# Chapter 1
# Role of Biotechnology in Wastewater Treatment: An Overview

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## ABSTRACT

*Biotechnology plays a pivotal role in advancing water treatment technologies, addressing the limitations of conventional methods. This chapter explores the integration of biotechnological approaches, such as the use of isolated enzymes, immobilized microorganisms, and bioelectrochemical systems, to enhance the efficiency and sustainability of water treatment processes. Emphasis is placed on innovative solutions like membrane bioreactors, constructed wetlands, and the application of nano biotechnology for the removal of micropollutants and other contaminants. The chapter also discusses the challenges and future prospects of scaling up these technologies for widespread application. The increasing industrialization and urbanization have led to significant wastewater pollution, posing severe environmental and health risks. Biotechnology offers innovative and sustainable solutions for wastewater treatment by leveraging biological processes and organism.*

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## INTRODUCTION

Among the new technologies that have appeared since the 1970s, biotechnology has attracted the most attention. It has proved capable of generating enormous wealth and influencing every significant sector of the economy. It has already substantially affected healthcare; production and processing of food; agriculture and forestry (Gavrilescu & Chisti, 2005). Biotechnology is the use of living organisms or their products to perform specific tasks or processes. It can be applied to various domains, such as medicine, agriculture, and industry. Biotechnology can also be used to improve environmental quality and sustainability. For example, biotechnology can help create biofuels, biodegradable plastics, and bioremediation agents. Water pollution is a worldwide issue that presents a severe threat to the survival of all life forms. Many countries have passed stricter laws for treating sewage water before dumping it into water bodies. From sustainability, improved water management and wastewater recycling have begun to get active attention. The growing concerns over water contamination have led to extensive research and development in water treatment techniques. They are expanding to promote the reuse of water and improve the quality of water for human consumption. Aquatic pollution can be caused by organic and inorganic impurities and microbiological contaminants. Population growth, industrial and mining activities, sewage and wastewater, radioactive waste, chemical fertilizers, pesticides, urban development, and other anthropogenic sources are all responsible for rising levels of aquatic pollution. Water quality is determined by the concentrations of particles and chemicals in water, such as heavy metals, nutrients, microorganisms, polycyclic aromatic hydrocarbon (PAH), and other pollutants. Many organic contaminants are endocrine-disrupting chemicals associated with testicular, prostate, and breast cancers. They can also cause serious complications in human and animal reproductive health, such as sperm count reduction in males and the production of fragile eggs in females, among other things (Sharma et al., 2023). Wastewater treatment is the process of converting wastewater into a usable or safe form. It typically involves physical, chemical, and biological methods to reduce solids, organic matter, nutrients, pathogens, and toxic substances. Biotechnology can be used to enhance the biological methods of wastewater treatment by introducing microorganisms, enzymes, or plants to degrade pollutants. For instance, activated sludge is a popular biological method that uses a combination of microorganisms and oxygen to break down organic matter and nutrients in wastewater. The microorganisms are then removed from the treated water by sedimentation or filtration. Additionally, anaerobic digestion is another biological method that uses bacteria without oxygen to convert organic matter into biogas. This process reduces sludge volume and greenhouse gas emissions. Lastly, phytoremediation is a biological method that uses plants to absorb and degrade pollutants in wastewater. Plants can