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3rd B.Sc. Biotechnology – Semester - VI

E-Notes (Study Material)

Elective Course : ENZYME TECHNOLOGY	**Code: CEBT54C**
Unit: 1 - Introduction: Historic background-General Terminology, Nomenclature and Classification of Enzymes. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes.	
Learning Objectives: The provide an overview of the characteristics of enzymes, its chemical and protein nature	
Course Outcome: The students will be able to explain the structure, function and specialised characteristics of enzymes	

Introduction

Enzymes are biological catalysts (also known as biocatalysts) that speed up biochemical reactions in living organisms. They can also be extracted from cells and then used to catalyse a wide range of commercially important processes. Almost all enzymes are proteins, made up of chains of amino acids. Enzymes bind to the reactant molecules, and hold them in such a way as to make the chemical bond-breaking and bond-forming processes take place more readily. They don't change the free energy of the reactants or products. They only reduce the activation energy required to reach the transition state. They have molecular weights ranging from 10,000 to 2,000,000.

Discovery and History of Enzymes

1833: Payne and Persoz found that that an alcohol precipitate of a malt extract contained a substance that converted starch into sugar. This was the first discovery of an enzyme and they named it diastase.

1850: Louis Pasteur observed that ferment of sugar into alcohol by yeast is catalysed by ferments (later named enzymes), which are always associated with the yeast cells.

1876: W.F. Kuhne coined the term enzyme (Greek, which means 'in yeast') since the fermenting ability was associated with the yeast.

1894: Emil Fischer performed some classical studies on carbohydrate metabolizing enzymes in which he demonstrated the specificity shown by an enzyme for its substrate. On the basis of his experiments, Fischer proposed the lock and key hypothesis to describe the interaction of enzyme with substrate.

1897: Edward Buchner succeded in extracting the set of enzymes from the yeast cells in active form and demonstrated for the first time the conversion of sugar into alcohol in vitro.

1926: J.B. Sumner (Cornell University, USA) isolated, purified and also successfully crystallized the enzyme urease from jack beans. He found that the urease crystals are purely made of proteins and hence reported that enzymes are nothing but proteins. But his conclusions were opposed vehemently by the well known German biochemist Richard Willstater, who insisted that enzymes are nothing but low molecular weight organic compounds and the proteins crystals were found in the urease preparation could be impurities.

1930: John Northrop and his colleagues from Rockfeller University, USA crystallized pepsin and trypsin and found that they were also proteins crystals. Received Nobel Prize in 1935.

1958: The induced-fit model was proposed by Daniel Koshland. His theory asserts that when the active site on the enzymes makes contact with the proper substrate, the enzyme molds itself to the shape of the molecule.

1964: R.B. Merrifield and his group paved the way for laboratory synthesis of enzymes for the first time (tailor made synthetic enzymes called Synzymes. The first enzyme which was assembled on a solid phase matrix was the Ribonuclease, which contains 124 amino acids.

1965: Lysozyme was the first enzyme for which the X-ray structure was determined at high resolution by David Phillips

1962 & 1967: Arber and Geller groups discovered restriction enzymes and ligases. Paved the way for the new branch of biology –Biotechnology.

1986: The belief that 'All enzymes are proteins but all proteins are not enzymes' was shattered by Alexander Rich and Thomas Cech's group discovered that certain RNA molecules also exhibited catalytic properties like enzymes. Those self-splicing 'Ribonucleic acid enzymes are called Ribozymes.

1996: Site- directed mutagenesis technique developed by M. Smith for precisely manipulating the genes of any enzyme even at one nucleotide level and study its effect on the properties of the new mutant enzyme.

Characteristics of Enzymes

Enzymes catalysis differ from chemical catalysis in several different aspects. Some of the general characteristics of enzymes are:

- The rate of reaction of an enzyme catalyzed reaction is 106 to 1012 times more than the uncatalyzed one.

- Another key feature of enzyme catalyzed reaction is specificity towards the substrate as well as their products.

- The physical conditions like temperature and pH at which enzymatic catalysis occurs is very mild as compared to the chemical catalysis.

- Almost all the enzyme catalysed reactions occur at temperature below $100^{O}C$ and nearly neutral pH.

- Catalytic activities of enzymes can be controlled by covalently modifying the enzyme, allosteric regulation.

Terminologies

- **Catalyst**- A catalyst is a reagent that increases the rate of a chemical reaction without itself being altered in the process.
- **Enzyme**- An **enzyme** is a substance that regulates the rate of chemical reaction in living things without itself being altered in the process. In other words, enzymes are biological catalysts.
- **Substrate**- A reactant in an organic or biochemical reaction is a substrate.
- **Active site-** The enzyme's active site is the region within an enzyme where the substrate binds for the reaction.
- **Holoenzyme or conjugated enzyme**- A complete, catalytically active enzyme together with its bound coenzyme and/ or metal ions is called a holoenzyme or conjugated enzyme **Apoenzyme**- The enzymes that need a non-protein portion to combine with them for their function are called **apoenzymes**.
- **Cofactor**- The non-protein portion of the enzymes is called the cofactor
- **Coenzyme**- The organic cofactor of the enzyme is called coenzyme
- **Prosthetic group**- A coenzyme or metal ion that is tightly or even covalently bound to the enzyme protein is called a prosthetic group. Binding of prosthetic group with the enzyme is permanent.
- **Isoenzyme**-Enzymes that exist in two forms
- **Metalloenzymes**- Enzymes that require metals for their activity

Nomenclature of Enzymes

The discovery of enzymes occurred across the globe and scientist were naming them inconsistently. This was leading in creating confusion in conducting the research. To resolve this, International Commission on Enzymes was established. They set some some rules for naming the enzymes. While naming, it was asked to consider the name of the substrate, type of reaction they catalyze and their name should end with ‘ase’. For example, Succinate dehydrogenase, where succinate is the substrate, the enzyme catalyses dehydrogenation reaction and the name ends with ‘ase’.

Enzyme Classification

General principles- Because of their close interdependence, it is convenient to deal with the classification and nomenclature together. There are three principles that define the naming and classification of enzymes

The first general principle

Names purporting to be names of enzymes, especially those ending in -*ase*, should be used only for single enzymes, *i.e.* single catalytic entities.

They should not be applied to systems containing more than one enzyme. When it is desired to name such a system on the basis of the overall reaction catalysed by it, the word *system* should be included in the name.

For example, the system catalysing the oxidation of succinate by molecular oxygen, consisting of succinate dehydrogenase, cytochrome oxidase, and several intermediate carriers, should not be named *succinate oxidase*, but it may be called the *succinate oxidase system*.

The second general principle

Enzymes are principally classified and named according to the reaction they catalyse.

The chemical reaction catalysed is the specific property that distinguishes one enzyme from another, and it is logical to use it as the basis for the classification and naming of enzymes.

Several alternative bases for classification and naming had been considered, *e.g.*

- Chemical nature of the enzymes. Eg. flavoprotein, a hemoprotein
- Chemical nature of the substrate. Eg. nucleotides, carbohydrates, proteins

The chemical nature of the enzyme has, however, been used exceptionally in certain cases where classification based on specificity is difficult.

The second basis for classification is hardly practicable, owing to the great variety of substances acted upon and because it is not sufficiently informative unless the type of reaction is also given.

It is the overall reaction, as expressed by the formal equation, that should be taken as the basis. Thus, the intimate mechanism of the reaction, and the formation of intermediate complexes of the reactants with the enzyme is not taken into account, but only the observed chemical change produced by the complete enzyme reaction.

A consequence of the adoption of the chemical reaction as the basis for naming enzymes is that a systematic name cannot be given to an enzyme until it is known what chemical reaction it catalyses. A second consequence of this concept is that a certain name designates not a single enzyme protein but a group of proteins with the same catalytic property.

The third general principle

The enzymes are divided into groups on the basis of the type of reaction catalysed, and this, together with the name(s) of the substrate(s) provides a basis for naming individual enzymes. It is also the basis for classification and code numbers.

Common and Systematic Names

The first Enzyme Commission gave much thought to the question of a systematic and logical nomenclature for enzymes, and finally recommended that there should be two nomenclatures for enzymes, one systematic, and one working or trivial.

The systematic name of an enzyme, formed in accordance with definite rules, showed the action of an enzyme as exactly as possible, thus identifying the enzyme precisely.

The trivial name was sufficiently short for general use, but not necessarily very systematic; in a great many cases it was a name already in current use.

The Commission for Revision of Enzyme Nomenclature decided to give the trivial names more prominence in the Enzyme List; they now follow immediately after the code number, and are described as Common Name. Also, in the index the common names are indicated by an asterisk. Nevertheless, it was decided to retain the systematic names as the basis for classification for the following reasons:

(i) the code number alone is only useful for identification of an enzyme when a copy of the Enzyme List is at hand, whereas the systematic name is self-explanatory;

(ii) the systematic name stresses the type of reaction, the reaction equation does not;

(iii) systematic names can be formed for new enzymes by the discoverer, by application of the rules, but code numbers should not be assigned by individuals;

(iv) common names for new enzymes are frequently formed as a condensed version of the systematic name; therefore, the systematic names are helpful in finding common names that are in accordance with the general pattern.

Scheme for the classification of enzymes and the generation of EC numbers

The first Enzyme Commission, in its report in 1961, devised a system for classification of enzymes that also serves as a basis for assigning code numbers to them. These code numbers, prefixed by EC, which are now widely in use, contain four elements separated by points, with the following meaning:

(i) the first number shows to which of the six main divisions (classes) the enzyme belongs,

(ii) the second figure indicates the subclass,

(iii) the third figure gives the sub-subclass,

(iv) the fourth figure is the serial number of the enzyme in its sub-subclass.

The main divisions and subclasses are:

EC 1. Oxidoreductases – catalyze the transfer of hydrogen or oxygen atoms or electrons from one substrate to another, also called oxidases, dehydrogenases, or reductases. Since these are ‘redox’ reactions, an electron donor/acceptor is also required to complete the reaction.

$$A_{red} + B_{ox} \leftrightarrow A_{ox} + B_{red}$$

- e.g. E.C.1.1 – CHOH group containing donor

E.C.1.1.1.- If NAD+ in NADP+ acts as electron acceptor.

- Examples of oxidoreductase enzyme:
  - Dehydrogenase, reductase, catalase etc.

EC 2. Transferases – catalyze group transfer reactions, excluding oxidoreductases (which transfer hydrogen or oxygen and are EC 1). These are of the general form:

$$A\text{-}B + C \leftrightarrow A + B\text{-}C$$

Nomenclature:

- E.C.2- transferase
- E.C.2.1- enzyme that transfer one carbon group
- E.C.2.1.1- if the group transfer is accepted by nicotinamide.

EC 3. Hydrolases – catalyze hydrolytic reactions. Includes lipases, esterases, nitrilases, peptidases/proteases. These are of the general form:

$$A\text{-}B + H2O \leftrightarrow A\text{-}H + B\text{-}OH$$

Nomenclature:

- E.C.3- Hydrolase
- E.C.3.1.1- carboxylic ester hydrolase
- E.C.3.1.1.3- Lipase (Glycerol ester hydrolase)

EC 4. Lyases – catalyze non-hydrolytic (covered in EC 3) removal of functional groups from substrates, often creating a double bond in the product; or the reverse reaction, ie, addition of function groups across a double bond. Includes decarboxylases and aldolases in the removal direction, and synthases in the addition direction.

$$A{=}B \leftrightarrow A\text{-}B$$

Nomenclature:

- E.C.4 – lyase
- E.C.4.1 – C-C lyase
- E.C.4.1.1.1- Pyruvate decarboxylase
- E.C.4.2.1.2- Fumarase

EC 5. Isomerases – catalyzes isomerization reactions, including racemizations and cistran isomerizations.

A-B-C↔A-C-B

Nomenclature:

- E.C.5- Isomerase
- E.C.5.1 – Epimerase and Racemase
- E.C.5.1.1.1 – Alanine racemase
- Glyceraldehyde-3-phosphate —-*triosphosphate isomerase*———-> Dihydroxyacetone phosphate

EC 6. Ligases -- catalyzes the synthesis of various (mostly C-X) bonds, coupled with the breakdown of energy-containing substrates, use. ATP

A + B + ATP --> A-B + ADP + Pi

Nomenclature:

- E.C 6- ligase
- E.C.6.1- form C-O bond
- E.C.6.1.1 – aminoacyl tRNA synthase

Properties Of Enzymes Can Be Classified Into:

1.Physical properties
2.Chemical Properties
3.General properties

Physical Properties of Enzymes

- Physically enzymes behave as colloids or as substance of high molecular weight.
- Enzymes are destroyed or inactivated at temperature below the boiling point of water.
- At 60 degrees Celsius most enzymes in liquid medium are inactivated.
- Dried enzymes extract can endure temperature 100 degree Celsius to 120 degrees Celsius or even higher. Thus enzymes are thermos-labile.
- There is always a specific temperature of optimum activity of every enzyme, which usually ranges from 25 degrees Celsius to 45 degrees Celsius. Enzymatic action is highest at 37 degrees Celsius and enzymes become inactive when temperature rises above 60 degrees Celsius.

Chemical Properties Of Enzymes

- Catalytic properties: Enzymes are biological catalyst. The small quantity of enzymes catalyses the larger quantities of substances. It means, enzymes have high capability to convert giant quantities of substrate into product. Enzymes increase the rate of reaction and remain unaffected by the reaction which they catalyse.

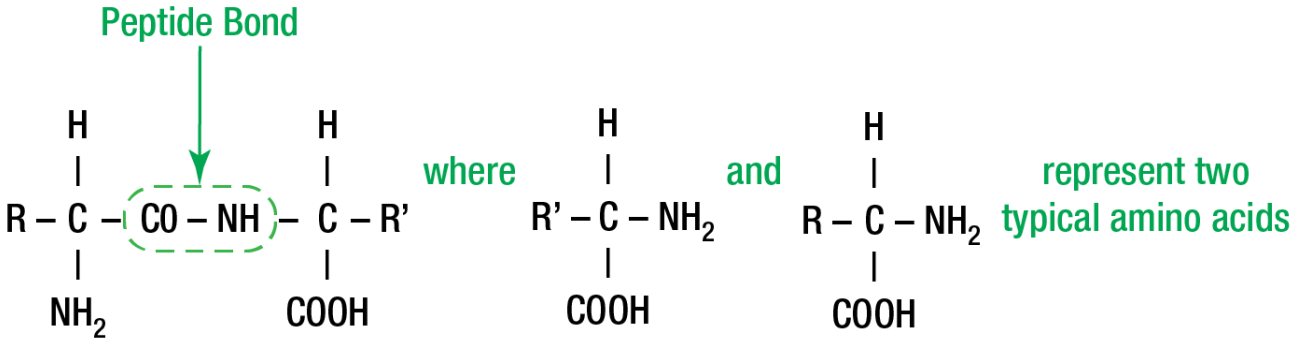
- Specificity of enzyme: Enzymes are highly specific in nature, i.e., a particular enzyme can catalyse a particular reaction. For example, Enzyme sucrase can catalyse only hydrolysis of sucrose.

General Properties Of Enzymes

- Enzymes initiate and accelerate the rate of biochemical reaction.
- The activity of enzymes depends upon the acidity of medium (pH specific). Each catalyst is most active at a specific pH. For example, pH 2 for pepsin, pH 8.5 for trypsin. Most intracellular enzymes function at near neutral pH.
- Enzymes can accelerate the reaction in either direction.
- All enzymes possess active sites which participate in the biochemical reactions.
- Enzymes are very unstable compounds mostly soluble in water, dilute glycerol, NaCl and dilute alcohol.
- Enzymes act actively at optimum temperature.
- All enzymes are protein in nature but all proteins may not be an enzyme.
- Enzymes lower the energy of activation of the substance molecule so the biochemical reaction can take place at normal body temperature which is 37 degrees Celsius.

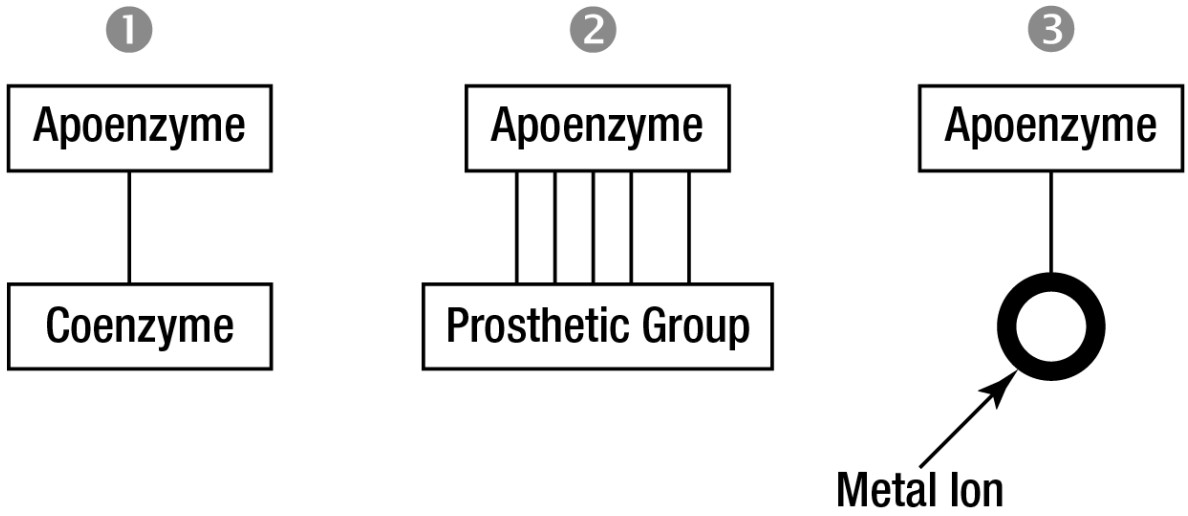
Chemical nature of enzymes

All known enzymes are proteins. They are high molecular weight compounds made up principally of chains of amino acids linked together by peptide bonds.



Enzymes can be denatured and precipitated with salts, solvents and other reagents. They have molecular weights ranging from 10,000 to 2,000,000.

Many enzymes require the presence of other compounds - cofactors - before their catalytic activity can be exerted. This entire active complex is referred to as the holoenzyme; i.e., apoenzyme (protein portion) plus the cofactor (coenzyme, prosthetic group or metal-ion-activator) is called the holoenzyme.



Apoenzyme + Cofactor = Holoenzyme

According to Holum, the cofactor may be:

1. A coenzyme - a non-protein organic substance which is dialyzable, thermostable and loosely attached to the protein part.

2. A prosthetic group - an organic substance which is dialyzable and thermostable which is firmly attached to the protein or apoenzyme portion.

3. A metal-ion-activator - these include K+, Fe++, Fe+++, Cu++, Co++, Zn++, Mn++, Mg++, Ca++, and Mo+++.

Cofactor

Cofactors bind in a temporary dissociable manner to the enzyme or to the substrate. They can be subdivided into two groups: metal ions and small organic molecules. Many enzymes require either one or more inorganic ions, such as Fe 2+ , Mg 2+ , Mn 2+ , or Zn 2+ for their activity. Enzymes that require these metal ions for their catalytic activity are called as metal activated enzymes. Metal ions such as Mg 2+ , Mn 2+ , or Zn 2+ bind at the enzymes active site as well as with the substrate simultaneously.

Co-enzyme

Cofactors that are small organic molecules are called coenzymes. Coenzymes are often derived from vitamins and can be either tightly or loosely bound to the enzyme. If coenzyme is tightly bound to the enzyme it is termed as prosthetic group. Same coenzyme can be used by a variety of enzymes for catalysis. However, enzymes that use the same coenzyme are usually mechanistically similar i.e. their mechanism of catalysis remains same.

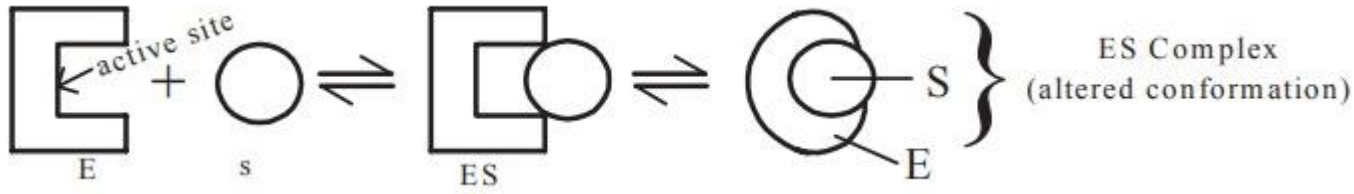
Prosthetic Group

A coenzyme or metal ion that is tightly or even covalently bound to the enzyme protein is called a prosthetic group. Binding of prosthetic group with the enzyme is permanent. Dissociation of the prosthetic group results in an irreversible loss of the catalytic activity of the enzyme. Some of the examples include pyridoxal phosphate, flavin mononucleotide (FMN), flavin dinucleotide (FAD), thiamin pyrophosphate, biotin, and the metal ions (Co, Cu, Mg, Mn, Se and Zn). Metal ions are the most common prosthetic groups. One third of enzymes contain tightly bound metal ions (metallo-enzymes). They have metal ions as their integral part and are different from the enzymes that need metal ions as cofactor (metal-activated enzyme).

Active site

A restricted region of the enzyme to which the substrate comes and binds and concernes with the process of catalysis is called as the active site. In some enzymes, the active site is a deep groove into which the substrate binds. Specific amino acids are present in the active site which are responsible for the catalytic action. These amino acids are called as 'catalytic' or 'active' amino acids. For example lysozyme has glutamic acid and aspartic acid as catalytic aminoacids. Chymotrypsin which is a proteolytic enzyme contains serine and histidine as catalytic amino acids.

The active site and the other part of the enzyme undergo conformational modification when they come in contact with the substrate



Koshland's induced fit hypothesis of enzyme-substrate interaction postulates that the active site of the enzyme consists of a number of 'active' contact amino acids which permit the substrate to come close to the reactive groups of the enzyme which thereupon undergoes a conformational change, binding the substrate firmly to the enzyme and promoting catalytic activity.

The Most Important Properties Of An Enzyme Are:

1.Catalytic Property
2.Specificity
3.Reversibility
4.Sensitiveness to heat and temperature and pH

Catalytic Property:
Enzymes have extra-ordinary catalytic power. They are active in very small quantities. A small amount of enzyme is enough to convert a large quantity of substrate. The enzymes remain unchanged after the reaction. The turnover number of enzymes ranges from 0.5 to 600000. Turn over number is the number

of substrate molecules converted by one molecule of enzymes per second when its active site is saturated with substrate.

Specificity:

Enzymes are very specific in their action. Particular enzymes act on particular substrates only. Enzymes are also specific to a particular type of reaction. In some rare cases, the specificity may not be too strong. Enzymes show different types of specificity as follows:

1.**Bond Specificity or linkage specificity**: It is also called as relative specificity. Here the enzymes are specific for a bond. eg; peptidase is specific or peptide bond, lipase is specific for ester bond in a lipid.

2.**Group Specificity:** It is also called structural specificity. Here the enzymes are specific for a group. eg; pepsin hydrolyse the peptide bonds in with the amino group belongs to aromatic amino acids.

3.**Substrate Specificity:** It is also called absolute specificity. Here the enzyme acts only on a particular substrate. eg; arginase acts only on arginine; carbonic anhydrase acts only on carbonic acid.

4.**Optical Specificity:** It is also called stereo-specificity. This is the highest specificity shown by an enzyme. Here the enzymes are specific not only to the substrate but also to its optical configuration.
e.g. L amino acid oxidase acts only L-amino acids, not on D-amino acids. Similarly, the alpha-amylase act only on alpha-14 glycosidic linkage of starch and glycogen. It is not able to hydrolyse the beta-14 glycosidic linkage of cellulose.

5.**Co-factor Specificity**: This shows that enzymes are not only specific to the substrate but also specific to its co-factors.

6.**Geometric Specificity:** Here the specificity is very less. Some enzymes will work with a small range of similar substrates having similar structural geometry. e.g. alcohol dehydrogenase can oxidise methanol and n-propanol to aldehydes.

Reversibility:

Most of the enzymes catalysed reactions are reversible. The reversibility of the reaction depends upon the requirements of the cell. In some cases, there are separate enzymes for forward and reverse reaction. Some enzyme-catalysed reactions are not reversible.

Sensitivity To Heat, Temperature And pH:

Enzymes are very sensitive to heat and temperature. They are thermolabile. The maximum activity of protein is at traditional temperature. The correct temperature for the utmost activity is termed optimum temperature. Enzymes will be inactive at very low temperatures; this is the reason for preserving food and vegetables in the refrigerator. The enzymatic activity increases with the increase in temperature up to a certain level. At higher temperature (60-70 degree Celsius), the enzyme is destroyed or denatured except Taq-Polymerase used in PCR reactions. The optimum temperature for it is 75 to 80 degrees Celsius. The optimum pH of most endo-enzyme is pH 7.0 (neutral pH). However, digestive

enzymes can function at different pH. For example, salivary amylase act best at pH 6.8, pepsin act best at pH2 etc. Any fluctuation in pH scale from the optimum causes ionization of R-groups of amino acids that decrease the protein activity. Sometime a change in pH causes the reverse reaction, e.g. at pH 7.0 phosphorylase break down starch into glucose 1- phosphate while at pH5 the reverse reaction occurs.

Enzymes are proteins

James Sumner(1926, 37) isolated enzyme urease and Catalase in pure crystalline form and found them to be made of protein.

Enzymes are proteins comprised of amino acids linked together in one or more polypeptide chains. This sequence of amino acids in a polypeptide chain is called the primary structure. This, in turn, determines the three-dimensional structure of the enzyme, including the shape of the active site. The secondary structure of a protein describes the localized polypeptide chain structures, e.g., α-helices or β-sheets.

The complete three-dimensional fold of a polypeptide chain into a protein subunit is known as its tertiary structure. A protein can be composed of one (a monomer) or more subunits (e.g., a dimer). The three-dimensional arrangement of subunits is known as its quaternary structure. Subunit structure is determined by the sequence and characteristics of amino acids in the polypeptide chain. The active site is a groove or crevice on an enzyme in which a substrate binds to facilitate the catalyzed chemical reaction. Enzymes are typically specific because the conformation of amino acids in the active site stabilizes the specific binding of the substrate. The active site generally takes up a relatively small part of the entire enzyme and is usually filled with free water when it is not binding a substrate.

Enzymes can be either be a single subunit or comprised of multiple subunits. The subunits in a multisubunit enzyme can sometimes work together in a mechanism called “cooperativity,” in which one subunit influences another for either positive, activity boosting effects or negative, inhibiting effects. Through cooperativity between subunits, an enzyme can either take on a T-state or an R-state. The T-state, or “tense” state, results in less affinity for binding substrate than regular state enzyme would. The R-state, or “relaxed” state, results in higher affinity and increased substrate binding for the enzyme as a whole. There are also two different models for the relationship between these two states of a multisubunit enzyme. The concerted model states that when an enzyme is in the T-state, if one subunit changes to the R-state, then all of the other subunits will change to the R-state at the same time, resulting in increased binding and affinity for other effectors. This model is also reversible, for if all subunits are in the R-state and an effector dissociates, then they will all go towards the T-state. On the other hand, the sequential model states that once one effector binds to one of the subunits, the rest of the subunit’s affinity for the effector increases, but they all do not necessarily change from one state to the other. They are merely more likely to change as well

Non-protein enzymes

Ribozyme is an enzyme that’s not a protein. Proteins are polypeptides of amino acid residues joined by peptide bonds. They make up the basic constituent of enzymes, which are catalytic compounds that

affect the rate of biological reactions. The majority of enzymes are proteins. Ribozyme is an RNA-based enzyme that acts as a catalyst during protein synthesis. RNase P is a widely used ribozyme.

RNases (or ribonucleases) are a class of hydrolytic enzymes that catalyzes both the in vivo and in vitro degradation of ribonucleic acid (RNA) molecules into smaller components. The nuclease operates at the level of transcription and translation and breaks down the RNA by cleaving the phosphorus-oxygen bonds.

RNase enzymes are categorized into two groups:

- **Exoribonucleases:** The exoribonuclease is an exonuclease ribonuclease that degrades RNA by removing terminal nucleotides from either the 5′ end or the 3′ end of the RNA molecule. It has six families of nucleases, including members such as RNase R, RNase T, and RNase D.

- **Endoribonucleases:** The endonuclease ribonuclease cleaves RNA molecules internally. It can cleave either single-stranded or double-stranded RNA, depending on the enzyme. It has several forms that structurally consist of either single proteins and or a complex of proteins with RNA.

Examples of single proteins are RNase III, RNase A, RNase T1, RNase T2, and RNase H. There are also complexes of the ribonuclease protein and RNA, including RNase P and the RNA-induced silencing complex.

Among all of these RNases, RNase A (or ribonuclease A) is the most commonly studied. It was first isolated from the pancreata of cattle and is also the first enzyme in which a complete amino acid sequence was determined. The bovine pancreatic ribonuclease (or Ribonuclease A) is also known as a digestive enzyme. It specifically “digests” or hydrolyzes RNA polymers by endonuclease cleavage of the phosphodiester bonds. It leads to the formation of covalent links between adjacent ribonucleotide residues in RNA molecules.

Different RNases are involved in various functions in organisms. Functions range from clearing unused and unprocessed cellular RNA, to affecting biological processes such as self-incompatibility, plant flowering, and angiogenesis.

Some of the RNase functions based on their types are given below:

- RNase III is actively involved in the regulation of transcription and mRNA lifetime.
- RNase L is an interferon-induced RNase that destroys all RNA within a cell.
- RNase T is the major contributor to the 3′-to-5′ maturation of many stable RNAs.
- RNase R can degrade RNA with secondary structures without any help from accessory factors.
- RNase H cleaves 3’-O-P RNA bonds in an RNA/DNA hybrid duplex to form 3’- hydroxyl and 5’- phosphate terminated products.

The lack of RNases or any mutations in the protein subunits of the enzyme prevents our bodies from responding to the above-mentioned metabolic functions and causes several syndromes and genetic disorders.

Practice Questions

1. Give a note on the different terminologies related to enzyme structure and function
2. Give example of enzymes under each classification and the chemical reactions catalyzed by them
3. Give examples of enzymes functioning under different pH conditions inside the body
4. Give examples of monomeric and polymeric enzymes
5. Give examples of organelle specific enzymes

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