillin works by inhibiting the activity of the enzyme responsible for the creation of bacterial cell wall. This means that water can enter the bacterial cell, causing it to swell, burst and die termed lysis.

2. Metabolic Control

Enzyme inhibitors are also important in metabolic control. Many metabolic pathways in the cell are inhibited by metabolites that control enzyme activity through allosteric regulation or substrate inhibition.

3. Pesticides

Many pesticides are enzyme inhibitors.