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BIOTECHNOLOGY FOR WASTEWATER TREATMENT: INNOVATIVE APPROACHES AND TECHNOLOGIES**Muhammad Muddassir ALI**

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ABSTRACT

Biotechnology plays an important role in improving wastewater treatment through innovative and sustainable approaches. It includes the use of living organisms such as bacteria, fungi, and algae to remove pollutants from water. One study reported that genetically modified bacteria developed using CRISPR-Cas9 technology showed enhanced ability to break down harmful chemicals in wastewater and were more resistant to environmental stress. Another study showed that biofilm-based systems like oxygenic photogranules and phototrophic biofilms were highly stable and effective in removing organic and inorganic pollutants from wastewater. In another study, the fungal strain *Trametes versicolor* was used in mycoremediation and showed good results in degrading pharmaceutical compounds and textile dyes present in wastewater. In one experiment, microbial fuel cells were used for wastewater treatment, and the results showed that they not only helped clean the water but also generated electricity during the process. These studies confirm that biotechnology-based methods are cost-effective, sustainable, and helpful in treating wastewater. It is concluded that biotechnology plays a key role in modern wastewater treatment technologies and will be essential for future water conservation.

Keywords: CRISPR-Cas9, Wastewater treatment, Biofilms, Mycoremediation, Microbial fuel cells, Biotechnology