Enzyme Catalysts

Enzyme catalysts or enzymes as a catalyst are biocatalysts that can be utilised in the transformation of organic compounds. A natural enzyme is generally a biological macromolecule that is produced by living organisms. Basically, these are complex nitrogenous proteins that help to catalyse the biochemical reactions in living organisms. More significantly, all biochemical reactions occurring in living organisms depend on catalysts.

There are also enzymes that have been more or less isolated and are employed in biocatalysis or enzyme catalysis. With the help of modern biotechnology, non-natural enzymes are also produced in labs today. With such developments, the modified enzymes are widely used to catalyze novel small molecule transformations that may be difficult to achieve using classical synthetic organic chemistry. When natural or modified enzymes are used to perform certain organic synthesis, it is known as chemoenzymatic synthesis. The reactions that are performed using the enzyme are classified as chemoenzymatic reactions.

Characteristics of Enzyme Catalyst

Enzyme Activators

Enzyme Inhibitors

Enzyme Catalysis

Mechanism of Enzyme Catalysis

Characteristics of an Enzyme Catalyst

In comparison to inorganic catalysts which include metals, acids and bases, enzymes are very particular when it comes to reactions. A certain type of enzyme can react with only one particular compound or its substrate. As far as the mechanism is concerned, when enzymes act as catalysts, they tend to weaken the substrate bonds, thereby lowering the overall activation energy. Reactions take place and the product is formed. A single enzyme molecule can be used repeatedly to transform several substrate molecules. Lets us also quickly go through some of the important characteristics of an enzyme catalyst below.

1. Specificity of Enzymes

Enzymes are highly specific in nature. This specific nature is of the following types:

(a) **Group-specific**: These enzymes will act on molecules having a specific functional group like amines, acids, etc. Enzymes are not only structural specific but also specific to the chemical groups surrounding them.

Example: Pepsin hydrolyses a peptide bond in which the amino group (NH2 group) is contributed by an aromatic amino acid such as phenylalanine, tryptophan.

(b) **Linkage-specific**: In this type, the activity of the enzyme depends upon the linkage of enzyme molecules with functional groups.

(c) **Bond-specific**: Enzymes are specific to the substrate having a similar bond and similar structure.

Example: α-amylase enzyme can hydrolyse α-1-4 glycosidic bond in glycogen and starch. Here, enzyme is specific to the α-1-4 glycosidic bond and not to the substrate.

(d) **Substrate-specific**: Enzyme specific for one substrate and one reaction.

Example: Maltase acts only on maltose.

(e**) Optical-specific**: Enzymes are specific to the optical configuration of the substrate.

Example: L-amino acid oxidase acts only on L-amino acids.

(f) **Geometrical-specific**: Enzymes can act on a different substrate having the same molecular geometry.

Example: Alcohol dehydrogenase can oxidize both ethanol and methanol to give corresponding aldehydes.

2. **Optimum Temperature**

High-temperature causes the deactivation of enzymes. So, most enzymes function effectively at an optimum temperature of 25 – 35°C.

3. **Enzyme Activators**

Certain substances increase enzyme activity to a very high or enormous rate. This activation exists as a molecule that is bound to an allosteric site of enzymes which “increase” the activation centre on the enzyme.

Example:

1. Hexokinase (I) acts as an activator to extract the glucose in the glycolysis pathway.

2. Glucokinase is an enzyme activator that combines with enzymes released by pancreatic cells used in the treatment of diabetes.

4. **Enzyme Inhibitors**

A certain molecule binds the active site of an enzyme and decreases its activity, which are known as enzyme inhibitors. These may be drugs, pathogens, pesticides. A drug acts as an enzyme inhibitor and attacks the active site.

Example: Hydrolysis of cane sugar

Sugarcane is sucrose (C12H22O11), which basically is a dextro rotator with a specific angle of rotation +62.5. In the process, enzyme invertase sucrose undergoes hydrolysis to give α – D(+) glucose and β – D(-) fructose as products. The solutes contain more leave rotatory fructose whose angle of the specific rotator is -92.2. Hence, this mixture is known as invert sugar and the process is the inversion of cane sugar.

Sucrose α-D(+)Glucose α-D(-)fructose

+62.5 (+52.4) (-92.2)

This conversion of Dextro rotators sucrose to fructose is done by enzyme and block the attack of substrate, which are known as competitive inhibitors.