PLANT SCIENCE RESEARCH AND PRACTICES

Plants and Microbes in an Ever-Changing Environment

Satya Shila Singh
Editor

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ISBN: 978-1-53610-928-3
Categories: **Biology**, **Life Sciences**, **Microbiology**, **Plant Science Research and Practices**
Tags: **9781536109184**, **9781536109283**, **microbiology**

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In: Plants and Microbes in an Ever-Changing Environment ISBN: 978-1-53610-918-4
Editor: Satya Shila Singh

Chapter 14

MOLECULAR MECHANISMS OF HEAVY METAL RESISTANCE IN BACTERIA

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ABSTRACT

Metals are an integral part of all ecosystems, occurring in elemental as well as locked in an ore form. On the basis of their density, metals are divided in to two groups. Metals with density more than 5g/cm^3 are called heavy metals while those with density less than 5g/cm^3 are called light metals. Heavy metals are often required by the cell in trace amount for different biochemical reactions; however, at higher concentrations they can have toxic effects. The cell may use the low concentrations of some heavy metals (such as iron, copper and nickel) in redox reactions, or other heavy metal ions (such as magnesium or zinc) to stabilize electrostatic forces, in enzymes and DNA binding proteins. Many ions (including Fe^{2+}, Mg^{2+}, Ni^{2+} and Co^{2+}) also form complex compounds such as iron-sulfur clusters that have diverse functions. The mechanism of metal ions toxicity can be divided in to three main categories, according to whether the metal ion (1) block essential functional groups of biological molecules, (2) displace an essential metal ion in biomolecules, or (3) modify the active confirmation of biomolecules. Heavy metals can also interfere with the metabolism of a structurally related metal, since the cellular metal binding sites are never entirely specific for a single metal and metals with similar structure and charge can often bind competitively. The occurrence of highly concentrated pockets and the concentration build-up of many metals in the environment have provided a selection pressure for the evolution of metal resistance mechanisms in many life forms and a number of such examples are commonly found in bacterial kingdom too. The genes responsible for encoding these mechanisms of heavy metal resistance in bacteria are often found on plasmids. Moreover since metals are hardly ever present in isolation, this usually gets reflected in multi-metal resistance phenotype. There is no single mechanism for resistance to all heavy metals in bacteria. The important mechanisms proposed for heavy metal resistance in bacteria and other microorganisms are as follows: active efflux, intracellular physical sequestration, extracellular sequestration or bioprecipitation,

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