

# The Importance of Enzyme Catalysts in Biochemical and Biological Process of Living Organisms

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## DESCRIPTION

Enzymes are remarkable biocatalysts that play a key role in the biochemical processes of living organisms. These specialized proteins act as nature's precise biochemical engineers, and accelerating a wide range of reactions in cells and organisms. Enzymes exhibit efficiency and specificity, making them indispensable for life as we know it. This article explores about enzyme catalysts, exploring their structure, function, and significance in various biological processes.

### The structure of enzymes

Enzymes are typically globular proteins with a complex three-dimensional structure. This structure is crucial to their function, as the active site of the enzyme is a specific region where substrates (molecules that undergo a chemical reaction) bind and interact. The shape of the active site complements the shape of the substrate molecules, much like a lock and key, ensuring a highly specific interaction.

Enzymes are often named based on the reactions they catalyze, with the suffix "-ase." For example, the enzyme that catalyzes the breakdown of starch is called amylase, while the enzyme that breaks down proteins is called protease. Each enzyme has a unique active site tailored to its specific substrate(s).

### Enzyme catalysis

Enzymes catalyze chemical reactions by lowering the activation energy required for the reaction to occur. Activation energy is the energy barrier that must be overcome for a chemical reaction to proceed. Enzymes achieve this by stabilizing the transition state of the reaction, which is a high-energy intermediate state that forms during the conversion of substrate(s) to product(s).

The enzyme-substrate complex forms when the substrate(s) bind to the enzyme's active site. This binding results in conformational changes in the enzyme that facilitate the reaction, allowing it to proceed more rapidly and with greater specificity. Once the reaction is complete, the enzyme releases

the product(s), which are then free to participate in other cellular processes.

### Key characteristics of enzyme catalysis

**Specificity:** Enzymes are highly specific, catalyzing only a particular reaction or set of reactions. This specificity is essential for maintaining the order and regulation of cellular processes.

**Efficiency:** Enzymes greatly accelerate reaction rates. Without enzymes, many biological reactions would be too slow to sustain life.

**Regulation:** Enzyme activity can be regulated to meet the cell's needs. Factors such as temperature, pH, and the concentration of substrates and products can influence enzyme activity.

### Significance of enzymes in biology

Enzymes are vital to the functioning of all living organisms. Their significance can be observed in several key biological processes

**Metabolism:** Enzymes are central to metabolic pathways, which involve a series of chemical reactions that convert nutrients into energy and essential molecules. For instance, enzymes like (Adenosine Tri- Phosphate) synthase play a crucial role in energy production within cells.

**Digestion:** Digestive enzymes, such as amylases, proteases, and lipases, break down complex food molecules into smaller, absorbable units that can be used for energy and growth.

**DNA replication and repair:** Enzymes like DNA polymerase and DNA ligase are essential for the replication and repair of genetic material.

**Immune system function:** Enzymes play a role in the immune system by facilitating the destruction of pathogens and foreign substances.

**Cellular signaling:** Enzymes are involved in intracellular and intercellular signaling pathways, allowing cells to respond to external stimuli and coordinate various processes.

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**Detoxification:** Enzymes in the liver, such as cytochrome P450, aid in the detoxification and elimination of harmful substances from the body.

**Blood clotting:** Enzymes like thrombin are involved in the blood clotting process, preventing excessive bleeding when injury occurs.

### Biotechnological applications

Enzymes have found widespread use in various industries and biotechnological applications due to their efficiency and specificity. Some notable examples include:

**Food industry:** Enzymes are used in food processing to enhance flavor, texture, and shelf life. They are also used in brewing, cheese production, and fruit juice clarification.

**Pharmaceuticals:** Enzymes are employed in the synthesis of pharmaceutical compounds and the production of antibiotics.

**Biofuel production:** Enzymes are critical in the production of biofuels such as ethanol and biodiesel from renewable resources.

**Environmental remediation:** Enzymes are utilized in bioremediation processes to degrade pollutants and contaminants in the environment.

Enzymes are remarkable catalysts that are indispensable for life. Their precise specificity and efficiency in catalyzing biological reactions make them essential players in countless cellular processes. Understanding enzymes at the molecular level has not only advanced our knowledge of biology but also opened up new avenues for biotechnological applications in various industries. As we continue to unravel the intricacies of enzymes, we gain insights into the fundamental workings of life itself.