

## Chapter 3

# Microbial Enzymes and Their Mechanisms in the Bioremediation of Pollutants

**Karthika Rajamanickam**

*Mahendra Arts and Science College (Autonomous), India*

**Jayanthi Balakrishnan**

*Mahendra Arts and Science College (Autonomous), India*

**Selvankumar Thangaswamy**

 <https://orcid.org/0000-0002-3500-8681>

*Mahendra Arts and Science College (Autonomous), India*

**Govarathanan Muthusamy**

*Kyungpook National University, South Korea*

### ABSTRACT

*Bioremediation is the process, with the help of microbes or their enzymes, to remove the pollutants present in the environment and change them into non-toxic compounds. Microbial enzymes have a wide range of metabolic activities and are involved in the transformation of pollutants. Enzymes like oxidoreductase, hydrolases, monooxygenase, dioxygenase, methyltransferases, and lipases are involved in the degradation process. Oxidoreductase catalyzes the transfer of electron and proton from the reduced organic substrate to another chemical compound from donor to acceptor. Monooxygenase and dioxygenases are the transferring oxygen from molecular oxygen ( $O_2$ ) utilizing FAD/NADH/NADPH as a co-substrate in this process. Lyases catalyze the cleavage of the bonds by elimination, leaving double bonds. Peroxidases catalyze the oxidation of lignin and other phenolic compounds at the expense of hydrogen peroxide ( $H_2O_2$ ) in the presence of a mediator. Lipases also involve catalyzing the hydrolysis of triacylglycerols to glycerol and free fatty acids.*

DOI: 10.4018/978-1-7998-4888-2.ch003

## **INTRODUCTION**

Over the last three decades, there is increasing environmental pollution that leads to public health issues due to global concern (Kimani, 2007). Mainly the anthropogenic pollution causes a serious problem for the environment. The pollution made by human activity due to the expansion of industries, the use of chemicals, consumption of massive quantity of Petro based raw materials, and a huge amount of chemical fertilizers in developed as well as developing countries (Fereidoun et al, 2007). Air, water, and land pollution are considered as major environmental pollution all over the world. Earth contains two-third of water but freshwater has only less than one percentage consumed by the living organisms. There is a chance of freshwater reached the condemning state and leads to scarcity of water. Human beings are responsible to take care of freshwater and benefited sufficiently. On a global scale, people live with a serious shortage of water it is estimated that nearly 1.3 billion people and children die with drinking dirty water 1.9 million which cause serious disease to the children (UNICEF, 2017). By 2025 it is predicted that nearly 60% of people significantly affected due to the water scarcity. Serious poverty for food may also occur because of water shortage or irrigation by polluted water. Water pollution is another source of water scarcity. If the emission of harmful pollutants to the environment it causes serious health problems to the living organisms. Unsafe disposal of wastewater is the most challenging in the ambient environment (Kanu et al, 2011). The freshwater reservoirs affected mainly by these wastewaters and it has emerged as a major challenge in developing countries (Fakayode, 2005).

Soil is a potent and renewable living system that is wellbeing in the food production and fibre for global balance, ecosystem function that balance the physical, chemical and biological factors (Karlen et al, 2003). Soil contains the biological elements to sustain biological activity, promote the air quality, water environments and maintain the health of the plant, animal and humans. Soil is a living resource for all living organisms, but huge contamination may affect the soil and the soil may be considered as functionally dead (Doran and Zeiss, 2000). Pollution of soil caused due to improper industrial and agricultural processes and deforestation. Nearly one-third of topsoil in the world gets depleted and most of the topsoil and its nutrients could be out off within the next 60 years. In most developing countries agriculture considered as one of the greatest economies and soil as a great resource of that country. According to the Earth Institute use of fertilizer in heavy amount plays an important role in air and land pollution. Land pollution is wealth and health of land would be destructed due to the misuse of land resources by human activities. When the humans apply chemicals for the agricultural land such as pesticides, herbicides, chemical fertilizers to the soil, disposal of wastes improperly, the introduction of a large quantity of heavy metals to the land, hydrocarbons and chlorinated hydrocarbons, radioactive materials, disease-causing agents, mining, pharmaceuticals and domestic sources like plastic bags, bottles.

Development of urbanization and industrialization economically have led to a rise in energy consumption and discharges of large amount of hazardous waste to the environment. The global environmental pollution includes emission of greenhouse gases, acid deposition, wastewater management which should be looking into multiple prospects including social, economic and engineering systems (Loux et al, 2011). This type of environmental pollution can cause adverse effects to humans, plants and animals like prenatal disorders, neurobehavioral disorders, cardiovascular problems, infant mortality, mental disorders, asthma, premature death, reduced energy levels of the organism, endothelial dysfunction and can cause various serious health problems (Kelishadi and Poursafa, 2010). Because of these prospective, there is a necessity to take effort to control the pollutants present in the environment otherwise due to

16 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/microbial-enzymes-and-their-mechanisms-in-the-bioremediation-of-pollutants/259565](http://www.igi-global.com/chapter/microbial-enzymes-and-their-mechanisms-in-the-bioremediation-of-pollutants/259565)

## Related Content

---

### Models of Cooperation between Medical Specialists and Biomedical Engineers in Neuroprosthetics

Emilia Mikoajewska and Dariusz Mikoajewski (2014). *Emerging Theory and Practice in Neuroprosthetics* (pp. 65-80).

[www.irma-international.org/chapter/models-of-cooperation-between-medical-specialists-and-biomedical-engineers-in-neuroprosthetics/109883](http://www.irma-international.org/chapter/models-of-cooperation-between-medical-specialists-and-biomedical-engineers-in-neuroprosthetics/109883)

### Microbial Cellulase in the Production of Second Generation Biofuels: State-of-the-Art and Beyond

Jovana Trbojevi-Ivi (2023). *Biomass and Bioenergy Solutions for Climate Change Mitigation and Sustainability* (pp. 233-257).

[www.irma-international.org/chapter/microbial-cellulase-in-the-production-of-second-generation-biofuels/314367](http://www.irma-international.org/chapter/microbial-cellulase-in-the-production-of-second-generation-biofuels/314367)

### Data Science and Computational Biology

Singaraju Jyothi and Bhargavi P (2019). *Biotechnology: Concepts, Methodologies, Tools, and Applications* (pp. 1277-1292).

[www.irma-international.org/chapter/data-science-and-computational-biology/228670](http://www.irma-international.org/chapter/data-science-and-computational-biology/228670)

### Biodiesel Production: Processes and Technologies

Avinash Alagumalai (2020). *Recent Technologies for Enhancing Performance and Reducing Emissions in Diesel Engines* (pp. 1-25).

[www.irma-international.org/chapter/biodiesel-production/249055](http://www.irma-international.org/chapter/biodiesel-production/249055)

### Bioremediation: New Prospects for Environmental Cleaning by Enzymes

Vikram Singh (2019). *Biotechnology: Concepts, Methodologies, Tools, and Applications* (pp. 1002-1030).

[www.irma-international.org/chapter/bioremediation/228656](http://www.irma-international.org/chapter/bioremediation/228656)