

Preface

Since earliest recorded times, humans have manipulated their surroundings in order to extract and exploit resources. In the modern era, resource extraction, processing, and utilization have increased tremendously. Several kinds of waste materials are produced, in which most of them are now classified as hazardous. While the side effects of industrial development increased, nations are also experiencing soil, groundwater, as well as surface water contamination. Many of the contaminants have an immediate threat to public health and environment. Unfortunately, there is no standard instruction that could be applied in remediation of a contaminated site, because each site has its own distinct feature, which will vary in terms of toxicity, volatility, mobility, and so on.

Regarding to these considerations, contaminants' behavior should be determined in order to removing them efficiently with minimum damage to the site. The purpose of soil remediation is not only to enhance the degradation, transformation, or detoxification of pollutants but also to protect the quality and capacity of the soil to function within ecosystem boundaries, to maintain environmental quality, and to sustain biological productivity. It is difficult to evaluate this market with any specificity, but the international market for remediation is estimated to be around US\$ 25–30 billion. It is challenging to establish such estimates, as many countries have not undertaken comprehensive identification of contaminated sites. The USA, Canada, Western Europe, Japan, and Australia are considered to be the dominant international markets for remediation, with an established presence of a large number of environmental companies, products, and services. Emerging economies of some more developed Asian, Eastern European, and Latin American countries will represent significant medium-term remedial market opportunities.

There are several different remediation strategies used around the world to treat soil contaminated with toxic metals and/or organic chemicals. Three widely used strategies are (1) immobilization or retention of toxicants within a confined area, (2) removal of contaminants from the soil, (3) destruction of organic pollutants by chemical, physical, or biological means. These strategies either individually or in combination with each other have been routinely implemented by the remediation industry to successfully treat contaminated soil. Biological remediation technologies

require knowledge of interdisciplinary sciences, involving microbiology, chemistry, hydrogeology, engineering, soil and plant sciences, geology, and ecology. Biological processes are typically implemented at a relatively low cost, and biological remediation methods have been successfully used to treat polluted soils, oily sludges, and groundwater contaminated by petroleum hydrocarbons, solvents, pesticides, and other chemicals.

Bioremediation started over 50 years ago with research examining the fate of pesticides in agricultural soils. Scientists began to use fungi and bacteria for the degradation of xenobiotic organic compounds toward the middle of the twentieth century. The use of bacteria showed fast and promising results, but research on evaluating fungi has lagged behind. This does not mean that fungi are not suitable organisms or that they function less satisfactorily than bacteria in degrading such compounds. The participation of fungi in bioremediation is now well established in all ecosystems. Mycoremediation is one of the most complex areas in applied remediation engineering. During the past two decades, many fungal scientists and engineers have wanted to try using fungi in the degradation of organic compounds, and for those who did try using them, good results were obtained. The discovery of the value of white-rot fungi in bioremediation has brought greater success and has thus stimulated research throughout the world. A new era in the use of fungal technologies for the degradation of organic compounds has begun. Thus, the need has arisen for a book that discusses the unique role of fungi in bioremediation.

The prime objective of this book is to highlight the potential of filamentous fungi in bioremediation and to discuss the physiology, chemistry, and biochemistry of organic and inorganic pollutant transformations. The chapters are written by leading international authorities in their fields and represent the latest and most complete synthesis of this subject area. The state of the science described here represents pioneer work that focuses on the new and exciting field of mycoremediation. The book contains elements from all scientific and engineering disciplines known globally and lays a strong foundation in the subject that will serve to connect knowledge developed in both the twentieth and twenty-first centuries. The book is encyclopedic in scope and presents various types of fungi and the associated fungal processes used to clean up wastes and wastewaters in contaminated environments. The book covers aspects related to degradative fungi, biochemistry, enzymology, reactor engineering, genetic engineering, ecology of biodegradation, and practical applications. The knowledge flows broadly from fundamental to practical aspects, making it useful to learn and apply bioremediation holistically. The book not only contains an interwoven synthesis and historical perspective of the technology but also provides “slow-release nutrition” for inventions and new frontiers for future research. The latest advances in genetic engineering and molecular biotechnologies that will be useful for the creation of suitable fungi capable of faster detoxification of these compounds are also described.

The book is intended to reach a wide audience, including managers and leaders in research and the practice of mycoremediation, and should be very useful as a reference tool for practicing engineers, scientists, waste site managers, and

regulatory experts. It will also provide useful information for experts in allied fields, such as botany, mycology, geology, ecology, fungal biochemistry, genetics, enzymology, metabolic engineering, environmental microbiology, and biotechnology. This should be a leading source for graduate and undergraduate students interested in understanding the capacities and processes of fungal biodegradation. Graduate students can conduct experiments or research in the laboratory or apply fungi in bioremediation at contaminated sites without seeking special guidance. The work will also serve as a handbook for the creation of new designs and components for mycoremediation processes.

The book will stimulate thought and greater research in the wider context of mycoremediation processes in the coming decades. Hazardous wastes and wastewaters constitute a problem of modern civilization that will not go away for centuries. New wastes and wastewaters are being generated every year with our growing industrialization. A day will come when fungi will play a greater role in the transformation and detoxification of hazardous wastes and wastewaters than at present.

Experts in the area of environmental microbiology, biotechnology, and bioremediation, from diverse institutions worldwide, have contributed to this book. We would like to express our sincere appreciation to each contributor for his/her work and for their patience and attention to detail during the entire production process. We sincerely hope these eminent contributors will encourage us in the future as well, in the greatest interest of academia.

The editors would like to thank Dr. Ashok K Chauhan (Founder President, Ritnand Balved Education Foundation), Sri Atul Chauhan (Chancellor, Amity University Uttar Pradesh), and Sri Aseem Chauhan (Chancellor, Amity University Rajasthan) for their encouragement and inspiration. We are extremely grateful to the staff members of Springer Heidelberg, especially Hanna Hensler-Fritton and Jutta Lindenborn, for their continued interest, critical evaluation, constructive criticism, and support. We wish to acknowledge the help and support given to us by our faculty colleagues, family members, and friends for their constant encouragement. Special thanks are due to our Ph.D. student Ms. Ruchika Bajaj for day to day monitoring the progress of the book and willing helping me.

Tehran, Iran
Urmia, Iran
Noida, Uttar Pradesh, India

Ebrahim M. Goltapeh
Younes R. Danesh
Ajit Varma

Fungi as Bioremediators

Goltapeh, E.M.; Danesh, Y.R.; Varma, A. (Eds.)

2013, XI, 489 p. 23 illus., 3 illus. in color., Hardcover

ISBN: 978-3-642-33810-6