Chapter 9: Enzyme Catalysis in Biochemistry

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Abstract

The phenomenon of enzyme catalysis is discussed by the author in this chapter, and the role of the phenomenon in both industrial applications and biochemical processes. Enzymes are biochemical catalysts, and they are highly specific and efficient catalysts of reactions under mild conditions without being depleted. The chapter explores the enzyme structure, the active sites and substrate specificity, and this prevents the understanding of how the catalytic activity is determined by the molecular architecture. It also introduces the Michaelis-Menten kinetics, i.e. the relationship between substrate concentration and rate, and also emphasises such parameters as Vmax and Km and the use of enzymes in industrial processes, particularly food processing, pharmaceutical, biofuels, detergents and waste treatment and hence a sustainable and environmentally friendly process. The chapter places more emphasis on enzyme immobilization, enhancing stability, and optimization of processes that will ensure its successful implementation on an industrial level. The chapter provides an insight that is comprehensive as it relates biochemistry and industrial chemistry to enable the reader to understand how enzymatic catalysis could be used to increase the rate of reaction, reduce energy consumption, and mitigate the environmental effects. This is crucial to the learners who are strategizing to be experts in the field of biotechnology, biochemical engineering, and industrial enzymology.

Keywords: Enzyme catalysis, Michaelis-Menten kinetics, Substrate specificity, Industrial enzymes, Biochemical applications, Immobilization, Process optimization.

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9.1. Introduction

Enzymes are biological catalysts that are found to be predominantly proteins (and in very rare cases, RNA molecules), and they immensely accelerate the rate of a biochemical reaction, but do not undergo degradation during the reaction. The functioning of them is such that less energy is required to activate a reaction therefore more complicated metabolic procedures are able to occur in effect and within a limited period at normal physiological concentrations. The importance of enzymes to life is that they regulate almost all the chemical reactions in the metabolism and digestion of cells, respiration, biosynthesis and energy generation. The ability of enzymes to have high specificity of substrate is a characteristic of such enzymes. All enzymes possess a shape which contains an active site and is specific to a given substrate with a lock-and-key or induced-fit binding mechanism. This type of specificity ensures that metabolic pathways are accurate and that unwanted side reactions are minimized. In contrast to inorganic catalysts, enzymes tend to operate under mild conditions and most of them are active at neutral pH and moderate temperatures (around 37 C in humans). Enzymes tend to be biologically sensitive and consequently, they tend to denature in respect to extreme conditions. The other important property of enzymes is the regulatory property. Fine regulation of enzyme activity can be achieved by the use of inhibitors, activators, co-factors and feedback mechanisms. Metabolic flux is regulated by inhibitors (competitive and non-competitive) and cofactors (metal ions, coenzymes (e.g. NAD_3, FAD) are needed to participate in the catalytic reaction. This rule helps cells to adapt to dramatically changing the physio

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