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Dharmendra Kumar Gupta  
Editor

# Plant-Based Remediation Processes

 Springer

*Editor*

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*This book is dedicated to my beloved mother  
Late Smt. Annapurna Gupta  
1949–2011*



# Preface

The idea of cleaning up contaminated environments by using green plants is not new. About 300 years ago, plants were proposed to be used in the treatment of wastewater (Hartman 1975). At the end of the nineteenth century, *Thlaspi caerulescens* and *Viola calaminaria* were the first plant species documented to accumulate high levels of metals in leaves (Baumann 1885). At present, there are about 420 species belonging to about 45 plant families which have been reported as hyperaccumulators of heavy metals (Cobbett 2003). Although the identification of new plant species with this property is still growing from field collections (Krämer 2003), only a few species have been tested in the laboratory to confirm their hyperaccumulating behaviors. The urgency to discover hyperaccumulators has shown several intriguing patterns (Baker and Whiting 2002). First, several plant families contain an inexplicably high number of hyperaccumulators: among those are Asteraceae, Brassicaceae, Euphorbiaceae, Fabaceae, Flacourtiaceae, and Violaceae, suggesting that several families and genera within them may be pre-adapted/predisposed to deal with high concentrations of metal. Second, there appears to be a disproportionately high percentage of hyperaccumulators in tropical regions.

Plant tolerance to heavy metals depends largely on plant efficiency in the uptake, translocation, and further sequestration of heavy metals in specialized tissues or in trichomes and organelles such as vacuoles. The uptake of metals depends on their bioavailability, and plants have evolved mechanisms to make micronutrients bioavailable. Some plants have developed resistance to high metal concentrations, basically by two mechanisms, avoidance and tolerance. The first mechanism involved exclusion of metals outside the roots, and the second mechanism consists basically in complexing the metals to avoid protein and enzyme inactivation. Some plants can also accumulate metals in their tissues at concentrations higher than those found in the soil, and these plants are referred as hyperaccumulators (Gupta and Sandalio 2012).

Given the nature and extent of contamination worldwide and the costs involved in remediation, recent years have seen a drive toward alternative yet effective technologies for the remediation of polluted sites. In this regard, bioremediation,

typically referring to microbe-based cleanup, and phytoremediation, or plant-based cleanup, have generated much interest as effective low-cost and environmentally friendly technologies for the cleanup of a broad spectrum of hazardous organic and inorganic pollutants (Pilon-Smits 2005). Plant-based environmental remediation has been widely pursued by academic and industrial scientists as a favorable low-impact cleanup technology applicable in both developed and developing nations (Robinson et al. 2003). Physiological, biochemical, and molecular approaches are continually being applied to identify the underlying mechanisms of metal tolerance and hyperaccumulation (Lasat 2002). The drive to find genes underlying these unique biological properties is partly fueled by interest in using transgenic plants in phytoremediation (Pilon-Smits 2005). Interestingly, as transgenics are being tested in the field and the associated risks assessed, their use appears to be more accepted and less regulated than has been the case for transgenic crops (Pilon-Smits and Pilon 2002).

In last two decades phytoremediation work got so much attention from the scientists and researchers throughout the globe. The main purpose of this book is to present recent advances in the field, mainly on the use of green plants for remediation of various metal/metalloids. Other key features of the book are related to biomonitoring of heavy metal pollution, different amendments for higher uptake of toxic metals, transport of heavy metal in plants, mechanism of toxicity, and remediation through engineering plants. Some chapters are also dealt with transgenic as well as metallomics approaches for the remediation of heavy metal/metalloids. Some chapters are focusing on recent protocols for phytotechnological tools for metal contaminations. Overall the information compiled in this book will bring in-depth knowledge and advancement of phytoremediation technologies in recent years.

Dr. Dharmendra Kumar Gupta is personally thankful to the authors for contributing their time, knowledge, and enthusiasm to bring this book into shape.

Mol, Belgium

Dr. Dharmendra Kumar Gupta

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