Biotechnological intervention for societal development (BioSangam 2020)

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Environmental deterioration due to rapid urbanization and industrialization has become a major concern over the past few decades. The release of inorganic (potentially toxic metals and metalloids) and organic (polycyclic aromatic hydrocarbons, polychlorinated biphenyls, pesticides, endocrine disrupting chemicals (EDCs)) pollutants from both natural and anthropogenic sources has severely contaminated the ecosystems, i.e., soil, water, and air. Various industrial processes such as coal combustion, oil and metal refineries, metal processing, acid mine drainage, agricultural waste, pharmaceutical industries, and electronic wastes are responsible for the contaminations in the environment. Most of these pollutants are toxic, persistent, and xenobiotic and pose a real threat to the environment. In addition, their coexistence and interaction with each other in the environment remains a greater concern as its adverse effects threaten the health of ecosystem and all life forms. Therefore, it is utmost necessary to promote advanced research for the mitigation and remediation of these toxic contaminants in sustainable way for a better world.

Various conventional methods including chemical, physical, or physico-chemical treatment methods are available for remediation of these contaminants. However, most of them have many limitations, including high cost and formation of toxic by-products, which make them inefficient for the sustainable removal of contaminants. Bioremediation of contaminants has gained significant interest in past decade as a cost-effective, eco-friendly, and efficient techniques for practical application and sustainable development. In bioremediation, toxic contaminants transform into completely non-hazardous

or less hazardous forms using biological systems including microorganisms or their products and plants (phytoremediation) to reclaim the contaminated water and soils.

The potential of biotechnology has, further, created greater interest for sustainable development such as waste recycling and recovery of valuable resources from waste via waste management. With the help of cutting-edge biotechnology, it can be possible to solve problems in many sectors pertaining to metal industry, agriculture, and environment leading to achieve sustainable development goals. Metals/minerals recovery using bioleaching is one such example. Minerals are not renewable resources and depleting fast due extensive mining activities and industrials usage. As the high-grade mineral resources are exhausting, it is important to implicate technology like bioleaching/bio-hydrometallurgy for the recovery of minerals from a various waste, such as low-grade ores, electronic wastes (WEEE), and other end products to ensure its sustainability. Although conventional methods like hydrometallurgy and pyrometallurgy are currently being executed for the metal recovery, their applications are limited due to high energy demands, excessive cost, and generation of large volume of wastes. In contrast, bioleaching/bio-hydrometallurgy as an eco-friendly, cost effective method serves dual benefits: metal recovery from waste streams and bioremediation of metals.

Further, genetic engineering as a modern tool plays a significant role in advancement of bioremediation and sustainable development. Genetically engineered microbes are increasingly being employed due to their significantly enhanced capabilities to degrade and eliminate wide ranges of pollutants. Cutting-edge technologies like metagenomics and pyrosequencing also provide better understanding of the microbial diversity and community structure which is very important to enhance the bioremediation of numerous toxic pollutants. With the help of these modern technologies, it is possible to study microbe-pollutant interactions, microbial response, cellular mechanisms and resistance against various pollutants in

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depth, which can accelerate the overall bioremediation process of the contaminated sites. Next-generation sequencing (NGS) technologies also help in better understanding the microbial ecology in extreme conditions to address the challenges associated with bioleaching or biosolubilisation and to improve the rate of metal recovery for practical application.

In this context, this special issue is timely and dedicated to the ongoing researches across all areas of biotechnology for sustainable development and controlling and mitigating the existing environmental problems and their effects. The special issue is also part of BioSangam 2020, a 4th International conference on “Biotechnological intervention for societal development”, of BioSangam series that was held from February 21 to 23, 2020, at Department of Biotechnology, Motilal Nehru National Institute of Technology Allahabad, Prayagraj, India. Total six papers related to the topic have been chosen. They include the effect of metal(loid)s on plants and the phytoremediation strategies for the removal of metal(loid)s (Singh et al. 2020; Banerjee et al. 2020), biosolubilization of manganese for sustainable recovery and combining bioremediation of manganese from waste stream containing high concentrations of manganese (Ghosh et al. 2020). Further, the role of genetic engineering in advancing biotechnological approaches for better understanding the microbial ecology and utilizing the metabolic potential of microorganisms for bioremediation of hydrocarbon and resource recycling has been reviewed by Sengupta and Pal (2021), while two other papers (Afzal et al. 2021; Dixit et al. 2021) have focused on biological synthesis of nanoparticles, and their properties and applications. As the rapid development of nanoscience and the synthesis and commercialization of nanomaterials is imminent, it is important to emphasize more on development of biological synthesis of nanoparticles for various industrial applications to ensure sustainability and reduce the hazardous threat on the ecosystem and human health. Overall, these papers highlight the recent advancement made in the all areas of

biotechnology and its multidisciplinary approaches for the pollution removal and resource recovery to ensure sustainability.

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