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REVIEW ARTICLE

Toxicity of Mercury and Its Compounds: Impacts on Human and Animal Health, Ecosystems, Mechanisms, and Bioremediation Strategies – A Systematic Review

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Abstract

Mercury is a pervasive, environmentally toxic global pollutant that significantly impacts ecosystems and human health. Its chemical and toxicological properties contribute to environmental contamination through natural processes like volcanic eruptions and human activities such as industrial emissions and agriculture. Over the past century, mercury levels in the environment have nearly doubled due to rapid industrialization, leading to bioaccumulation and biomagnification in food chains, especially in aquatic ecosystems, which significantly impact human food safety.

This review examines mercury's toxic effects on multiple organ systems through acute and chronic pathways. Mercury induces neurotoxicity, nephrotoxicity, immune dysfunction, cardiovascular damage, and endocrine disruption, including cancer promotion in both humans and animals. Mercury compounds and mercury-containing xenobiotics interfere with cellular and molecular mechanisms, leading to oxidative stress, DNA damage, mitochondrial damage, apoptosis, epigenetic alterations, and impaired signaling pathways.

The review also highlights mercury's environmental persistence, affecting biodiversity by impairing various species' growth, reproduction, and survival, from microorganisms to higher vertebrates and invertebrates. It explores mercury's broader ecological footprint, including its role in disrupting food web dynamics, soil health, and plant productivity, ultimately impacting global biodiversity and ecosystem stability. The potential for mercury-induced bioaccumulation in aquatic life is emphasized, highlighting its cascading effects on human food safety. Addressing these challenges, the review discusses advances in remediation strategies, such as chelation therapy, natural antioxidants of phytochemical origin, and innovative biotechnological interventions. By incorporating documented research findings, this review aims to inspire future research and policymaking to mitigate mercury's adverse health effects and ensure environmental sustainability.

Review Highlights:

- Mercury is a toxic pollutant harming ecosystems and human health globally.
- It bioaccumulates in food chains, impacting food safety and biodiversity.
- Mercury causes neuro, nephro, hepato, cardio, and endocrine toxicity, harming organs.
- It disrupts DNA, mitochondria, and cell signaling, leading to severe toxicity.
- Advances in remediation include chelation, antioxidants, and biotech solutions.

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- Bioaccumulation
- Biomagnification
- Toxic effects
- Organ dysfunction
- Remediation strategies

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