

## CSIR NET Life Science Unit 12

### Bioremediation

Bioremediation is a process in which living organisms, mainly microorganisms, green plants, and their enzymes are used to remove, degrade, mineralize or transform, and detoxify the environmental pollutants/hazardous components known as xenobiotic compounds. In this process, environmental waste compounds turn into less toxic forms during the treatment of contaminated sites in order to return them to their original condition.

This process is used to reduce the toxicity and concentration of various chemical pollutants, like pesticides, polyaromatic hydrocarbons, halogenated petroleum hydrocarbons, nitroaromatic compounds, metals, and industrial solvents.

Bioremediation has been used successfully in large- and small-scale applications. The main example of the success of this application is Alaska oil-spill clean-up for the treatment of pollutants.

With the proper utilization of natural and modified microbes and their processes and appropriate engineering models these techniques can be applied to the clean-up of contaminated groundwater, soil, lagoons, waste streams, and sludge.

#### Types of Bioremediations

The main methods of bioremediation, that is, in situ and ex-situ remediation. This categorization is based on the origin, transportation, and removal of pollutants from contaminated sites.

##### **1. In situ bioremediation**

In situ bioremediation involves the treatment of pollutants in actual contaminated sites without any excavation or disturbance. In situ bioremediation is divided into intrinsic in situ bioremediation in this no enhancement practice involved. Or other is enhanced in situ bioremediation which involves venting, sparging, and phytoremediation. This method is economically feasible, as there is no extra cost needed for any excavation and transportation processes. In situ remediation is commonly used for the treatment of sites contaminated with dyes, chlorinated solvents, heavy metals, and hydrocarbons. The common process of in situ bioremediation is described below;

- **Bioaugmentation**

In the process, of bioaugmentation groups of microbes like indigenous microbes, other sites microbes, or genetically engineered microbes are added to the site of contamination which improves the degradation processes. A common example of this method is to treat municipal wastewater and soil contaminated with aromatic and chlorinated hydrocarbons.

- **Biostimulation**

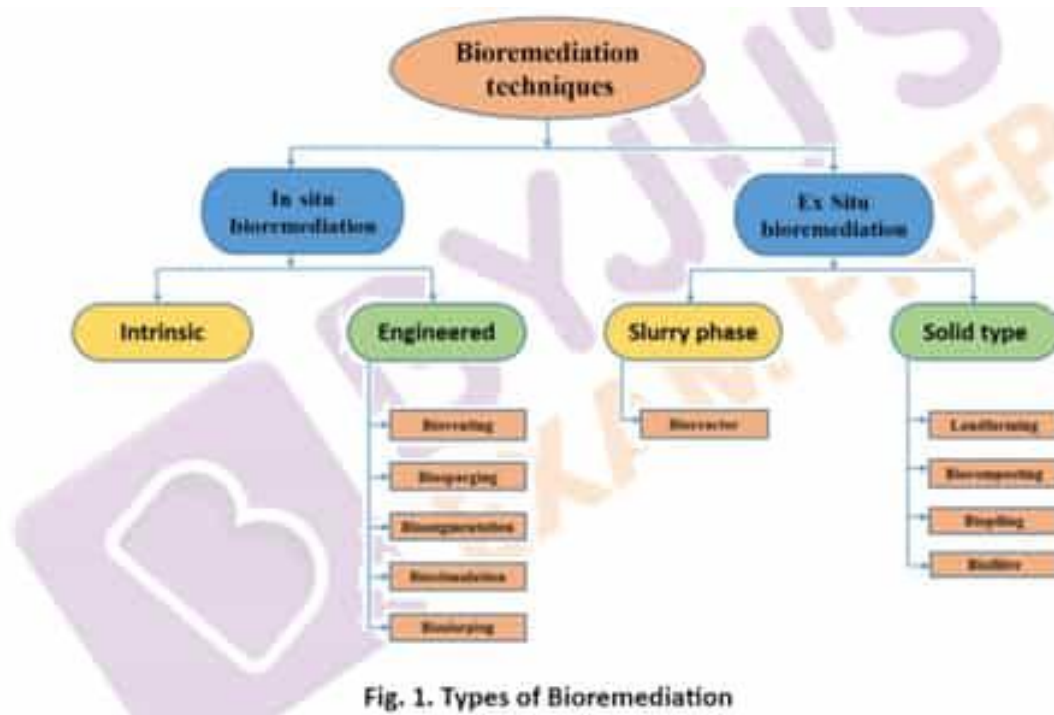
In this method, stimulation of indigenous microbial population growth is done by supplying necessary nutrients in contaminated soil or groundwater which cause the effective treatment of pollutants. This is a common method for the hydrocarbon's treatment of and metal-contaminated site.

- **Bioventing**

In the process of bioventing, supply of air (oxygen) and nutrients are done in a controlled manner by this well to the contaminated soil stimulate microbial activity for the degradation process this technique is effectively used for the removal of pollutants from deep under the surface .and for the biodegradation of low-molecular-weight hydrocarbons, absorbed fuel residuals, spilt light petroleum, and volatile pollutants from the soil.

- **Bioslurping**

In bioslurping, many processes combine, like bioventing, vacuum enhanced pumping, and soil vapour extraction, by this removal of soil and groundwater pollutants, is done which uses an indirect supply of oxygen and stimulates microbial biodegradation. These techniques are mainly used for the volatile and semivolatile organic contaminants removal from soil and liquid.



- **Biosparging**

in the process of biosparging supplied of air is done into the soil subsurface which can cause the upward movement of volatile organic pollutants from the surface zone for the biodegradation process this enhances pollutant removal from the site of pollution by stimulating microbial activity, biosparging is mostly used for the treatment of aquifers polluted with hydrocarbons and petroleum products

1. **Ex-situ bioremediation**

In the type of ex-situ bioremediation excavation and transportation of pollutants is done from the actual polluted site to another site. After transportation removal of pollutants is done by using several bioremediation techniques and these are further classified into different categories based on the

pollutant types, depth and degree of pollution, treatment cost, and the geographical and geological features of the polluted site, examples are landfarming, composting, biopiling, bioreactors, and biofilters,

- **Biopiling**

Biopiling is also known as the heap technique is a combination of landfarming and composting. in This process contaminated soil sample is tested for degradation potential, mechanical separation of the soil sample for the homogenization of the soil after piling of excavated polluted soil than after

further amendment of soil done with nutrients, and aeration for enhancement the microbial degradation.

This method is mostly used for treating soil contaminated with low-molecular-weight pollutants and petroleum hydrocarbons, example is BTEX, PAHs, and phenols,

- **Landfarming**

In landfarming, excavation of contaminated soil is done then spread and tilled from time to time the fixed soil layer support above the ground allows the aerobic biodegradation of pollutants by microbes. Tillage nurtures the aeration, nutrients, and water to enhance the microbial activity in the process of landfarming. landfarming is used for the treatment of aliphatic and polycyclic aromatic hydrocarbon and PCBs contaminated sites. This is the simplest and cheapest method and as an alternative to the dumping method.

- **Bioreactors**

A reactor or container is used to degrade the contaminant under controlled conditions Factors that are controlled is bioaugmentation, supplementation of nutrients, mass transfer, the bioavailability of pollutants, and optimized reaction conditions this makes the technique most efficient. this method is used for the treatment of contaminated soil or water with volatile organic pollutants such as benzene, toluene, ethylbenzene, and xylene.

- **Biofilters**

The method is used for the f gaseous pollutants removal. In this technique, elimination of

gaseous pollutants are done with columns embedded with microbes.

Some Other type of Bioremediation is ;

### **Phytoremediation**

Phytoremediation is a technique of bioremediation in which plants and their roots utilizes for the remediation of contaminated soil and water. In this process pollutant removal mechanism by plants happens by the uptake of pollutants by a passive process, translocation of the pollutant from root to shoot occurs by xylem flow and accumulation in the shoot. This is mainly used for heavy metal treatment.

## Microbes involve in Bioremediation

Some important microbe use in bioremediation are;

- *Pseudomonas putida*.
- *Dechloromonas aromatica*.
- *Deinococcus radiodurans*.
- *Methylobium petroleiphilum*.
- *Alcanivorax borkumensis*.
- *Phanerochaete chrysosporium*.



# Mentor Guru