ENZYMES

Proteins employed as catalysts in biochemical reactions are termed biocatalysts.

Specific Characteristics

Enzymes have following two specific characters as:

(i) Specificity

(ii) Efficiency

Specificity of Enzymes

(a) Typically, an enzyme is specialized to catalyze a single biochemical reaction.

(b) Enzymes can enhance the reaction rate by up to a factor of 10^{20}.

(c) Occasionally, an enzyme can facilitate multiple reactions, and a single reaction may be catalyzed by multiple enzymes.

Ex. Enzyme present in Yeast (Zymase) can ferment both glucose and fructose into alcohol and also cane-sugar can be hydrolyzed by invertase and sucrase enzymes.

Efficiency of Enzymes

(a) A single enzyme molecule has the capability to transform millions of substrate molecules into product within a second.

Ex. Carbonic anhydrase enzyme present in red blood cells has a highest turnover number.

(b) Tertiary structure enables the collection of crystals. Enzymes lose their structure at elevated temperatures.

(c) Enzymes can be preserved at low temperatures, as they become inactive.

Importance of Enzymes

In the myriad of enzymes found in the body, the absence or damage of just one enzyme can lead to the development of intricate diseases.

Ex. Scarcity of Phenylalanine hydroxylase enzyme in human body is result in Phenylketonuria disease.

Factors Affecting Enzyme Action

(i) The highest rate of enzyme-catalyzed reactions occurs at the ideal temperature and pH, which are typically around 37ºC (310 K) and a physiological pH of approximately 7.4, in the human body under standard atmospheric pressure. In fact, when the temperature or pH is elevated, the reaction rate initially increases until it reaches a maximum (at 37ºC or pH = 7.4), and subsequently decreases.

(ii) Enzyme activators (co-enzymes).

The presence of specific substances known as coenzymes can enhance the activity of certain enzymes. It has been noted that when a protein includes a small quantity of a vitamin as a non-protein component, its activity is significantly improved. Typically, activators consist of metal ions like Na^+, Mn^2+, Cu^2+, Co^2+, and so on. These metal ions form weak bonds with the enzyme molecules, augmenting their catalytic capabilities.

For instance, when amylase is exposed to NaCl, which provides Na^+ ions, it exhibits a notably elevated catalytic activity.

(iii) Enzyme inhibitors and poisons.
Similar to catalysts, enzymes can experience a reduction in activity when specific substances are present. These substances are referred to as inhibitors or poisons, and they function by binding to the active functional groups, thereby diminishing or completely inhibiting the catalytic activity of the enzymes. Many drugs are utilized for their ability to act as enzyme inhibitors within our bodies.

Nutrients

Sodium, Potassium, and Chlorine

- Na^+ serves as the primary mineral cation in the extracellular fluid.
- K^+ functions as the primary cation within the cell.
- Cl^- acts as the primary mineral anion in the extracellular fluid (ECF).
- Both Na^+ and K^+ are crucial for maintaining water and acid-base balance.
- Na^+ and K^+ play vital roles in nerve impulse transmission.

Calcium and Phosphorus

- Calcium and phosphorus are deposited in bones and teeth to provide them with strength and rigidity.
- Ca^{2+} is essential for blood coagulation, neuromuscular function, cardiac function, and the actions of various enzymes and hormones.
- Phosphorus is involved in the formation of numerous compounds such as nucleic acids, phospholipids, coenzymes, and high-energy compounds like ATP.
- Calcium plays a critical role in sustaining intestinal peristalsis and the growth of body tissues.

Iron

- Iron is necessary for the synthesis of hemoglobin.
- Iron is essential for both oxygen transportation to tissues and the operation of oxidative systems within tissue cells.

Magnesium

- Magnesium acts as a catalyst for numerous intracellular enzymatic reactions, particularly those related to carbohydrate metabolism.
- Mg is the central metal atom in chlorophyll.

Iodine

Iodine is employed in the synthesis of thyroid hormones.

Zinc

- Zinc is a component of carbonic anhydrase, found in red blood cells, aiding in CO_2 transport.
- Zinc is a constituent of lactic dehydrogenase, crucial for the interconversion between pyruvic acid and lactic acid.
- Zinc is a component of certain peptidases, thus playing a significant role in the digestion of proteins in the gastrointestinal tract.

Cobalt

- Cobalt contributes to erythropoiesis and the activities of specific enzymes.
- It is a component of vitamin B_{12}.

Copper

- Copper assists in the utilization of iron.
- Copper deficiency can lead to anemia due to the failure in iron utilization.

Molybdenum

- Molybdenum is a component of oxidase enzymes, such as xanthine oxidase.
- It plays a crucial role in biological nitrogen fixation.

Fluorine

- Fluorine helps maintain normal dental enamel and prevents dental caries.
- Excessive fluorine intake can result in fluorosis, characterized by mottled teeth and enlarged bones