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# Environmental Biotechnology For Soil and Wastewater Implications on Ecosystems

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Susmita Mukherjee  
Editors

# Environmental Biotechnology For Soil and Wastewater Implications on Ecosystems

 Springer

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## Foreword

This edition containing 14 scientific articles contributed by many researchers present a multifarious discussion on the emerging problem of soil and water pollution and their remediation utilizing biotechnology. The articles were presented in the International Conference on Biotechnology and Biological Sciences, BIOSPECTRUM 2017.

Industrial development and urbanization have improved our lives but at the same time affected the ecosystem most adversely. With increasing population, more waste is getting generated and end up in landfill sites. The landfill leachates along with the sewages carrying industrial effluents together contaminate the groundwater and water bodies. In this way, heavy metals, organic and inorganic toxic elements and harmful microbes are translocated from soil/water to plants/animals through the food chain, ultimately affecting the human health. Therefore, it is urgently necessary to mitigate this problem. Here, the young researchers have thrown light on the remediation process by utilizing microorganisms, microalga and hydrophytes. They have also discussed about the fluoride, mercury, lead and excess fertilizer-related soil contamination. All these articles are very much relevant in today's world. I hope this will certainly make us think about this burning issue, so that we can combat the problem more effectively.

I do hope that the present compilation of important research will be of great help to the researchers in this field.

I would like to thank the publishers for their endeavour in publishing the research articles.

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Dr. Debjani Nath

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## Preface

In recent years, there has been considerable interest in studying the multidimensional aspects of biotechnology, which include biochemistry, environmental biotechnology, microbial biotechnology, plant biotechnology, molecular genetics, nanobiotechnology and drug development, food and applied biotechnology and many more. They receive wide applications together with the potential impact on virtually all domains of human interactions. Environmental biotechnology is the application of the scientific and engineering knowledge in the prevention and protection of natural environment and ecosystem from adverse effects through biotreatment and bioremediation of different types of wastes also bio-monitoring of environment and treatment processes.

Studying ecology is important as it has practical applications in conservation biology and natural resource management. Soils play an important role in all of our natural ecological cycles. Soil also provides benefits through their contribution in a number of additional processes, called ecosystem services. These services range from waste decomposition to acting as a water filtration system in degrading environmental contaminants. The diversity and abundance of life that exists within the soil are greater than any other ecosystem. A handful of soil can contain billions of different organisms that play a critical role in determining soil quality and support plant growth. Most of the ecological cycles move among the atmosphere (air), hydrosphere (water), lithosphere (land) and biosphere (living things); other nutrient cycles are limited to movement between rocks, soils, plants and animals; they are part of sedimentary cycles. The geological carbon cycle takes place over hundreds of millions of years and involves the cycling of carbon through the various layers of the Earth, which involves interaction of a cascade of microorganisms that appear in synchronization with the soil environment. Soil also plays a central role in the management, processing and detoxification of a variety of wastes, both natural and man-made. Soil organisms decompose many organic compounds, such as manure, remains of plants, fertilizers and pesticides, preventing them from entering into groundwater.

Open dumping of municipal solid wastes and the discharges from industries through waste water are major threats to ecosystem. In a densely populated country like India, generation of waste water is quite high. Waste water disposal and management is an important concern in all the developing countries with minimum

infrastructure of waste water treatment. Untreated or half-treated waste water when discharged in the water bodies causes pollution not only to the aquatic system but causes a complex ecological problem at large. All ecosystems are connected, and they are dependent on water; hence, contaminated water will contaminate different components of the ecosystem. All industrial and agricultural activity, unplanned disposal of wastes and unplanned excavation activities have adverse effect on soil.

The pollutants affect growth of plants, decrease soil fertility, add toxicity to soil and thus destroy the plants, soil microbes and other organisms in the soil. The contaminants indirectly affect the groundwater and associated soil, leading to disturbed ecological balance. Contamination of soil gets accumulated by the plants and through food chain gets magnified.

An ecosystem is a self-contained, dynamic system made of a population of species in its physical environment. It involves the complex interactions between the organisms – plants, animals, bacteria and fungi – that make up the community. Pollutants like oil, detergents, nitrogen and phosphate from fertilizers can have a tremendous impact on the ecosystem, especially if the water gets polluted. In a lake, for example, these pollutants disturb the ecological balance by stimulating plant growth and causing the death of fish and other aquatic animals due to suffocation resulting from lack of oxygen. According to WHO report, around 70% of industrial wastes are dumped into surrounding water bodies. Under this circumstances, biological treatment of the pollutants can be an alternative, and it is mostly done by the microbes as they have the ability to break down a range of organic compounds.

Biotechnology offers a plethora of activities for effectively addressing issues like waste monitoring, assessment and treatment of contaminated water, soil and even air. Bioremediation is less energy consuming and less expensive process.

The advantages of biological treatment involve biodegradation or detoxication of a wide spectrum of hazardous substances by natural microorganisms, availability of a wide range of biotechnological methods for destruction of hazardous wastes and diversity of the conditions suitable for biodegradation. The main considerations for application of biotechnology in waste treatment are due to the reason that it is technically and economically more affordable.

This edition of the book comprises the proceedings of the First International Conference on Biotechnology and Biological Sciences, BIOSPECTRUM 2017, and is an attempt to promote and present the research works of scientists and researchers including students in India and abroad, in the area of biotechnology and its application in addressing environmental problems. This book involves recent researches to address environmental issues through biological applications.

Twelve papers in the book encompass different angles of research in soil and waste water. A paper illustrates the problem of the Indo-Gangetic Plain. The Indo-Gangetic Plain (IGP) is one of the largest agricultural regions in the world feeding large population of the country. But the lack of crop rotation and excessive use of agrochemicals have resulted into severe loss in soil fertility and slowdown in the crop productivity in middle IGP. Farmers are compelled to apply higher fertilizer input per hectare (ha) every year to maintain or increase crop productivity. Under

such circumstance, the paper analyses that rhizospheric soil is better than non-rhizospheric soil due to microbial activity. Another paper is an experimental study to evaluate kinetic coefficients for designing an activated sludge process unit for treatment of specifically dairy waste water so that even if it is discharged in the normal drainage system, it will not cause any toxic effect. Another very important work on landfill discusses about landfill leachate, as landfill leachate can cause probable pollution of soil, and removal of mercury from such landfill leachate making it beneficial by protecting the soil from toxicity. In a research on assessment of self-rectification capacity of the main sewage canal while passing through the East Kolkata Wetlands, a Ramsar site in West Bengal, India, self-rectification happens in a sewage canal primarily by microorganisms; this paper analyses that self-rectification efficiency of this main sewage canal is quite high prior to discharging into the main outfall. Another research work on health risk assessment of some heavy metals at municipal solid wastes landfill site illustrates that the soil is very prone to heavy metal contamination and it affects the sub-surface water. Phytoremediation, which is a sustainable and cost-effective green technology in which plants are used as a biological tool for removal of different pollutants from contaminated water, is shown in a work to remove fluoride. Another work on bioremediation using microalgae proved to be efficient. There is a paper on easy and low-cost filtration for making groundwater free from pollutants. Many more such papers on the recent research trend are included in this book for a varied category of readers.

Finally, the editors are extremely thankful to the International Advisory Committee and the Technical Program Committee for their valuable guidance and support in different aspects. We express our sincere gratitude to the students for their consistent support. We express our heartfelt gratitude to the management, staff and faculty members of UEM Kolkata for making the conference a success.

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## About the Editors

**Rita Kundu** is a Professor at the Department of Botany, Calcutta University. Her specialization is on cell biology and genetics. She did pioneering research in cancer genetics. As part of her work in cancer biology, she worked on inducing cell death, either through apoptosis/autophagy/any other way, in the cervical cancer cell lines using traditional medicinal plants and other organic sources (marine/freshwater algal compounds, microbial compounds, synthetic organic compounds) to regulate cell proliferation. She has also worked on phytoremediation. Presently, her prime interest is to identify the metal-resistant crop (rice) varieties of south West Bengal and study their stress responses. She is the author of numerous papers.

**Rajiv Narula** received his Bachelor's degree with an Honors in botany from the esteemed Presidency College (now Presidency University), Calcutta, in 2001. He went on to get a Masters in biotechnology from GGD University, Chhattisgarh, where he graduated winning top honors (First Class – Gold Medal as University Topper) in 2003. He came to USA in Fall 2005 from India to pursue a PhD in environmental engineering from Clarkson University, Potsdam, NY. After completing his doctoral thesis on pathogen reduction and recycling of bedding materials on dairy farms (May 2011), he joined State University of New York in Canton in Fall 2011, first as an instructor and finally being hired as an Assistant Professor of environmental science and chemistry in Fall 2012.

**Rajashree Paul** has obtained her B Tech degree in computer science and engineering from Kalyani University, West Bengal, India, and MS degree in computing science from Simon Fraser University, Canada. She has over 10 years of experience in software industry and is currently an Assistant Professor in the Computer Science Department, University of Engineering and Management, Kolkata. Her current research interest is the study of electronic, optical, and mechanical properties of quantized structures. Mrs. Paul is affiliated with the conferences and workshops both in India and abroad and organizes different technical presentations and various industry-University interactions.

**Susmita Mukherjee** is a faculty in the Department of Biotechnology, University of Engineering and Management, Kolkata. She did her Graduation and Postgraduation in Zoology. Having more than 10 years of teaching experience, she has participated in different national and international conferences and has authored many papers. Her doctoral work and research interest are on protection of the natural ecosystem and environment. She has worked on the implications of different ecological factors on the sewage-fed fisheries. She has also worked on the environmental aspect of solar photovoltaic cells, which is apparently green energy. Presently, she is working on the phytoremediation of arsenic (As) and other heavy metals in the arsenic-prone areas of West Bengal.