Bacterial Bioremediation of Environmental Heavy Metal Pollution

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Heavy metal contamination has become more prevalent in the environment due to an increase in anthropogenic sources, such as mining, electronic manufacturing waste, and other industrial processes. Humans can be exposed to high concentrations of bioavailable heavy metals such as arsenic, chromium, and lead from a wide variety of places such as dermal exposure to soil or ingestion of contaminated products. This exposure can cause varying negative health effects such as neurotoxicity, kidney damage, anemia, and cancer. Many traditional methods of environmental treatment such as electrokinetic extraction or soil washing can be costly and time consuming, necessitating alternative methods that are cheaper and more sustainable to be developed. Using microorganisms to detoxify heavy metals, called bioremediation, has emerged as a promising solution. Two pathways, called biosorption and bioaccumulation, allow for a wider scope of applications, since biosorption doesn't require the bacterial biomass to be alive for metal removal, and bioaccumulation can utilize the already-evolved mechanisms of native bacteria who tolerate high metal concentrations. Additionally, genetically engineering bacteria to enhance detoxification of heavy metals has become of interest, with novel use cases for metal specific proteins and operons that contribute to toxicity resistance and removal of heavy metals. The variety of available information about specific bacterial strains and their uses in bioremediation warrants an effort to consolidate it, while additionally analyzing patterns in mechanisms used for multiple heavy metals to provide a critical summary of the state of the current field.
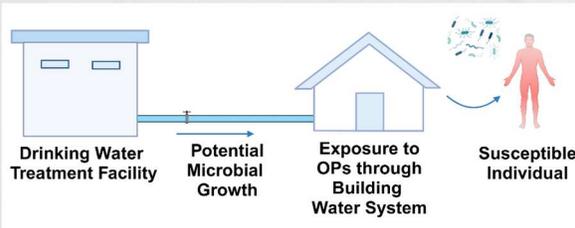
Opportunistic Pathogens in Drinking Water Distribution Systems: Insights from Multi-Utility Analysis

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Opportunistic pathogens (OPs) are microorganisms that can cause infections, particularly in susceptible individuals such as the elderly and immunocompromised people. Unlike traditional enteric pathogens, which are introduced through fecal contamination, OPs can survive and grow within drinking water systems. The ability to colonize engineered water systems makes the occurrence of OPs more difficult to predict and control. This study examines the presence of OPs across multiple drinking water utilities participating in the collaborative CODOWN project. In 2024, a total of a total of 281 water samples were collected from participating utilities and analyzed using quantitative molecular methods to measure the presence and concentration of target pathogens. In addition, water quality parameters and treatment characteristics were evaluated to identify factors that may influence OP occurrence. This multi-utility dataset provides insight into how OPs vary across drinking water systems. The findings contribute to a better understanding of OP persistence and support efforts to improve drinking water management and protect public health.