Bioremediation

Title	**A critical review on speciation, mobilization and toxicity of lead in soilmicrobe-plant system and bioremediation strategies**
Author Name	Anamika Kushwaha, Nidhi Hans, Sanjay Kumar, Radha Rani
Journal Name	Ecotoxicology and Environmental Safety
Year	2019
Volume and Issue	147
Pages	1035-1045
Abstracts	Lead accumulation in soils is of serious concern in agricultural production due to the harmful effects on soil microflora, crop growth and food safety. In soil, speciation of lead greatly affects its bioavailability and thus its toxicity on plants and microbes. Many plants and bacteria have evolved to develop detoxification mechanisms to counter the toxic effect of lead. Factors influencing the lead speciation include soil pH, organic matter, presence of various amendments, clay minerals and presence of organic colloids and iron oxides. Unlike, other metals little is known about the speciation and mobility of lead in soil. This review focuses on the speciation of lead in soil, its mobility, toxicity, uptake and detoxification mechanisms in plants and bacteria and bioremediation strategies for remediation of lead contaminated repositories.
Keywords	Lead; Speciation; Toxicity; Detoxification; Bioremediation

Title	**Enzymatic bioremediation: a smart tool to fight environmental pollutants**
Author Name	Lakhan Kumar Navneeta Bharadvaja
Journal Name	Smart Bioremediation Technologies
Year	2019
Pages	99-118
Abstracts	Enzyme-mediated bioremediation refers to the use of naturally occurring enzymes in microorganisms or plants to degrade or reduce harmful, undesirable, and recalcitrant environmental pollutants in order to clean contaminated sites. Enzymes are biocatalysts which lower the activation energy and facilitate quick and complete breakdown of substrates. The smaller size of enzymes as compared to microbial cells enables them to contact contaminants easily, facilitating rapid and effective degradation or reduction to an admissible or less harmful state. Advancements in nanotechnology coupled with enzyme technology have introduced a new concept of single-enzyme nanoparticles to treat pollutants or contaminants. These are more productive, selective, and faster than enzymatic treatment alone. Use of enzymes as compared to plants and microorganisms for bioremediation is rapid, cost-effective, accessible, and highly specific. The microbial whole cell needs the introduction of nutrients and air to maintain the optimum growth rate, and solvents and/or surfactants to enhance its bioavailability and immobilization. It is more feasible from an enzymatic perspective than using whole cells. Additionally, enzyme-mediated biotransformation reduces the generation of toxic by-products significantly as compared to chemical and some microbial remediations. Enzyme-based biosensors have further contributed to the miniaturization of analytical instruments with superior qualitative and quantitative estimation of compounds of interest present at the site. Enzyme technology has enhanced sensitivity and performance, providing a complete solution to all problems associated with microbial remediation. Despite such advantages, enzymatic remediation has also certain limitations which restrict its application to remediation processes, such as the production cost of enzymes, and their stability and activity across a wide range of contaminants. Being a sustainable and environment-friendly method, it has acquired the prime position in comparison to other remediation techniques available today to treat all types of waste materials mixed with soil, water, or air, rendering the degradation process highly controllable, specific, and easy to monitor and manage. This chapter discusses in detail bioremediation, its types, recent developments in enzyme-mediated smart bioremediation technologies, limitations and challenges to enzymatic bioremediation, and the way forward.
Keywords	Bioremediation; microbial remediation; enzymatic bioremediation; enzyme technologies; biosensors; single-enzyme nanoparticles; nanozymes

Title	A review of phytoremediation technology: heavy metals uptake by plants
Author Name	A Sumiahadi and R Acar
Journal Name	IOP Conf. Series: Earth and Environmental Science
Year	2018
Volume and Issue	142, 012023
Abstracts	Heavy metal is one of the serious environmental pollutions for now days as impact of industrial development in several countries. Heavy metals give toxic effects on human health and cause several serious diseases. Several techniques have been using for removing heavy metal contaminants from the environmental but these techniques have limitations such as high cost, long time, logistical problems and mechanical complexity. Phytoremediation can be used as an alternative solution for heavy metal remediation process because of its advantages as a cost-effective, efficient, environment- and eco-friendly technology based on the use of metal-accumulating plants. According to previous studies, several plants have a high potential as heavy metals bioaccumulator and can be used for phytoremediation process of heavy metals.
Keywords	Heavy metal; heavy metal contaminants; human health; remediation; metal-accumulating plants; bioaccumulator

Title	Bioremediation of Heavy Metal Stress by Rhizobium Chickpea Symbiosis
Author Name	Naseem Akhtar, Azhar Hussain, Aneela Riaz & Muhammad Aftab
Journal Name	J. Agri. Res.
Year	2018
Volume and Issue	56,1
Pages	27-34
Abstracts	A pot experiment was conducted in Soil Bacteriology Section, Ayub Agricultural Research Institute, Faisalabad, Pakistan to study the role of Rhizobium in heavy metal remediation in two consecutive years (2013-14 and 2014-15). Growth and yield of chickpea, under metal contaminated soil, was evaluated. At the time of pot filling copper was applied as CuSo4.5H2O @ 50, 100,150 and 200 mg kg-1 soil in all the treatment. In these treatments, chickpea seed was inoculated with peat based Rhizobium inoculums. Fertilizers @ 30-60 kg NP ha-1 were applied at sowing. The trial was laid out according to CRD having four repeats. The results revealed that post-harvest soil carried lower Cu contents compared to pre-sowing soil even without inoculation. However, Rhizobium inoculation decreased the Cu contents upto 73-98%. Significant increase in grain yield (16.8 g pot-1) was observed by Rhizobium inoculation at Cu concentration of 50 mg kg-1. The physical parameters of the plants like root/shoot length, biomass, dry weight, nodular mass and number of nodules plant-1 were also increased significantly at all Cu levels combined with Rhizobium inoculation. It is concluded that rhizobial inoculation exerted positive effect on growth of crop in metal infected soil.
Keywords	Bacteriology; heavy metal remediation; fertilizers; rhizobium inoculation; nodular mass

Title	**Rhizobium-Legume Symbioses: Heavy Metal Effects and Principal Approaches for Bioremediation of Contaminated Soil**
Author Name	Sara Lebrazi & Kawtar Fikri - Benbrahim
Journal Name	Legumes for Soil Health and Sustainable Management
Year	2018
Pages	Pages 205-233
Abstracts	Leguminous plants play a vital role in agriculture, economy, and even food security for the world's population. Indeed, they are considered as a major source of protein for human food worldwide, providing 22% protein, 32% fat, and 7% carbohydrates. They provide a bulk of soil organic matter (SOM) in agricultural soils and have a crucial role in the soil for long-term sustainability. This is due to their significant role in improving soil fertility and ability to form Rhizobium-legume symbiosis enabling atmospheric nitrogen (N) fixation. Recently, Rhizobium-legume symbioses have attracted attention for their biochemical and ecological capacity to degrade and remove organic pollutants. They are also known for their resistance to heavy metal which make them efficient tools for rehabilitating contaminated soils. However, high heavy metal concentrations in soil may have an adverse effect on both Rhizobium and its host plant and also on their symbiotic properties. In fact, the repartition of heavy metals in soil is widespread, with an annual global heavy metal release estimated at 22.10−3 Tg of Cd, 939.10−3 Tg of Cu, 783.10−3 Tg of Pb, and 1.35 Tg of Zn. Moreover, consumption of agri-foods grown in heavy metal-polluted soils may have serious implications on human health. Recent data indicate that exposure to low levels of some heavy metals such as cadmium can have adverse health effects, mainly in the form of kidney damage, but also bone and fracture effects.
Keywords	Rhizobium; Legume; Symbiosis; Contamination; Heavy metals; Phytoremediation; Soil fertility

Title	Microbial and Plant-Assisted Bioremediation of Heavy Metal Polluted Environments: A Review
Author Name	Omena Bernard Ojuederie & Olubukola Oluranti Babalola
Journal Name	International Journal of Environmental Research and Public Health
Year	2017
Volume and Issue	14(12): 1504
Abstracts	Environmental pollution from hazardous waste materials, organic pollutants and heavy metals, has adversely affected the natural ecosystem to the detriment of man. These pollutants arise from anthropogenic sources as well as natural disasters such as hurricanes and volcanic eruptions. Toxic metals could accumulate in agricultural soils and get into the food chain, thereby becoming a major threat to food security. Conventional and physical methods are expensive and not effective in areas with low metal toxicity. Bioremediation is therefore an eco-friendly and efficient method of reclaiming environments contaminated with heavy metals by making use of the inherent biological mechanisms of microorganisms and plants to eradicate hazardous contaminants. This review discusses the toxic effects of heavy metal pollution and the mechanisms used by microbes and plants for environmental remediation. It also emphasized the importance of modern biotechnological techniques and approaches in improving the ability of microbial enzymes to effectively degrade heavy metals at a faster rate, highlighting recent advances in microbial bioremediation and phytoremediation for the removal of heavy metals from the environment as well as future prospects and limitations. However, strict adherence to biosafety regulations must be followed in the use of biotechnological methods to ensure safety of the environment.
Keywords	Ecosystem; food chain; metal toxicity; heavy metal pollution; microbial enzymes; phytoremediation

Title	**Application of compost for effective bioremediation of organic contaminants and pollutants in soil**
Author Name	Matthias Kästner and Anja Miltner
Journal Name	Applied Microbiology and Biotechnology
Year	2016
Volume and Issue	100(8)
Pages	3433-3449
Abstracts	Soils contaminated with hazardous chemicals worldwide are awaiting remediation activities; bioremediation is often considered as a cost-effective remediation approach. Potential bioapproaches are biostimulation, e.g. by addition of nutrients, fertiliser and organic substrates, and bioaugmentation by addition of compound-degrading microbes or of organic amendments containing active microorganisms, e.g. activated sludge or compost. In most contaminated soils, the abundance of the intrinsic metabolic potential is too low to be improved by biostimulation alone, since the physical and chemical conditions in these soils are not conducive to biodegradation. In the last few decades, compost or farmyard manure addition as well as composting with various organic supplements have been found to be very efficient for soil bioremediation. In the present minireview, we provide an overview of the composting and compost addition approaches as 'stimulants' of natural attenuation. Laboratory degradation experiments are often biased either by not considering the abiotic factors or by focusing solely on the elimination of the chemicals without taking the biotic factors and processes into account. Therefore, we first systemise the concepts of composting and compost addition, then summarise the relevant physical, chemical and biotic factors and mechanisms for improved contaminant degradation triggered by compost addition. These factors and mechanisms are of particular interest, since they are more relevant and easier to determine than the composition of the degrading community, which is also addressed in this review. Due to the mostly empirical knowledge and the non-standardised biowaste or compost materials, the field use of these approaches is highly challenging, but also promising. Based on the huge metabolic diversity of microorganisms developing during the composting processes, a highly complex metabolic diversity is established as a 'metabolic memory' within developing and mature compost materials. Compost addition can thus be considered as a 'super-bioaugmentation' with a complex natural mixture of degrading microorganisms, combined with a 'biostimulation' by nutrient containing readily to hardly degradable organic substrates. It also improves the abiotic soil conditions, thus enhancing microbial activity in general. Finally, this minireview also aims at guiding potential users towards full exploitation of the potentials of this approach.
Keywords	Soil amendment; Composting; Biodegradation; Organic contaminants; Microbial communities; Bioremediation processes; Fate of pollutants; Residual concentrations; Metabolic cooperation; Functional redundancy

Title	**Emerging pollutants in the environment: present and future challenges in biomonitoring, ecological risks and bioremediation**
Author Name	Maria Gavrilescu Kateřina Demnerová, Jens Aamand, SpirosAgathos, Fabio Fava
Journal Name	New Biotechnology
Year	2015
Volume and Issue	32 (1)
Pages	147-56
Abstracts	Emerging pollutants reach the environment from various anthropogenic sources and are distributed throughout environmental matrices. Although great advances have been made in the detection and analysis of trace pollutants during recent decades, due to the continued development and refinement of specific techniques, a wide array of undetected contaminants of emerging environmental concern need to be identified and quantified in various environmental components and biological tissues. These pollutants may be mobile and persistent in air, water, soil, sediments and ecological receptors even at low concentrations. Robust data on their fate and behaviour in the environment, as well as on threats to ecological and human health, are still lacking. Moreover, the ecotoxicological significance of some emerging micropollutants remains largely unknown, because satisfactory data to determine their risk often do not exist. This paper discusses the fate, behaviour, (bio)monitoring, environmental and health risks associated with emerging chemical (pharmaceuticals, endocrine disruptors, hormones, toxins, among others) and biological (bacteria, viruses) micropollutants in soils, sediments, groundwater, industrial and municipal wastewaters, aquaculture effluents, and freshwater and marine ecosystems, and highlights new horizons for their (bio)removal. Our study aims to demonstrate the imperative need to boost research and innovation for new and cost-effective treatment technologies, in line with the uptake, mode of action and consequences of each emerging contaminant. We also address the topic of innovative tools for the evaluation of the effects of toxicity on human health and for the prediction of microbial availability and degradation in the environment. Additionally, we consider the development of (bio)sensors to perform environmental monitoring in real-time mode. This needs to address multiple species, along with a more effective exploitation of specialised microbes or enzymes capable of degrading endocrine disruptors and other micropollutants. In practical terms, the outcomes of these activities will build up the knowledge base and develop solutions to fill the significant innovation gap faced worldwide.
Keywords	Anthropogenic sources; Micropollutants; Biomonitoring; Biosensors; Speciallised microbes