BIOTECHNOLOGY-2011
doi:10.4172/2155-6199.1000001

World Congress on
Biotechnology

Bioremediation Technologies

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Bioremediation is an eco- friendly, cost-effective and natural technology targeted to remove heavy metals, radio nuclides, xenobiotics compounds, organic waste, pesticides etc. from contaminated sites or industrial discharges through biological means. Bioremediation is the use of microorganismal metabolism to remove pollutants. Technologies can be generally classified as *in situ* or *ex situ*. *In situ* bioremediation involves treating the contaminated material at the site, while *ex situ* involves the removal of the contaminated material to be treated elsewhere. Some examples of bioremediation technologies are bioventing, bioleaching, landfarming, bioreactor, composting, bioaugmentation, rhizofiltration and biostimulation.

Bioremediation can occur on its own (natural attenuation or intrinsic bioremediation) or can be spurred on via the addition of fertilizers to increase the bioavailability within the medium (biostimulation). Recent advancements have also proven successful via the addition of matched microbe strains to the medium to enhance the resident microbe population's ability to break down contaminants. Microorganisms used to perform the function of bioremediation are known as **Bioremediators.**(bioaugmentation).

The rapid expansion and increasing sophistication of various industries in the past century has remarkably increased the amount and complexity of toxic waste effluents, which may be bioremediated by suitable plants & microbes, either natural occurring or tailor-made for the specific purpose. This technology is termed as bioremediation. **Bioremediation process involves detoxification, where the waste is made less toxic, and mineralization, where the waste material is converted into inorganic compounds such as carbon dioxide, water and methane**.

In this technology, higher plants or microbes are used alone or in combination for phyto extraction of heavy metals from metal contaminated sites. Through microbial interventions, either the metals are immobilized or mobilized through redox conversions at contaminated sites. If mobilized, metal accumulating plants are put in place to accumulate metals in their body. Then after, metal-loaded plants are harvested and incinerated to reduce the volume of waste and then disposed off as hazardous materials or used for recovery of precious metals, if possible. In case of immobilization, metals are no longer available to be toxic to organisms.