Innovative Approaches to Bioremediation in Aquatic Environments

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Abstract

Bioremediation, the process of using microorganisms, plants, or their enzymes to remove or neutralize pollutants from the environment, has emerged as a sustainable and efective solution to the increasing pollution in aquatic environments. This paper explores innovative approaches in bioremediation techniques aimed at restoring the ecological balance of aquatic ecosystems afected by industrial, agricultural, and domestic pollutants. The study investigates various methods, including microbial bioremediation, phytoremediation, and the use of engineered systems such as biosorption and bioaugmentation. The integration of genetic engineering and nanotechnology has opened new avenues for more ef cient and specifc pollutant removal, providing a cost-efective and eco-friendly alternative to traditional remediation techniques. The paper also highlights challenges and future directions in the application of bioremediation technologies in aquatic environments, focusing on scalabilitymca ɹ O e = o ironments(

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