

Preface

In the earth's crust, metalloid arsenic (As) is widely distributed with an average concentration of 2 mg kg^{-1} . Arsenic has been known as a poison since ages. It is commonly used in several industries like paints, dyes, metals, soaps, insecticides, and semi-conductors. Various anthropogenic activities such as mining, burning fossil fuels, paper production, and cement manufacturing lead to the release of As into the environment. Arsenic may exist in several forms, with As(III) and As(V) being the most prevalent toxic form of inorganic arsenic, which naturally occurs in the ground and surface water of many parts of the world including soils. Millions of people worldwide are exposed directly to this Group A carcinogen through drinking water and other uses. Even ingestion of low dose of As via food or water is the main pathway of this particular metalloid into the organism, where absorption takes place in the stomach and intestines, followed by release into the bloodstream. At chronic poisoning, As is converted by the liver to a less toxic form; however, the poisoning is also associated with a range of cancers in different organs prevalently in bladder, skin, and lung, with the highest relative risks found for cancer in the bladder. Arsenic toxicity depends on the chemical species $[\text{As(III)} > \text{As(V)}] > \text{organic species}$.

Generally As contamination affects plant growth and crop yield and its accumulation in food may severely affect animals as well as humans. Arsenate, chemically analogous to phosphate, is taken up by plants mainly through root phosphate absorption systems. Once it enters inside the plant cell, As(V) interferes with essential cellular processes, such as oxidative phosphorylation and ATP synthesis in mitochondria by replacing phosphate moiety, while the toxicity of As(III) is due to its propensity to bind to sulfhydryl groups, with subsequent damaging effects on general protein functioning. Only a few plants are well known for which they may suppress phosphate transport systems and there are even few candidates, where As methylation and volatilization would occur to a significant level. The efflux of As is also recently discovered and it is still ambiguous to what extent it is prevalent among plants. However, the synthesis of metalloid (As) binding peptides like glutathione (GSH) and phytochelatins (PCs) is observed in almost all plants studied to date and leads to instant detoxification (in terms of loss of reactivity in chelated form) of a specific ion. Complexation of arsenite $[\text{As(III)}]$ with phytochelatins (PCs) is an important

mechanism employed by plants to detoxify arsenic; how this complexation affects As mobility is yet to be fully understood. In plant tissue, solubility of As increased through chelation with cyclohexylenedinitrotetraacetic acid, nitrilotriacetic acid, or As-sulfur complexes and thus facilitates mobilization.

Natural biodegradation/bioremediation processes can clean up wide-ranging environmental contaminants. Organisms like bacteria and fungi or plants have the capability to degrade or detoxify hazardous environmental pollutants into less toxic forms. Understanding the mechanisms of As homeostasis may enable the selective breeding of more tolerant varieties or varieties with increased concentrations of essential minerals or decreased concentrations of As in the edible parts of the crops. Moreover, such knowledge could be used for developing plants for the purpose of phytoremediation.

The main purpose of the book is to provide detailed and comprehensive knowledge to the academicians, scientists, and students (undergraduate, graduate, and master) who are working in the field of arsenic contamination, sources, and their impact on environment. This book will encompass a range of topics like historical perspectives to recent advancement in the field of arsenic contamination and associated theories, effects of As on human health, available and prospective biological and physico-chemical options for combating arsenic contamination issue.

Dr. Dharmendra K. Gupta and Dr. Soumya Chatterjee personally convey their sincere thanks to Springer publisher as well as contributing authors for their valuable time and enthusiasm to write their perspective chapters on this very important issue to bring this book into the present shape.

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The Issues and Solutions

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