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EDITORIAL
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Editorial: Efficient Treatment of Industrial Wastewater With Microbiome and Synthetic Biology

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Editorial on the Research Topic

Efficient Treatment of Industrial Wastewater With Microbiome and Synthetic Biology

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The development of human civilization depends on a wide range of anthropogenic industries. Expanding industrial activities provide substantial products for our society, but also produce significant volume of wastewater, containing tons of excessive nutrients, organic pollutants (Li et al., 2015) and heavy metals (Qasem et al., 2021). To efficiently remove these anthropogenic pollutants in industrial wastewater, diverse physicochemical strategies, such as adsorption, membrane filtration, photocatalytic reactions, have been applied (Qasem et al., 2021). After decades of study and technical improvement, the application of these classical technologies reaches a relatively stable performance in wastewater treatments and has reduced a wide range of contaminates from industrial effluents. For instance, both conventional (e.g., activated carbons and zeolites) and nanostructured (e.g., fullerenes) absorbents could produce a nearly 90% removal of heavy metal ions in wastewater (Burakov et al., 2018). Despite being very effective in purification, these strategies show many disadvantages, such as high cost and energy consumption, as well as solid waste production from treatments. All these drawbacks bring a significant economy burden for factories and the byproducts likely cause secondary pollution to the environment. Accordingly, the introduction and adoption of microbial and synthetic biology approaches to improve the efficiency of wastewater treatment have received significant attention from researchers globally (Zhang et al., 2021).

The biological strategies, mainly driven by microbial reactions, are effective and environmentally friendly. These biological treatment strategies not only remove pollutants with low investment, but also generate methane and other sustainable natural resources from industrial wastewater, improving the economy benefits for applied factories (Li et al., 2021; Liang et al., 2021). Currently, the microbiota in many wastewater treatments has been investigated, while the information regarding the functional microorganisms, the molecular mechanisms for pollutant degradation, and the ecological network of the microorganisms in the industrial wastewater treatment plant, is still limited (Wei et al., 2020).

Addressing the present knowledge gap, Kumar et al. analyzed the microbial composition within the textile industry wastewater from several wastewater treatment plants in India. They found the dominance of *Aeromonas caviae*, *Desulfovibrio desulfuricans*, *Klebsiella pneumoniae*, etc. during the treating process. They also identified important catalytic enzymes from Pseudomonadaceae and suggested their potential application during the dye degradation process. Jing et al. focused on the application of fungi in the wastewater treatment process. They performed a series of incubation experiments to identify the removal efficiency of edible fungi residue on lead in wastewater. Together with the significant quantity of fungi residue supply, this might be an effective approach for heavy metal removal in a wide range of industries. Apart from bacteria and fungi, microalgae also play an important role during the wastewater treatment process. Sattayawat et al. examined the biological roles of 49 unique genes and proteins from microalgae during the heavy metal removal. They outlined that the genetic parts within their constructed library could be implemented in synthetic biology-based designs, providing opportunities for microalgae as heavy metal bio-removers globally.

The development of microbiome and synthetic biology provides an insight into the microbiota for complex pollutant removal. Currently, the comparison of industrial-scale wastewater treatment plants is rarely reported, though the microbial inoculation, especially highly efficient strains, among different plants might significantly improve the removal process. More importantly, the development of additional microbiota sources from natural environments, such as oceans and benthic sediments, to wastewater treatment is urgent for dealing with brackish and low carbon supply wastewaters (Mai et al., 2021). Accordingly, Jin et al. described the similarity and difference in nitrogen transformation between wastewater treatments and marine environments. The functional key genes/enzymes and microorganisms in the processing of nitrogen from oceans showed a great potential for adoption in wastewater treatments. Similarly, the further development and introduction of natural or engineered microbiota for complex pollutants in industrial wastewater is of great interest in the future (Zou et al., 2021).

To conclude, the present research topic focuses on the use of microbiome and synthetic biology tools, to recover the pathway/genes/enzymes for enhancing pollutant removal in industrial wastewater. The microbiota, including living microorganisms and residue, used in different types of industrial wastewater was described. Their unique genes and proteins related with contaminant removal in wastewater plants were outlined, and the application potential for synthetic biology-based designs were highlighted. For the future application, the inoculation of pollutant removal microbial strains among different treatment plants should be strongly encouraged. In addition, given the abundant microbial sources in the biosphere (e.g., Jiang et al., 2020, 2021), the selection and introduction of suitable microbial strains from natural environments for dealing with contaminant removal at industrial settings is recommended.

AUTHOR CONTRIBUTIONS

YW and SJ conceived the study. SJ wrote the manuscript. All authors revised the manuscript.

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