IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, October 2023

Microbial Strategies for Heavy Metal Removal from Industrial Wastewater

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Abstract: *The contamination of industrial wastewater with heavy metals poses a severe environmental and public health concern. Traditional methods of heavy metal removal often prove costly and environmentally unsustainable. In this context, microbial strategies have emerged as a promising and eco-friendly approach for effective heavy metal remediation from industrial wastewater. Microorganisms, including bacteria, fungi, and algae, have developed various mechanisms to withstand and sequester heavy metals from their surroundings. This review explores the diverse microbial strategies employed in heavy metal removal, encompassing biosorption, bioaccumulation, bioprecipitation, and bioleaching. These strategies exploit microbial cell surfaces, extracellular polymeric substances, and intracellular compartments to immobilize, transform, or release heavy metals. Moreover, recent advancements in genetic engineering and biotechnology have enabled the development of tailored microbial strains with enhanced metal-removal capabilities. The application of these engineered microbes, as well as naturally occurring strains, in bioremediation processes is discussed. This review also delves into the factors influencing microbial metal removal efficiency, such as pH, temperature, metal concentration, and co-existing contaminants. Additionally, the potential drawbacks and limitations of microbial strategies, including biomass disposal and long-term performance, are addressed. As heavy metal pollution continues to be a pressing global issue, understanding and harnessing microbial strategies for heavy metal removal from industrial wastewater holds significant promise for sustainable and cost-effective remediation practices. Integrating microbial processes into existing treatment methods can offer innovative solutions to mitigate the environmental impact of heavy metal contamination, thereby safeguarding ecosystems and public health.*

Keywords: biosorption, bioaccumulation, bioprecipitation, and bioleaching, heavy metal

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