Bioremediation Technologies For Polycyclic Aromatic Hydrocarbon Compounds 58

In situ bioremediation--the use of microorganisms for on-site removal of contaminants--is potentially cheaper, faster, and safer than conventional cleanup methods. But in situ bioremediation is also clouded in uncertainty, controversy, and mistrust. This volume from the National Research Council provides direction for decisionmakers and offers detailed and readable explanations of the processes involved in in situ bioremediation, circumstances in which it is best used, and methods of measurement, field testing, and modeling to evaluate the results of bioremediation projects. Bioremediation experts representing academic research, field practice, regulation, and industry provide accessible information and case examples; they explore how in situ bioremediation works, how it has developed since its first commercial use in 1972, and what research and education efforts are recommended for the future. The volume includes a series of perspective papers. The book will be immediately useful to policymakers, regulators, bioremediation practitioners and purchasers, environmental groups, concerned citizens, faculty, and students.

Emerging Technologies in Environmental Bioremediation introduces emerging bioremediation technologies for the treatment and management of industrial wastes and other environmental pollutants for the sake of environmental sustainability. Emerging bioremediation approaches such as nano-bioremediation technology, electro-bioremediation technology, microbial fuel cell technology, Modified Ludzack-Ettinger Process, Modified Activated Sludge Process, and phytotechnologies for the remediation of industrial wastes/pollutants are discussed in a comprehensive manner not found in other books. Furthermore, the book includes updated information as well as future directions for research in the field of bioremediation of industrial wastes. This book will be extremely useful to students, researchers, scientists and professionals in the field of microbiology and biotechnology, Bio (chemical) engineers, environmental researchers, eco-toxicology, and many more. Includes the recovery of resources from wastewater Describes the importance of microorganisms in environmental bioremediation technologies Points out the reuse of treated wastewater through emerging technologies Pays attention to the occurrence of novel micro-pollutants Emphasizes the role of nanotechnology in pollutant bioremediation

Soil and Sediment Remediation discusses in detail a whole set of remediative technologies currently available to minimise their impact. Technologies for the

treatment of soils and sediments in situ (landfarming, bioscreens, bioventing, nutrient injection, phytoremediation) and ex situ (landfarming, bio-heap treatment, soil suspension reactor) will be discussed. The microbiological, process technological and socio-economical aspects of these technologies will be addressed. Special attention will be given to novel biotechnological processes that utilise sulfur cycle conversions, e.g. sulfur and heavy metal removal from soils. Also the potential of phytoremediation will be highlighted. In addition, treatment schemes for the clean-up of polluted megasites, e.g. harbours and Manufactured Gaswork Plants (MGP), will be elaborated. The aim of Soil and Sediment Remediation is to introduce the reader in: the biogeochemical characteristics of soil and sediments- new techniques to study soil/sediment processes (molecular probes, microelectrodes, NMR) clean up technologies for soils polluted with organic (PAH, NAPL, solvents) or inorganic (heavy metals) pollutants- preventative and remediative strategies and technologies available in environmental engineering novel process applications and bioreactor designs for bioremediation the impact of soil pollution on society and its economic importance.

This book focuses on two key issues confronting humanity, viz., energy and environment. There is a need to devise strategies for protecting the environment,

at the same time adequately meeting the ever-growing energy needs of the world. Harnessing the power of microbes is one step towards finding cheap, green and sustainable solutions to the problems of energy and environment. The book is divided into eight major topics. These topics include emerging trends in microbial biotechnology, harnessing sustainable energy sources from microorganisms, mechanistics of bioenergy production, bioenergy from wastes and pollutant removal, microalgae for biofuels, bioremediation technologies for petroleum hydrocarbons, polycyclic aromatic hydrocarbons and xenobiotics, bioremediation of nuclear wastes, and the role of extremophilic microorganisms in environmental cleanup.

Microbial Biodegradation and Bioremediation brings together experts in relevant fields to describe the successful application of microbes and their derivatives for bioremediation of potentially toxic and relatively novel compounds. This single-source reference encompasses all categories of pollutants and their applications in a convenient, comprehensive package. Our natural biodiversity and environment is in danger due to the release of continuously emerging potential pollutants by anthropogenic activities. Though many attempts have been made to eradicate and remediate these noxious elements, every day thousands of xenobiotics of relatively new entities emerge, thus worsening the situation.

Primitive microorganisms are highly adaptable to toxic environments, and can reduce the load of toxic elements by their successful transformation and remediation. Describes many novel approaches of microbial bioremediation including genetic engineering, metagenomics, microbial fuel cell technology, biosurfactants and biofilm-based bioremediation Introduces relatively new hazardous elements and their bioremediation practices including oil spills, military waste water, greenhouse gases, polythene wastes, and more Provides the most advanced techniques in the field of bioremediation, including insilico approach, microbes as pollution indicators, use of bioreactors, techniques of pollution monitoring, and more

Presents accounts of current research in polynuclear aromatic compounds, showing examples of studies both of pure compounds and of complex, fossil fuel related mixtures. Offers a thorough knowledge of aromatic chemistry through coverage of reduction, oxidation, and thermal reactions--including applications developed for both coal and petroleum materials. Featured topics include quantum chemical structure-reactivity relationships, spatial configurations of large polynuclear hydrocarbons, cyclophanes, and desulfurization of heterocycles. Scientists studying all aspects of the chemistry of polynuclear aromatics will discover important, pertinent information in this volume.

This timely reference presents the state of the art of the emerging and rapidly changing field of bioremediation of chlorinated solvents, PCBs, and other chlorinated compounds, as well as PAHs, both in situ and on site. This landmark publication reports significant advances in bioremediation, with an emphasis on practical applications and state-of-the-art developments. Laboratory and field-oriented reviews are presented with the objective of tying treatability studies and recent laboratory developments to field applications. No other reference source gives you access to the most current techniques and methods for the bioremediation of chlorinated and polycyclic aromatic hydrocarbon compounds. This book represents the work of leading experts in the fields of in situ and on-site bioremediation from North America, Europe, and Asia. The chapters include current field applications and laboratory studies undertaken, in some cases, in countries with regulatory standards more stringent than those of the United States.

This book arose from the combination of diverse areas of knowledge, experience, research, and points of view that try to demonstrate that mycobacteria are a complex science and very relevant to scientific studies that affect the human being in the world. Sophisticated techniques for improving human health do not guarantee that the "battle" against mycobacteria has been won, since tuberculosis, mycobacteriosis, and leprosy

are a daily challenge in the world. The book includes contributions made by prestigious experts and research groups in different areas of mycobacteria, and they have contributed new perspectives of their area giving a comprehensive, important, and fascinating emphasis of this field that continues to offer challenges that lead various disciplines to understand their biology and pathogenicity. It is hoped that these chapters will be very useful for learning and discussion.

The data obtained from this preliminary short-term project demonstrated that dispersants such as 54GO are effective in accelerating the bio-remediation of soils containing contamination from waste oils, diesel, creosote and manufactured gas plant waste. This acceleration appears to be in the observation that 54GO quickly separates the hydrocarbon wastes from the soil particles, thereby allowing closer contact with the microbes. The project time limitations impacted the scope of data but was able to demonstrate a general reduction in the levels of contaminates. In this project only Total Petroleum Hydrocarbons [TPH] and 17 polycyclic aromatic hydrocarbons [PAH] were analyzed. These were chosen because they are standardized by EPA methodology. The raw data from these analytical methods indicate that there are many more intermediate metabolizes from the bio-remediation process that were not identified or measured [a limitation of the 17 analyte EPA Method 8270 protocol]. The limited data from these bio-reactors indicates that when both 54GO [dispersant] and stress selected microbes are used the reduction of contaminate metabolizes is the greatest. The use of

microbes alone was also effective, but not consistent and to a lesser degree. An additional observation with 54GO, either alone or with microbes is that significant amounts of hydrocarbons were extracted or released from the test soils and became a separate phase floating on the surface of these bio-reactors. The levels of floating oil in these bio-reactors made mixing and sampling difficult tasks. This latter effect of, 54GO, indicates that this family of dispersants are excellent candidates for classic soil washing techniques and may be better served by pre-treating waste soils before mixing with microbes. It is estimated that 75% or more of the hydrocarbons were in the oil phase in these bio-reactors even in low water conditions [saturated soil].

The symposium included 600 presentations in 50 sessions on bioremediation and supporting technologies used for a wide range of contaminants already in, or poised to invade, soil, groundwater, and sediment. Three hundred and fifty-two papers were selected and organized into ten volumes. Volume three presents bench- and pilot-scale projects focusing on the use of biological treatment approaches for remediating problem compounds such as RDX, HMX, TNT, DDT, PCBs, PAHs, and chlorophenols. Articles average eight pages, and contain abstracts and references. Annotation copyrighted by Book News Inc., Portland, OR.

This handbook provides a comprehensive overview of microbial interactions with the major forms of hydrocarbons, oils, and lipids in or entering the biosphere. It is the definitive resource on the physiological mechanisms and adaptive strategies

characteristic of the microbial lifestyle that plays out at hydrophobic material: aqueous liquid interfaces.

The fourth edition of Soil Microbiology, Ecology and Biochemistry updates this widely used reference as the study and understanding of soil biota, their function, and the dynamics of soil organic matter has been revolutionized by molecular and instrumental techniques, and information technology. Knowledge of soil microbiology, ecology and biochemistry is central to our understanding of organisms and their processes and interactions with their environment. In a time of great global change and increased emphasis on biodiversity and food security, soil microbiology and ecology has become an increasingly important topic. Revised by a group of world-renowned authors in many institutions and disciplines, this work relates the breakthroughs in knowledge in this important field to its history as well as future applications. The new edition provides readable, practical, impactful information for its many applied and fundamental disciplines. Professionals turn to this text as a reference for fundamental knowledge in their field or to inform management practices. New section on "Methods in Studying Soil Organic Matter Formation and Nutrient Dynamics" to balance the two successful chapters on microbial and physiological methodology Includes expanded information on soil interactions with organisms involved in human and plant disease Improved readability and integration for an ever-widening audience in his field Integrated concepts related to soil biota, diversity, and function allow readers in multiple disciplines

to understand the complex soil biota and their function

Green Sustainable Process for Chemical and Environmental Engineering and Science: Biosurfactants for the Bioremediation of Polluted Environments explores the use of biosurfactants in remediation initiatives, reviewing knowledge surrounding the creation and application of biosurfactants for addressing issues related to the release of toxic substances in ecosystems. Sections cover their production, assessment and optimization for bioremediation, varied pollutant degradation applications, and a range of contaminants and ecological sites. As awareness and efforts to develop greener products and processes continues to grow, biosurfactants are garnering more attention for the potential roles they can play in reducing the use and production of more toxic products. Drawing on the knowledge of its expert team of global contributors, this book provides useful insights for all those currently or potentially interested in developing or applying biosurfactants in their own work. Provides an accessible introduction to biosurfactant chemistry Highlights the optimization, modeling, prediction and kinetics of key factors supporting biosurfactant-enhanced biodegradation processes Explores a wide range of biosurfactant applications for remediation and degradation of pollutants

This volume provides a clear understanding of how microbes, following their degradative processes, contribute maximally to the benefit of mankind through biotransformations of waste materials as well as a wide variety of health-risk compounds. The book contains twenty four chapters contributed by leading scientists

from different parts of the world, covering various aspects of bioremediation of xenobiotics such as toxic, carcinogenic, teratogenic, and mutagenic compounds, which include halogenated aromatics, derivatives of heavy metals, microbial toxins, tannins, dyes, sulfur compounds of coal and petroleum and pesticides. The bioremediation of agricultural residue, industrial as well as municipal wastes, fuel oils, lubricants, natural rubber products, and other synthetic polymers, which pollute the environment substantially, also constitutes an important component of the book. All biotechnological aspects of microbial transformations pertaining to biodegradation/bioremediation of hazardous wastes, ranging from screening methods for microbes with degradative potential, processes of degradation, strain improvement for enhanced biodegradation and elimination of xenobiotics of health and environmental concern have been dealt with. The book intends to widen the scope of Applied Microbiology and Biotechnology in general and biotransformations in particular. It will provide an opportunity for scientists in the areas of biochemistry, food industry, environmental science and engineering and their implications in technologically feasible, environment friendly and economically viable bioremediation options. Also, it forms an interface between agro-industrial establishments and the academic world and will generate new thought provoking ideas for scientists of future generations for the safeguard of both human and animal health as well as the environment.

Bioremediation is an eco-friendly, cost-effective and natural technology targeted to

remove heavy metals, radionuclides, xenobiotic compounds, organic waste, pesticides etc. from contaminated sites or industrial discharges through biological means. Since this technology is used in in-situ conditions, it does not physically disturb the site unlike conventional methods i.e. chemical or mechanical methods.

This book contains a collection of different biodegradation research activities where biological processes take place. The book has two main sections: A) Polymers and Surfactants Biodegradation and B) Biodegradation: Microbial Behaviour.

Traditional reliance on chemical analysis to understand the direction and extent of treatment in a bioremediation process has been found to be inadequate. Whereas the goal of bioremediation is toxicity reduction, few direct, reliable measures of this process are as yet available. Another area of intense discussion is the assessment of market forces contributing to the acceptability of bioremediation. Finally, another important component is a series of lectures and lively exchanges devoted to practical applications of different bioremediation technologies. The range of subjects covers a wide spectrum, encompassing emerging technologies as well as actual, full-scale operations. Examples discussed include landfarming, biopiling, composting, phytoremediation and mycoremediation. Each technology is explored for its utility and capability to provide desired treatment goals. Advantages and limitations of each technology are discussed. The concept of natural attenuation is also critically evaluated since in some cases where time to remediation is not a significant factor, it may be an alternative to active

bioremediation operations.

Polycyclic aromatic hydrocarbons (PAHs) are a diverse class of toxicants that are ubiquitously and persistently present in the environment. These compounds present a risk for human health and the environment, as they are mutagens, carcinogens and teratogens. Bioremediation has shown promise as a potentially effective and low-cost treatment option, but concerns about the slow process rate and bioavailability limitations have hampered more widespread use of this technology. In the fundamental work of this thesis a series of experiments was designed utilizing the biosurfactant produced by Pseudomonas aeruginosa LBP5, LBP9 and CB1. Specifically, these experiments were designed to determine if the presence of various levels of partially purified biosurfactants produced by the isolates, would affect the degradation of a range of PAHs. The biodegradation and biotransformation of PAHs were studied in three bioremedial systems: soil slurry, liquid culture experiments with enriched consortium on PAHs from petroleum contaminated sites and Bioslurry reactor study with autochthonous consortium. Biosurfactant-producing and polycyclic aromatic hydrocarbon degrading microorganisms were isolated from petroleum-contaminated crane service station soil and creosote contaminated wood treatment plant soils in Pretoria area. Bacterial isolates LBP9 and LBP5 isolated from crane service station soil and isolates CB1, CN2, CN3, CN5 isolated from creosote contaminated soil were found to be the most efficient biosurfactant producing strains. The biosurfactant produced by

the strains LBP9, LBP5 and CB1 were extracted and characterized by attenuated total reflectance Fourier transform infrared spectroscopy (ATR FTIR) and Thin layer chromatography (TLC). Evaluation of the ability of the LBP9 biosurfactant for applications in enhancing biodegradation of mixed polycyclic aromatic hydrocarbons (PAHs) with a consortium of bacteria indicated that the biosurfactant was able to enhance the removal of significant amount of PAHs from the liquid culture medium at different concentrations. In this study at 400 mg/L amendment of lipopeptide the solubility of Phenanthrene, Fluoranthene and Pyrene was increased to 19.4, 33 and 45.4 times their aqueous solubility, respectively, and the extent of substrate utilization rate of the PAHs was enhanced up to 3 fold in the sole substrate microcosms. A second goal of these experiments was to discern the efficacy of exogenous lipopeptide application and stimulation of in situ biosurfactant production through biostimulation / nutrient amendments in the removing of polycyclic aromatic hydrocarbons (PAH) from creosote PAH contaminated soil. This work also suggests that it may be more practical to stimulate indigenous biosurfactant production within a soil than to add pre-purified compound. In general, the results presented in the studies show the potential of biosurfactants in assisting the bioremediation of polycyclic aromatic hydrocarbon contaminated environmental media in a reasonable timeframe.

This book provides a broad overview how extremophiles can be used in biotechnology, including for the production and degradation of compounds. It reviews various recent

discoveries and applications related to a large variety of extremophiles, considering both prokaryotes as well as eukaryotes.

Bioremediation refers to the clean?up of pollution in soil, groundwater, surface water, and air using typically microbiological processes. It uses naturally occurring bacteria and fungi or plants to degrade, transform or detoxify hazardous substances to human health or the environment. For bioremediation to be effective, microorganisms must enzymatically attack the pollutants and convert them to harmless products. As bioremediation can be effective only where environmental conditions permit microbial growth and action, its application often involves the management of ecological factors to allow microbial growth and degradation to continue at a faster rate. Like other technologies, bioremediation has its limitations. Some contaminants, such as chlorinated organic or high aromatic hydrocarbons, are resistant to microbial attack. They are degraded either gradually or not at all, hence, it is not easy to envisage the rates of clean-up for bioremediation implementation. Bioremediation represents a field of great expansion due to the important development of new technologies. Among them, several decades on metagenomics expansion has led to the detection of autochthonous microbiota that plays a key role during transformation. Transcriptomic guides us to know the expression of key genes and proteomics allow the characterization of proteins that conduct specific reactions. In this book we show specific technologies applied in bioremediation of main interest for research in the field,

with special attention on fungi, which have been poorly studied microorganisms. Finally, new approaches in the field, such as CRISPR-CAS9, are also discussed. Lastly, it introduces management strategies, such as bioremediation application for managing affected environment and bioremediation approaches. Examples of successful bioremediation applications are illustrated in radionuclide entrapment and retardation, soil stabilization and remediation of polycyclic aromatic hydrocarbons, phenols, plastics or fluorinated compounds. Other emerging bioremediation methods include electro bioremediation, microbe-availed phytoremediation, genetic recombinant technologies in enhancing plants in accumulation of inorganic metals, and metalloids as well as degradation of organic pollutants, protein-metabolic engineering to increase bioremediation efficiency, including nanotechnology applications are also discussed.
A synthesis of years of interdisciplinary research and practice, the second edition of this bestseller continues to serve as a primary resource for information on the assessment, remediation, and control of contamination on and below the ground surface. Practical Handbook of Soil, Vadose Zone, and Ground-Water Contamination: Assessment, Prevention, and Remediation, Second Edition includes important new developments in site characterization and soil and ground water remediation that have appeared since 1995. Presented in an easy-to-read style, this book serves as a comprehensive guide for conducting complex site investigations and identifying methods for effective soil and ground water cleanup. Remediation engineers, ground water and soil scientists,

regulatory personnel, researchers, and field investigators can access the latest data and summary tables to illustrate key advantages and disadvantages of various remediation methods.

Petroleum hydrocarbons are ubiquitous persistent environmental contaminants generated by natural combustion processes as well as from human activities. Polycyclic aromatic hydrocarbons (PAHs) are a major component of petroleum hydrocarbons. Biodegradation is a promising process for responding to contamination by petroleum hydrocarbons. The ability of microorganisms to degrade hydrocarbons and facilitate their mineralization by forming more labile organic compounds through the breakdown of intramolecular bonds has been extensively studied. Microbial degradation is a rate-limiting factor in many biogeochemical cycles. As a result, microorganisms have contributed to the development of different bioremediation technologies.

The book describes hazardous waste industries, sources of waste generation, characterization and treatment processes/ methods and technique and technology to deal with the treated waste as per the prescribed standard. Advanced treatment based on the microbial remediation, plant-based decontamination, rhizoremediation and nano-based remediation is also explained. Advances in treatment technology using biotechnological tools/bionanotechnology for removal of contaminants are described. This volume will help readers to develop biotechnological and nanotechnological approaches for the remediation of hazardous waste and the developed technology that

can be transferred from laboratory to land and piloting to commercial scenarios. Prof. M. H. Fulekar a Professor and Joint Director (R&D), Centre of Research for Development, Parul University. Dr. Bhawana Pathak is working as an Associate Professor and Dean in School of Environment and Sustainable Development, Central University of Gujarat.

Smart Bioremediation Technologies: Microbial Enzymes provides insights into the complex behavior of enzymes and identifies metabolites and their degradation pathways. It will help readers work towards solutions for sustainable medicine and environmental pollution. The book highlights the microbial enzymes that have replaced many plant and animal enzymes, also presenting their applications in varying industries, including pharmaceuticals, genetic engineering, biofuels, diagnostics and therapy. In addition, new methods, including genomics and metagenomics, are being employed for the discovery of new enzymes from microbes. This book brings all of these topics together, representing the first resource on how to solve problems in bioremediation. Provides the most novel approaches in enzyme studies Gives insights in real-time enzymology that are correlated with bioremediation Serves as a valuable resource on the use of genomes, transcriptomes and proteomes with bioremediation Refers to enzymes as diagnostic tools

Pollution is the release of chemical, physical, biological or radioactive contaminants to the environment. Principal forms of pollution include: air pollution, the release of

chemicals and particulates into the atmosphere. Common examples include carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs), and nitrogen oxides produced by industry and motor vehicles. Ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Water pollution affects oceans and inland bodies of water. Examples include organic and inorganic chemicals, heavy metals, petrochemicals, chloroform, and bacteria. Water pollution may also occur in the form of thermal pollution and the depletion of dissolved oxygen. Soil contamination often occurs when chemicals are released by spill or underground storage tank leakage. Contaminants include hydrocarbons, heavy metals, MTBE, herbicides, pesticides and chlorinated hydrocarbons. Often occurs with water pollution, thanks to surface runoff and groundwater. Radioactive contamination was added in the wake of 20th-century discoveries in atomic physics. Noise pollution encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar. Light pollution, includes light trespass, over-illumination and astronomical interference. Visual pollution, which can refer to the presence of overhead power lines, highway billboards, scarred landforms (as from strip mining), open storage of junk or municipal solid waste. The nature, distribution and ecological effects of all types and forms of pollutants in air, soil and water are the subject of this book.

Polycyclic aromatic hydrocarbon compounds (PAHs) are common and challenging contaminants that affect soil and sediments. Methods for treating PAHs have

undergone change and refinement in the recent past, and this volume presents the latest trends in PAH remediation theory and practice. The papers in this volume cover topics ranging from the remediation of manufactured gas plant (MGP) sites to the remediation of sediments. The papers present lab and field studies, characterization studies, comparison studies, and descriptions of technologies ranging from composting to thermally enhanced bioremediation to fungal technologies and other innovative approaches.

Hazardous waste management is a complex, interdisciplinary field that continues to grow and change as global conditions change. Mastering this evolving and multifaceted field of study requires knowledge of the sources and generation of hazardous wastes, the scientific and engineering principles necessary to eliminate the threats they pose to people and the environment, the laws regulating their disposal, and the best or most cost-effective methods for dealing with them. Written for students with some background in engineering, this comprehensive, highly acclaimed text does not only provide detailed instructions on how to solve hazardous waste problems but also guides students to think about ways to approach these problems. Each richly detailed, self-contained chapter ends with a set of discussion topics and problems. Case studies, with equations and design examples, are provided throughout the book to give students the chance to evaluate the effectiveness of different treatment and containment technologies.

This volume represents an excellent description of the hottest topics in the field of phyto- and rhizoremediation. The book shows especially the importance of cooperation between plant and microorganisms, there is practically no phytoremediation without rhizoremediation. Newest approaches based on methods of molecular biology and genetic engineering are described, as well as plant science achievements.

Our Earth is considered as a natural system which organizes and controls itself. However, the present scale of anthropogenic activity is unprecedented in the history of mankind compelling the intelligentia to ponder over the scientific causes of the problems, processes and sustainable and pragmatic solutions. The current rate of resource use and consumption pattern are depleting the planet's finite resources and damaging life-supporting ecosystems. A large number of toxic substances are increasingly found in air, water, soil, and flora and fauna. We are in the midst of a period of increasing interconnected and complex global challenges that seek action across temporal and spatial scales, diverse sectors, and concerted efforts from global citizens. The environment on account of human's action has been experiencing imbalances and ecological catastrophe. Environmental issues like global climate change, biodiversity loss, the rapid depletion of natural resources, degradation of global commons, stratospheric ozone depletion have been restricting the safe operating space and

transgressing the planetary boundaries endangering the existence of human societies. The global environmental problems if not scientifically managed may end up in the civilizational collapse. Nevertheless, the underlying commonality among these environmental issues is interrelatedness, complexity, and difficulty in identifying and implementing solutions. The global environmental challenges can be managed by adopting sustainable green technologies which dovetails the principles of environmental sustainability with social and ecological sustainability. Green growth is construed as a new development paradigm that sustains economic growth while at the same time ensuring environmental sustainability. Bioremediation Technologies for Polycyclic Aromatic Hydrocarbon Compounds Bioremediation technologies are gaining immense credibility in the field of waste management because of their eco-compatibility nature. Biomass can interact and confront with water and soil pollutants in both active (live) as well as passive (dead) way, thereby offering numerous opportunities of exploring them for environmental clean-up. In 21st century, wastes are no longer a waste but are recognized as a valuable Resource. Employing novel and integrated strategies for the development of modern bioremediation processes is desperate need of the hour. This edited book on Applied Bioremediation - Active and Passive Approaches contains mix of interesting chapters that will certainly add to the

advancement of knowledge and will provide the required valuable resource and stimulus to the researchers worldwide.

This book contains a collection of research works focused on the biodegradation of different types of pollutants, both in water and solids. The book is divided in three major sections: A) Biodegradation of organic pollutants in solids and wastewater, B) Biodegradation of complex pollutants, and C) Novel technologies in biodegradation and bioremediation.

This authoritative text addresses the latest in bioremediation technologies for three difficult-to-treat contaminant groups: chlorinated solvents, PCBs, and PAHs - one of the most complex and expensive areas of applied remediation engineering. Bioremediation of Recalcitrant Compounds assesses innovative R&D projects developed for each contaminant group by a specially funded consortium of experts. Considering factors such as availability, toxicity, and treatability, world-class experts chronicle the development of field-ready biotechnologies, reflecting on the science and engineering challenges encountered as the research team progressed from bench-scale testing to the field. This book features the experimental work involved in enzymatic reactions for the biodegradation of co-solvent extraction of chlorinated solvents, bioaugmentation enhanced PAH degradation, and genetically engineered

microorganisms (GEMs) for enhanced PCB degradation. Comparisons to traditional methods of remediation also provide new insight on how to optimize biotreatment. Concluding with future directions of research and development in this area, Bioremediation of Recalcitrant Compounds is a must-have for professionals seeking cutting-edge, innovative biotreatment technologies for these hazardous organic compounds.