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BIOREMEDIATION AND DETOXIFICATION STRATEGIES USING MICROORGANISMS: MOLECULAR ASPECT TO COMBAT HEAVY METAL CONTAMINATION

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Abstract

The increased contamination of air, soil, and water resources with heavy metals around us is due to the industrial revolution and other anthropogenic activities, which create serious health problems. Remediation of such non-biodegradable heavy metals from the sources is of utmost importance considering their persisting nature in the environment and simultaneous toxic effects on living systems. The removal of such harmful elements from contaminated environments using microorganisms could help in cleaning polluted ecosystems. Bioremediation involves the interaction of the contaminated environment containing heavy metals with biologically active microbes and the elimination of heavy metals through different mechanisms, such as adsorption, complexation, precipitation, methylation, etc. These living microorganisms have opened up avenues to detoxify heavy metals through several biological processes including active efflux or protein sequestration, bio-stimulation, and biosorption. An overview of the impact of heavy metals on human health, aquatic life, plants, or soil and the mechanism of detoxification of heavy metals by various microorganisms is presented in this article. The study elucidates how microbial enzymes catalyze the conversion of toxic metal ions, offering a molecular perspective on bioremediation. Through genetic adaptations, microbes develop specialized mechanisms to sequester or expel heavy metals, enhancing possibilities in removing contamination. This comprehensive understanding underscores the importance of leveraging bioremediation to mitigate health risks associated with heavy metal exposure, necessitating further research and application in contaminated environments.

Key words: bioremediation, detoxification, heavy metals, microorganisms, molecular mechanisms

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