Chapter 12
Nano-Bioremediation:
Nanotechnology and Bioremediation

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ABSTRACT

The functional aspect of nanotechnology (NBT) is driven either to accelerate the performance of materials and/or to reduce the quantity of materials that are used for the purpose. Most significantly, its potential attribute to the environment includes the treatment and remediation, sensing and detection, and pollution prevention. In general nano-bio remediation (NBR) involves the use of nano-materials either in in-situ (in place), or ex-situ (off-place) treatment of contaminated materials. To accomplish this, the elemental or zero-valent metals and like materials in nano-form (1-100 nm) have been applied as an instinctive need to embrace sustainable environment. The use of nanomaterials initially reduces the biodegradable contaminants and then it promotes to achieve the standard levels. Thus, the role of nano-materials could be an efficient, effective approach to remediate the environmental contaminant sustainably. However, further research is required to record the detailed fate of the nano-materials that are used in environment remediation.

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INTRODUCTION

Globally, urbanization as well as industrial revolution ever since 19th Century brought great economical *cum* technological advancements. The technological innovations raised the course of humanity, through the process of excessive resource extraction, product dissemination and in addition greater disposal of waste materials into the environment with no proper diligence (Cecchin *et al*., 2016). Generation and non-diligent disposal of materials led to several serious contamination issues challenging environmental, social and economy of world. In order to mitigate these concerns, efficient managerial strategies need to be adopted to achieve the environmental sustainability. In recent years sustainable remediation techniques gained greater importance, primarily aiming at reduction of contaminants concentration their by lowering the risk level as well as to eliminate the global environmental impacts induced by greenhouse gas emissions (Reddy and Adams, 2010). Bio-based approach has already substantially affected environmental protection. Thus bioremediation is considerably a clean, green and sustainable solution for treatment of contaminated materials and is in general considered as 'environmentally appropriate'. However, bio-based techniques are time consuming and at higher contaminant concentration toxic to the organisms involved for the purpose.

With emergence of bio-mimetic nanotechnology in the recent past has attracted the researches to intensively explore this concealed avenue. Arena of nano-biotechnology intersects the knowledge from all branches of science, technology and involves all forms of living organisms (Baker and Satish, 2012). The scope of nano-biotechnology has higher potential to support extensively at managing major global environmental challenges. Thus integration of nano-biotechnology along with bioremediation possibly achieves efficient, effective and sustainable solution for clean environment. This chapter reveals the recent trends, in the context of nano-biotechnology in pollution prevention and treatment either in place (*in-situ*) or off place (*ex-situ*) of contaminants. Hence, disclosure of nano-bioremediation technology might have far-reaching beneficial portent for the protection against large tracts of polluted sites that are overwhelmed with the waste materials.

NANO-BIOTECHNOLOGY AND UNIQUENESS OF NANOPARTICLES

Nanotechnology as we know in its modern and post-modern forms, is the young branch of knowledge but mankind has empirically used since thousands of years (Pradeep, 2007, Anuradha, 2013). It is an umbrella term covering wide range of technologies comprising structures and processes at nanometer scale (Abbasi *et*