Arbuscular Mycorrhiza In Metal Hyperaccumulating Plants

For B.Sc. and M.Sc. Students of Different Indian Universities as per UGC Model Curriculum. This is revised edition of the book "Plant Biotechnology". Several new topics such as Aquporins, Artificial intelligence Automation in Micropropagation, Biochips, Green House, Hydroponic, Inteins, Nanotechnology, Space Biotechnology, Supercritical Fluid extraction, etc. have been included in this revised. This edition provides latest information on the frontier area of biotechnology.

Cadmium Toxicity and Tolerance in Plants: Agronomic, Genetic, Molecular and Omic Approaches presents research and latest developments on mechanisms of cadmium tolerance covering both lab and field conditions. This book contains important insights and options for minimizing Cd accumulation in plants and mitigating Cd toxicity. Topics covered include using various omics approaches to understanding plant responses to Cd, novel technologies for developing Cd tolerance and integrated breeding approaches to mitigate Cd stress in crops. Cadmium Toxicity and Tolerance in Plants: Agronomic, Genetic, Molecular and Omic Approaches is a valuable resource for both researchers and students working on cadmium pollution and plant responses as well as related fields of environmental contamination and toxicology. Provides data on mechanisms of cadmium tolerance at the cell, organ and whole plant level Covers several major approaches, molecular and agronomic, in addressing cadmium toxicity in plants and soil Offers real-world, application focused techniques

The environment is considered the surroundings in which an organism operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation. It is this environment which is both so valuable, on the one hand, and so endangered on the other. And it is people which are by and large ruining the environment both for themselves and for all other organisms. This book reviews the latest research in this field which is vital for everyone.

Several studies have demonstrated that mycorrhizal associations play vital role in plant nutrition. They greatly increase the efficiency of nutrient and water uptake, enhance resistance to pathogens, and buffer plant species against several environmental stresses and drought resistance. Mycorrhizae also improve plant growth and survival in soils co

Endophytes are commonly known as microorganisms, mainly bacteria and fungi, which live inside plant tissues without inducing symptoms. Considering the long-lived trees, endophytes have a fundamental role in preparing their hosts to face extreme weather conditions, drought, heat, cold, and pathogen and herbivore attacks. The current knowledge clearly demonstrates the importance of endophytes in shaping the plant diversity in a forest. Endophytes have an important capacity for biocontrol of forest diseases. Considering endophyte diversity and the range of various compounds and enzymes they can produce, endophytes can be used for various biotechnological applications.

This book reviews the potential mechanisms in arbuscular mycorrhizas (AMs), in the hope that this can help arbuscular mycorrhizal fungi (AMF) to be more used efficiently as a biostimulant to enhance stress tolerance in the host plants. AMF, as well as plants, are often exposed to all or many of the abiotic and biotic stresses, including extreme temperatures, pH, drought, water-logging, toxic metals and soil pathogens. Studies have indicated a quick response to these stresses involving several mechanisms, such as root morphological modification, reactive oxygen species change, osmotic adjustment, direct absorption of water by extraradical hyphae, up-regulated expression of relevant stressed genes, glomalin-related soil protein release, etc. The underlying complex, multi-dimensional strategy is involved in morphological, physiological, biochemical, and molecular processes. The AMF responses are often associated with homeostatic regulation of the internal and external environment, and are therefore critical for plant health, survival and restoration in native ecosystems and good soil structure.

In the years since the first edition of “Arbuscular Mycorrhizas: Physiology and Function” was published, an exceptional proliferation of interest in mycorrhizal biology has developed. This has been associated with advances in different research disciplines such as genetics, genomics, proteomics, metabolomics and physiology, advances which have generated better insight into topics of mycorrhizal biology, including the mechanisms of host-mycorrhiza interactions pre- and post-penetration, the influence of the symbiosis on the host and its surroundings, and the evolution and diversity of mycorrhization. It therefore became necessary to both update and expand the book's coverage in this, its second edition.

The book focuses in detail on learning and adapting through partnerships between managers, scientists, and other stakeholders who learn together how to create and maintain sustainable resource systems. As natural areas shrink and fragment, our ability to sustain economic growth and safeguard biological diversity and ecological integrity is increasingly being put to the test. In attempting to meet this unprecedented challenge, adaptive management is becoming a viable alternative for broader application. Adaptive management is an iterative decision-making process which is both operationally and conceptually simple and which incorporates users to acknowledge and account for uncertainty, and sustain an operating environment that promotes its reduction through careful planning, evaluation, and learning until the desired results are achieved. This multifaceted approach requires clearly defined management objectives to guide decisions about what actions to take, and explicit assumptions about expected outcomes to compare against actual outcomes. In this edited book, we address the issue by pursuing a holistic and systematic approach that utilizes natural resources to reap sustainable environmental, economic and social benefits for adaptive management, helping to ensure that relationships between land, water and plants are managed in ways that mimic nature.

Written for researchers and practitioners in environmental pollution, management and ecology, this interdisciplinary account explores the ecological issues associated with industrial pollution to provide a complete picture of this important environmental problem from cause to effect to solution. Bringing together diverse viewpoints from academia and environmental agencies and regulators, the contributors cover such topics as biological resources of mining areas, biomonitoring of freshwater and marine ecosystems and risk assessment of contaminated land in order to explore important questions such as: What are the effects of pollutants on functional ecology and ecosystems? Do current monitoring techniques accurately signal the extent of industrial pollution? Does existing policy provide a coherent and practicable approach? Case studies from throughout the world illustrate major themes and provide valuable insights into the positive and negative effects of industrial pollution, the provision of appropriate monitoring schemes and the design of remediation and restoration strategies.

This book offers present-day retrospectives and future perspectives on ‘phytobiont’ studies in the context of phyto-micro restitution, filling some of the information gaps in this promising research field. It discusses several ecosystem restitution strategies using dissimilar groups of microbes alone or in association with plants, as well as advances in metagenomics

technology for studying in situ micro and macro communities in contaminated soil. It addresses topics such as the status quo, and the perspectives of microbial researchers and scientists, foresters, students, environmentalists, agriculturists and professional engineers. The rising pollution levels caused by xenobiotics is one of the biggest problems of our times, and as such the book comprehensively elaborates the latest research in this field and describes how the issue can be tackled using micro-organisms. With detailed diagrams and illustrations, the book is a valuable resource for experts and novices in the field of microbial bioremediation, phyto-bioremediation and environmental microbiology

With the advent of the industrial revolution , the biosphere has been continuously polluted with a myriad of contaminants that urgently need global attention. In this perspective, most of the genera of the plant family Brassicaceae (Crucifereae or the mustard family) are a significant part of the plants- and associated microbes-based strategies adopted for the cleanup of varied contaminants from environmental compartments. Important genus such as Alyssum, Arabidopsis, Brassica and Thlaspi from Brassicaceae which, besides acting as an attractive genetic model, well-represent the metal hyperaccumulation among approximately 0.2% of all angiosperms and thus, play a key role in the phytoremediation technology. This book i) provides an exhaustive evaluation of the current status of contaminants (metals/metalloids)-addition to varied environmental compartments and its consequences, ii) offers comprehensive and state-of-the-art information on the significance of the plants from the family Brassicaceae in solving environmental pollution issues, iii) examines the physiological, biochemical and molecular-genetic strategies adopted by the plants from Brassicaceae for the remediation of and tolerance to varied environmental contaminants, and iv) supplies a broad reference to the field of environmental science and related disciplines. As a pioneer work and significant addition to the Environmental Pollution book series, the current volume promises to be a useful asset for researchers, students, other academicians and policy makers involved in sustainable remediation of varied environmental compartments.

Molecular Aspects of Plant Beneficial Microbes in Agriculture explores their diverse interactions, including the pathogenic and symbiotic relationship which leads to either a decrease or increase in crop productivity. Focusing on these environmentally-friendly approaches, the book explores their potential in changing climatic conditions. It presents the exploration and regulation of beneficial microbes in offering sustainable and alternative solutions to the use of chemicals in agriculture. The beneficial microbes presented here are capable of contributing to nutrient balance, growth regulators, suppressing pathogens, orchestrating immune response and improving crop performance. The book also offers insights into the advancements in DNA technology and bioinformatic approaches which have provided in-depth knowledge about the molecular arsenal involved in mineral uptake, nitrogen fixation, growth promotion and biocontrol attributes. Covers the molecular attributes of biocontrol, PGPR and mycorrhizal associations involved in the three-way interaction between beneficial microbes-host-pathogen Explores the role of technological interventions in exploring molecular mechanisms Provides detailed and comprehensive insights about recent trends in the use of microbial genetic engineering for agricultural application

This volume explores the various functions and potential applications of mycorrhizas, including topics such as the dynamics of root colonization, soil carbon sequestration and the function of mycorrhizas in extreme environments. Some contributions focus on the use of arbuscular mycorrhizal fungi in various crop production processes, including soil management practices, their use as biofertilizers and in relation to medicinal plants. Other chapters elucidate the role of arbuscular mycorrhizal fungi in the alleviation of plant water stress and of heavy metal toxicity, in the remediation of saline soils, in mining-site rehabilitation and in the reforestation of degraded tropical forests. In addition to their impact in ecosystems, the economic benefits of applying arbuscular mycorrhizal fungi are discussed. A final chapter describes recent advances in the cultivation of edible mycorrhizal mushrooms.

Microbe Mediated Remediation of Environmental Contaminants presents recent scientific progress in applying microbes for environmental management. The book explores the current existing practical applications and provides information to help readers develop new practices and applications. Edited by recognized leaders in the field, this penetrating assessment of our progress to date in deploying microorganisms to the advantage of environmental management and biotechnology will be widely welcomed by those working in soil contamination management, agriculture, environment management, soil microbiology, and waste management. The polluting effects on the world around us of soil erosion, the unwanted migration of sediments, chemical fertilizers and pesticides, and the improper treatment of human and animal wastes have resulted in serious environmental and social problems around the world, problems which require us to look for solutions elsewhere than established physical and chemical technologies. Often the answer lies in hybrid applications in which microbial methods are combined with physical and chemical ones. When we remember that these highly effective microorganisms, cultured for a variety of applications, are but a tiny fraction of those to be found in the world around us, we realize the vastness of the untapped and beneficial potential of microorganisms. Explores microbial application redressing for soil and water contamination challenges Includes information on microbial synthesized nanomaterials for remediation of contaminated soils Presents a uniquely hybrid approach, combining microbial interactions with other chemical and physical methods

The quality of agricultural soils are always under threat from chemical contaminants, which ultimately affect the productivity and safety of crops. Besides agrochemicals, a new generation of substances invades the soil through irrigation with reclaimed wastewater and pollutants of organic origin such as sewage sludge or cattle manure. Emerging pollutants such as pharmaceuticals, nanomaterials and microplastics are now present in agricultural soils, but the understanding of their impact on soil quality is still limited. With focus on in situ bioremediation, this book provides an exhaustive analysis of the current biological methodologies for recovering polluted agricultural soils as well as monitoring the effectiveness of bioremediation.

This title discusses various effects of heavy metal exposure to legumes as well as the bioremediation potential of

rhizosphere microbes. Availability of heavy metals, their uptake and the effects of metals on various signaling pathways within legumes are presented. Furthermore, the effects of heavy metals to nitrogen fixing microorganisms and how microsymbionts can overcome metal stress is presented in detail. The role of nitrogen fixers in decontamination of heavy metal toxicity, mycoremediation of metal contaminated soils, microbially mediated transformation of heavy metals and action of plant growth promoting rhizobacteria and nitrogen fixers together in detoxifying heavy metals are broadly explained. This volume is a useful tool for scientists, policy makers and progressive legume growers intending to develop safe and healthy legumes for future generations.

This book is perfectly timed for the worldwide explosion of interest in mycorrhizal research. With a strong emphasis on the latest findings in genetics and molecular biology, it contains all current information and speculation on the structure, function and biotechnological applications of mycorrhizas.

Mycorrhizal fungi are microbial engines which improve plant vigor and soil quality. They play a crucial role in plant nutrient uptake, water relations, ecosystem establishment, plant diversity, and the productivity of plants. Scientific research involves multidisciplinary approaches to understand the adaptation of mycorrhizae to the rhizosphere, mechanism of root colonization, effect on plant physiology and growth, biofertilization, plant resistance and biocontrol of plant pathogens. This book discusses and goes into detail on a number of topics: the molecular basis of nutrient exchange between arbuscular mycorrhizal (AM) fungi and host plants; the role of AM fungi in disease protection, alleviation of soil stresses and increasing grain production; interactions of AM fungi and beneficial saprophytic mycoflora in terms of plant growth promotion; the role of AM fungi in the restoration of native ecosystems; indirect contributions of AM fungi and soil aggregation to plant growth and mycorrhizosphere effect of multitrophic interaction; the mechanisms by which mycorrhizas change a disturbed ecosystem into productive land; the importance of reinstallation of mycorrhizal systems in the rhizosphere is emphasized and their impact on landscape regeneration, and in bioremediation of contaminated soils; Ectomycorrhizae (ECM) and their importance in forest ecosystems and associations of ECM in tropical rain forests function to maintain tropical monodominance; in vitro mycorrhization of micro-propagated plants, and visualizing and quantifying endorhizal fungi; the use of mycorrhizae, mainly AM and ECM, for sustainable agriculture and forestry.

Human activities have dramatically changed the composition and organisation of soils. Industrial and urban wastes, agricultural application and also mining activities resulted in an increased concentration of heavy metals in soils. How plants and soil microorganisms cope with this situation and the sophisticated techniques developed for survival in contaminated soils is discussed in this volume. The topics presented include: the general role of heavy metals in biological soil systems; the relation of inorganic and organic pollutions; heavy metal, salt tolerance and combined effects with salinity; effects on abuscular mycorrhizal and on saprophytic soil fungi; heavy metal resistance by streptomycetes; trace element determination of environmental samples; the use of microbiological communities as indicators; phytostabilization of lead polluted sites by native plants; effects of soil earthworms on removal of heavy metals and the remediation of heavy metal contaminated tropical land.

Heavy metal pollution represents a global challenge to both public health and environmental sustainability. Any means to reduce heavy metal pollution in the environment is of considerable economic significance. The use of green plants to clean up heavy metal pollution is an environmentally friendly as well as a low-cost approach to the problem. This plant-based biotechnology is commonly known as ‘phytoremediation’. Presently, there is limited application of this technology because useful plants with enhanced heavy metal resistance/tolerance are still needed to assist remediation of environments polluted with heavy metals. A key to improved phytoremediation of heavy metal pollution lies in research seeking for a better understanding of the mechanism(s) of heavy metal resistance/tolerance in plants. This E-book presents a unique treatment of the topics that have never been comprehensively brought together before in a single advanced reference. The volume explores aspects of plant biology that are critical for employing phytoremedation techniques to combat heavy metal contamination such as the specific plant biology, seed biology, plant tissue culture and enzymology. This E-book will be a useful reference to plant biologists, biotechnologists and environmental engineers seeking information about phytoremediation of heavy metals from the environment.

This is the fourth updated and revised edition of a well-received book that emphasises on fungal diversity, plant productivity and sustainability. It contains new chapters written by leading experts in the field. This book is an up-to-date overview of current progress in mycorrhiza and association with plant productivity and environmental sustainability. The result is a must hands-on guide, ideally suited for agri-biotechnology, soil biology, fungal biology including mycorrrhiza and stress management, academia and researchers. The topic of this book is particularly relevant to researchers involved in mycorrhiza, especially to food security, plant microbe interaction and environmental protection. Mycorrhizas are symbioses between fungi and the roots of higher plants. As more than 90% of all known species of plants have the potential to form mycorrhizal associations, the productivity and species composition and the diversity of natural ecosystems are frequently dependent upon the presence and activity of mycorrhizas. The biotechnological application of mycorrhizas is expected to promote the production of food while maintaining ecologically and economically sustainable production systems.

Heavy-metal contamination is one of the world's major environmental problems, posing significant risks to agro-ecosystems. Conventional technologies employed for heavy-metal remediation have often been expensive and disruptive. This book provides comprehensive, state-of-the-art coverage of the natural, sustainable alternatives that use a wide range of biological materials in the removal/detoxification of heavy metals, consequently leading to the improvement of crops in these soils. Novel, environmentally friendly and inexpensive solutions are presented based on a sound understanding of metal contamination and the roles of plants and microbes in the management of these toxic soils. Written by worldwide experts, the book provides not only the necessary scientific background but also addresses the challenging questions that require special attention in order to better understand metal toxicity in soils and its management through bioremediation.

Rapid progress has been made in arbuscular mycorrhizal research and in the understanding of the early events in colonization and host-induced changes. These developments, and those in the realm of rhizosphere, have produced a challenging scenario for future research, which is discussed here.

Bio-Geotechnologies for Mine Site Rehabilitation deals with the biological, physical, chemical, and engineering approaches necessary for the reclamation of mine waste. As mining has negative effects on natural resources and deteriorates the quality of the surrounding environment, this book provides coverage across different types of mining industries, which are currently creating industrial deserts overloaded with technogenic waste. The book offers cost-effective strategies and approaches for contaminated sites, along with remediation and rehabilitation methods for contaminated soils and waste dumps. It is an essential resource for students and academics, but is also ideal for applied professionals in environmental geology, mineral geologists, biotechnologists and policymakers. Deals with global and holistic approaches of abandoned mine land rehabilitation Includes mine waste rehabilitation case studies from around the world Covers integrated technologies, such as bioremediation of metalliferous soil Provide strategies for sustainable ecosystems on mine spoil dumps Offers novel methods for the remediation of acid mine drainage

This book describes the various applications of microorganisms in improving plant growth, health and the efficiency of phytochemical production. The chapters trace topics such as the role of PGPRs in improving salt stress and heavy metal tolerance in plants; the prevention and control of plant diseases; boosting soil fertility and agriculture productivity; the induction of secondary metabolite biosynthesis in

medicinal and aromatic plants; the enhancement of phytochemical levels, and the action mechanisms, diversity and characterization of PGPRs. The reviews will be of interest for scientists in the fields of agriculture, microbiology, soil biology, plant breeding and herbal medicinal products.

Heavy metal accumulation in soil and water from natural sources or anthropogenic activities have produced severe environmental contamination in some parts of the world due to the persistence of metals in the environment by their accumulation throughout the food chain. The purpose of this book is to present the most recent advances in this field, mainly concerning the uptake and translocation of heavy metals in plants, mechanisms of toxicity, perception of metal and regulation of cell response under metal stress. Another key feature of this book is related to the studies on signaling and remediation processes in recent years, which have taken advantage of recent technological advances including "omic" approaches. In recent years transcriptomic, proteomic and metabolomic studies have become very important tools for analyzing both the dynamics of changes in gene expression and the profiles of protein and metabolites under heavy metal stress. This information is also very useful for plotting the complex signaling and metabolic network induced by heavy metals, in which hormones and reactive oxygen species (ROS) also play an important role. Understanding the mechanism involved in sequestration and hyperaccumulation is very important to developing new strategies of phytoremediation, which are reviewed in several chapters of this book. The information included yields very stimulating insights into the mechanism involved in the regulation of plant responses to heavy metals, which in turn improve our knowledge of cell regulation under metal stress and the use of plants for phytoremediation.

This book is a compilation of case studies from different countries and covers contemporary with future prospective for sustainable development of agriculture. The book highlights the real-world as well as future generation situations facing the challenges for the twenty first century will be production of sufficient food and highlights the strengths, weaknesses and opportunities, to meet the needs of fast growing population it is imperative to increase agricultural productivity in an environmentally sustainable manner. Due to imbalanced use of chemical fertilizers and agrochemicals has a considerable negative impact on economy and environmental sustainability of nation, for the sustainable alternative means to solve these problems, the efficient utilization of biological agents have been extensively studied. Naturally existing plant-microbe-environment interactions are utilized in many ways for enhancing plant productivity. A greater understanding of how plants and microbes live together and benefit each other can therefore provide new strategies to improve plant productivity, in most sustainable way. To achieve the objective of sustainable agricultural practices there is a need for understanding both basic and applied aspects of agriculturally important microorganisms. Focus needs to be on transforming agricultural systems from nutrient deficient to nutrient rich soil-plant system. This book is split into two parts, with an aim to provide comprehensive description and highlight a holistic approach. It elucidated various mechanisms of nutrients solubilisation and its importance in enhancement of plant growth, nutrient content, yield of various crops and vegetables as well as soil fertility and health. Unit-1 in this book explains the importance of soil microbes in sustainable crop production. It contains chapters detailing the role and mechanism of action of soil microbes which enhances the productivity via various bio-chemical and molecular channe ls. In unit-2 the role of microbes in plant protection is elaborated. With the help of case studies of food crops, multiple ways in which soil microbes help in fighting and preventing plant diseases is explained. With the given content and layout book will be an all-inclusive collection of information, which will be useful for students, academicians, researchers working in the field of rhizospheric mechanisms, agricultural microbiology, soil microbiology, biotechnology, agronomy and sustainable agriculture and also for policy makers in the area of food security and sustainable agriculture.

Heavy metals are severe environmental pollutants, and many of them are toxic even at very low concentrations. With industrial development, soil pollution with heavy metal elements have dramatically increased. The uptake of heavy metals via plants that are exposed to contaminated soils is a risk for human health and a major hazard for the ecosystem as a whole, including soil microorganisms. On the other hand, plants may be used in the decontamination of soils. The topics presented in this book include: sources of heavy metals contaminants in soils; plant species that can grow on contaminated soils; the phytoremediation of contaminated soils; tolerance, accumulation and detoxification mechanisms of zinc, copper, arsenic, cadmium and vanadium in plants; the critical role of sulfur metabolism in heavy metal tolerance; the role of aquatic macrophytes, plant growth-promoting bacteria, sugar crops and earthworms in detoxification; and heavy metal stabilization by promoting zeolite synthesis in soils.

This book summarizes the development of highly tolerant cultivars via plant breeding, genomics, and proteomic approaches. This book could supplement data for budding researchers by providing extensive ongoing measures to improve the detoxification competence of appropriate species via wide range of plant improvement approaches. It also offers insights into heavy metal signalling,metal chelation by organic acids, amino acids, and phosphate derivatives, and illustrates other strategies that have been extensively investigated, such as genetic engineering, ecological improvement of the rhizosphere using mycorrhiza and chelator enhanced phytoremediation technology. This book could provide simple anthology for undergraduate and postgraduate students to understand fundamentals of heavy metal pollution in the environment. The book closes with a prelude to an inclusive study of biodiversity that could provide new biofilters for metal detoxification.

Arbuscular Mycorrhiza (AM) is the most common mycorrhizal type involved in agricultural systems, and the most widespread plant root symbiosis. The fungi involved (Glomales) are known to promote plant growth and health by acting as biofertilizers, bioprotectors and bioregulators. The main aim of this book is to provide readers with theoretical and applied knowledge essential for the use of AM fungi in improving plant health and fitness, production of high quality food and in conservation of natural resources. The different chapters target understanding the role of AM fungi in sustainable crop production, discussing ways to improve biological equilibria between microorganisms in the mycorrhizosphere, analysing genetic, physiological, cellular and molecular bases of AM functioning and establishing technologies for inoculum production, according to the regulatory guidelines for application.

This text details the plant-assisted remediation method, “phytoremediation”, which involves the interaction of plant roots and associated rhizospheric microorganisms for the remediation of soil contaminated with high levels of metals, metalloids, fuel and oil hydrocarbons, nano particles, pesticides, solvents, organic compounds and various other contaminants. Many chapters highlight and compare the efficiency and economic advantages of phytoremediation and nano-phytoremediation to currently practiced soil and water treatment practices. Volume 6 of Phytoremediation: Management of Environmental Contaminants continues the series. Taken together, the six volumes provide a broad–based global synopsis of the current applications of phytoremediation using plants and the microbial communities associated with their roots to decontaminate terrestrial and aquatic ecosystems.

This second and expanded edition of the first book on agromining (phytomining) presents a comprehensive overview of the metal farming & recovery of the agromining production chain. Agromining is an emerging technology that aims to transform the extraction of sources of target elements not accessible by traditional mining and processing techniques. Agromining, which is based on sustainable development, uses hyperaccumulator plants as 'metal crops' farmed on sub-economic soils or minerals wastes to obtain valuable target elements. This volume is edited and authored by the pioneers in the rapidly expanding field of agromining and presents the latest insights and developments in the field. This book provides in-depth information on the global distribution and ecology of hyperaccumulator plants, their biogeochemical pathways, the influence of rhizosphere microbes, the physiology and molecular biology of hyperaccumulation, as well as aspects of propagation and conservation of these unusual plants. It describes the agronomy of metal crops and opportunities for incorporating agromining into rehabilitation and mine closure, including test cases for agromining of nickel, cobalt, manganese, arsenic, selenium, cadmium, zinc, thallium, rare earth elements and platinum group elements. Since the first edition was published, there have successful nickel

agromining field trials in the tropics (in Malaysia and Guatemala), and these are presented in a dedicated case study chapter. Other new chapters focus on the processing of bio-ore for elements other than nickel, such as rare earth elements and cadmium, and on agromining from industrial wastes such as tailings, and industrial by-products and sites. Furthermore, the book features two new chapters that provide a comprehensive assessment of accumulation a very wide range elements from the Periodic Table in various plant species around the globe, and a chapter on practical methods for discovery of hyperaccumulator plant species in the field and in the herbarium. This book is of interest to environmental professionals in the minerals industry, government regulators, and academics.

Phytoremediation, Volume 83, the latest release in the Advances in Botanical Research series, covers a variety of new topics, including Metallophytes from calamine and serpentine soils (incl. tolerance mechanisms), The (endophytic) microbiome of plants from metal contaminated environments: small organisms (inhabitants), large influence, the Potential role of plant-associated bacteria in plant metal uptake and implications in phytotechnologies, Plant associated fungi from trace element rich soils and their possible role in metal uptake by their host plants, Phytoextraction: Status and Promise, Molecular and cellular aspects of contaminant toxicity in plants, and a section on Bio- and phytoremediation of pesticide-contaminated environments: a Review. This series publishes in-depth and up-to-date reviews on a wide range of topics in the plant sciences, featuring reviews by recognized experts on all aspects of plant genetics, biochemistry, cell biology, molecular biology, physiology and ecology. Publishes in-depth and up-to-date reviews on a wide range of topics in the plant sciences Presents the latest information on phytoremediation Features a wide range of reviews by recognized experts

Colonization and Species Diversity of Arbuscular Mycorrhizal Fungi and Their Efffects on Metal Tolerance and Metal Accumulation in Two Metal Hyperaccumulators, Pteris Vittata L. and Sedum Alfredii HanceMycorrhizaState of the Art, Genetics and Molecular Biology, Eco-Function, Biotechnology, Eco-Physiology, Structure and SystematicsSpringer Science & Business Media

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.

Emerging Technologies and Management of Crop Stress Tolerance: Volume II - A Sustainable Approach helps readers take technological measures to alleviate plant stress and improve crop production in various environmental conditions. This resource provides a comprehensive review of how technology can be implemented to improve plant stress tolerance to increase productivity and meet the agricultural needs of the growing human population. The book considers issues of deforestation, disease prevention, climate change and drought, water and land management, and more. It will help any scientist better understand environmental stresses to improve resource management within a world of limited resources. Includes the most recent advances methods and applications of biotechnology to crop science Promotes the prevention of potential diseases to inhibit bacteria postharvest quality of fruits and vegetable crops by advancing application and research Presents a thorough account of research results and critical reviews

New analytical techniques have enhanced current understanding of the behavior of trace and ultratrace elements in the biogeochemical cycling, chemical speciation, bioavailability, bioaccumulation, and as applied to the phytoremediation of contaminated soils. Addressing worldwide regulatory, scientific, and environmental issues, Trace Elements in the Environment explores these frontiers, including biotechnological aspects of metal-binding proteins and peptides and phytoremediation strategies using trees, grasses, crop plants, aquatics, and risks to ecological and human health. Discussing trace elements in the holistic environment, this book covers advances in state-of-the-art analytical techniques, molecular biotechology, and contemporary biotechnology that enhances knowledge of the behavior of trace elements in the biogeosphere and at the cellular and molecular level. The editors and their hand-picked panel of contributors provide authoritative coverage of trace elements in the environment. They highlight cutting-edge applications of emerging strategies and technologies to the problems of trace elements in the environment. The editors discuss emerging areas such as bacterial biosorption of trace elements, processes, and applications of electroremediation of heavy metals-contaminated soils, application of novel nanoporous sorbents for the removal of heavy metals, metalloids, and radionuclides. The book focuses on the effects of increasing levels of trace elements on ecological and human health, evaluates the effectiveness of methods of phytoremediation, and covers risk assessment, pathways, and trace element toxicity. Containing more than 150 illustrations, tables, photographs, and equations, the book's coverage spans the entire body of knowledge available about how and why plants interact with metals and other trace elements.

Fundamental societal changes resulted from the necessity of people to get organized in mining, transporting, processing, and circulating the heavy metals and their follow-up products, which in consequence resulted in a differentiation of

society into diversified professions and even societal strata. Heavy metals are highly demanded technological materials, which drive welfare and progress of the human society, and often play essential metabolic roles. However, their eminent toxicity challenges the field of chemistry, physics, engineering, cleaner production, electronics, metabolomics, botany, biotechnology, and microbiology in an interdisciplinary and cross-sectorial manner. Today, all these scientific disciplines are called to dedicate their efforts in a synergistic way to avoid exposure of heavy metals into the eco- and biosphere, to reliably monitor and quantify heavy metal contamination, and to foster the development of novel strategies to remediate damage caused by heavy metals.

Phytoremediation aids to augment bioremediation as it uses broad range plants to remediate soil, sediment, surface water and ground water that have been contaminated with toxic metals, organic, pesticides and radionuclides. This book serves to disseminate detailed up to date knowledge regarding the various aspects of phytoremediation and plant-microbe interaction. The book highlights process and molecular mechanisms for industrial waste detoxification during phytoremediation in wetland plants, role of endophytic bacteria for phytoremediation of environmental pollutants, constructed wetland treatment system for treatment and recycling of hazardous wastewater, amongst other relevant topics. Key Features: Focuses on phytoremediation process for different pollutants, mainly heavy metal detoxification in the presence of other co-pollutants. Includes plant-soil-microbe interactions in phytoremediations and remediation of contaminated water. Explores life cycle assessment of industrial waste contaminated site with organic pollutants. Discusses hyperaccumulator versus non-hyperaccumulator plants for environmental waste management. Includes bacterial assisted phytoremediation and siderophore formation in specific environmental conditions.