

**JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY**

**SECTOR 62, NOIDA, UTTAR PRADESH**



**ENVIRONMENTAL STUDIES PROJECT BASED LEARNING REPORT**

**BATCH – B11**

**TOPIC: BIOREMEDIATION**

**SUBMITTED BY**

KAMAL GARG                      21103231

HIMANSHU DIXIT                21103262

SRISHTI GARG                    21103227

DIVYA                                21103233

**SUBMITTED TO**

Dr. Nivedita

## **ACKNOWLEDGEMENT**

We wish to express our profound and deep sense of gratitude to Dr. Nivedita for motivating us to make such a report and for sparing time to go through every tiny detail and give his valuable suggestions to make this project report a success. We are mainly indebted to the authors of many references and articles which were used as the reference. Last but not the least we would like to thank our friends and family for their help in every way for the success of this project report.

## INDEX

1. Introduction	4-5
2. Types of Bioremediation	6
3. How Bioremediation works	7
4. Different bioremediation techniques	8-9
5. Advantages	10
6. Disadvantages	11
7. Images	12-13
8. Conclusion	14
9. References	15

## INTRODUCTION

Intensification of agriculture and manufacturing industries has resulted in increased release of a wide range of xenobiotic compounds to the environment. Excess loading of hazardous waste has led to scarcity of clean water and disturbances of soil thus limiting crop production

[1]. Bioremediation uses biological agents, mainly microorganisms i.e., yeast, fungi or bacteria to clean up contaminated soil and water

[2]. This technology relies on promoting the growth of specific micro flora or microbial consortia that are indigenous to the contaminated sites that are able to perform desired activities

[3]. Establishment of such microbial consortia can be done in several ways e.g., by promoting growth through addition of nutrients, by adding terminal electron acceptor or by controlling moisture and temperature conditions. In bioremediation processes, microorganisms use the contaminants as nutrient or energy sources

The population explosion in the world has resulted in an increase in the area of polluted soil and water. As the number of people continues increasing day by day it also brings with it a growing pressure on our natural resources i.e., air, water and land resources. In order to outfit to the demands of the people, the rapid expansion of industries, food, health care, vehicles, etc. is necessary. But it is very difficult to maintain the quality of life with all these new developments, which are unfavourable to the environment in which we live, if proper management is not applied. In nature there are various fungi, bacteria and microorganisms that are constantly at work to break down organic compounds but the question arises when pollution occurs, who will do this clean up job? Since the

quality of life is inextricably linked to the overall quality of the environment, global attention has been focused on ways to sustain and preserve the environment. This endeavour is possible by involving biotechnology. The types of contaminants that environmental Biotechnology investigators have expertise with include chlorinated solvents, petroleum hydrocarbons, polynuclear aromatic hydrocarbons, ketones, TNT, inorganic nitrogen ( $\text{NO}_3$ ,  $\text{NH}_4$ ), Tt, Pu, Np, Cr, U and other heavy metals. Bioremediation is the term used to describe biological strategies applicable to repair of damaged environment using biological factors. In the case of oil spills, the process exploits the catabolic ability of microorganism feeding on oil. Several workers] have described various application of microorganism in the bioremediation of oil pollution with encouraging results.

This project covers all aspects of Bioremediation and how it can be beneficial for mankind in reducing hazardous actions and conditions. Bioremediation is a branch of biotechnology that employs the use of living organisms, like microbes and bacteria, in the removal of contaminants, pollutants, and toxins from soil, water, and other environments. Bioremediation is used to clean up oil spills or contaminated groundwater. Bioremediation is a process used to treat contaminated media, including water, soil and subsurface material, by altering environmental conditions to stimulate growth of microorganisms and degrade the target pollutants.

# Types of Bioremediation

There are three different types of bioremediation: microbial bioremediation, phytoremediation, and mycoremediation.

**1. Microbial bioremediation:** Microbial bioremediation is the use of microorganisms, such as bioremediation bacteria, to neutralize and remove the contaminants. Using the contaminants as a food source, the microbes break them down into harmless substances.

**2. Phytoremediation:** Phytoremediation is the use of plants to bind, extract, and remove contaminants, such as hydrocarbons, pesticides, and heavy metals.

**3. Mycoremediation:** Mycoremediation is the use of fungi to neutralize and remove contaminants. The digestive enzymes of fungi are strong enough to break down contaminants, such as pesticides and hydrocarbons, into harmless substances.

## **How bioremediation works**

Bioremediation occurs naturally, without the use of any chemical catalysts, when biological agents come into contact with the contaminants. However, it is necessary to create the ideal environmental conditions to facilitate and expedite the bioremediation process. The conditions include the right temperature, pressure, pH, and moisture.

In microbial bioremediation, the microbes secrete enzymes to break the contaminants into smaller pieces, which they then consume. As a by-product of the digestion process, they release water, carbon dioxide, and amino acids. These are then removed. Mycoremediation works in a similar way. The digestive enzymes secreted by fungi break down the contaminants.

In phytoremediation, natural chemicals present in plants react with the contaminants. They either neutralize them or bind with them to form harmless substances.

## Different bioremediation techniques

Bioremediation techniques can be divided into two broad categories: ex situ bioremediation and in situ bioremediation. Ex situ bioremediation involves excavating the contaminants from the contaminated site and transporting them to a designated treatment site. They include bio pile, windrow, bioreactor, and landfarming.

**1. Bio pile:** Bio pile involves piling the polluted soil, amending the nutrients, and aerating the soil to enhance the activity of the microbes.

**2. Windrow:** Windrow involves turning and aerating the polluted soil periodically to increase the activities of the bacteria that feed on hydrocarbons.

**3. Bioreactor:** A bioreactor is a vessel that is used to convert raw materials to products after a series of biological reactions. It is used in bioremediation to treat contaminated substances.

**4. Landfarming:** Landfarming involves excavating or tilling the polluted soil and treating it to increase microbial activity. It is one of the simplest bioremediation techniques. In situ bioremediation involves treating the contaminated substances at the site of contamination. It causes little or no disturbance to the soil structure. It includes natural attenuation, Bio slurping, bioventing, Biosparging, and permeable reactive barrier (PRB).



**1. Bioventing:** Bioventing involves treating the contaminated soil with a controlled flow of oxygen to increase the activities of the indigenous microbes. Nutrients and moisture may also be added during the process.

**2. Bio slurping:** Bio slurping involves combining bioventing, soil vapor extraction, and vacuum-enhanced pumping to increase the activities of bioremediation bacteria and other microbes. This technique is very effective in restoring sites contaminated by petroleum hydrocarbons.

**3. Biosparging:** Biosparging involves injecting air into the soil subsurface to increase the bioremediation activities of the microbes. It is similar to bioventing, but the air is injected into the saturated zone.

**4. Permeable reactive barrier (PRB):** PRB involves submerging a permanent or semi-permanent reactive barrier (made mostly of zero-valent iron) into the trajectory of polluted groundwater. As the water flows through the barrier, it traps the pollutants and subjects them to a series of reactions. The result is clean and pollution-free water.

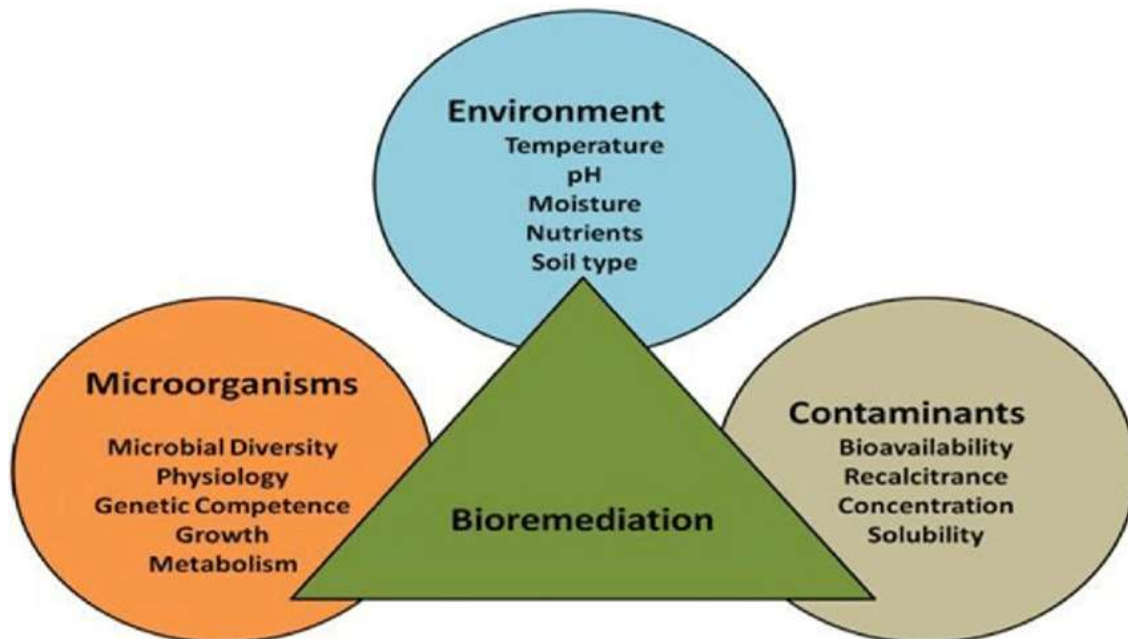
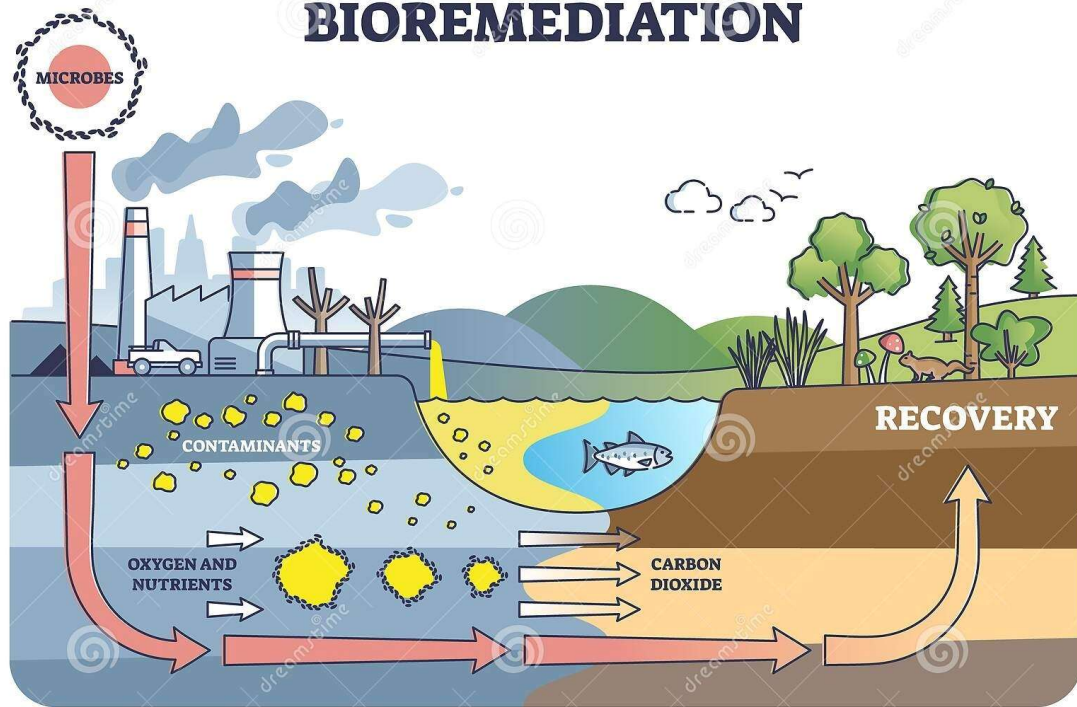
## **Advantages of bioremediation**

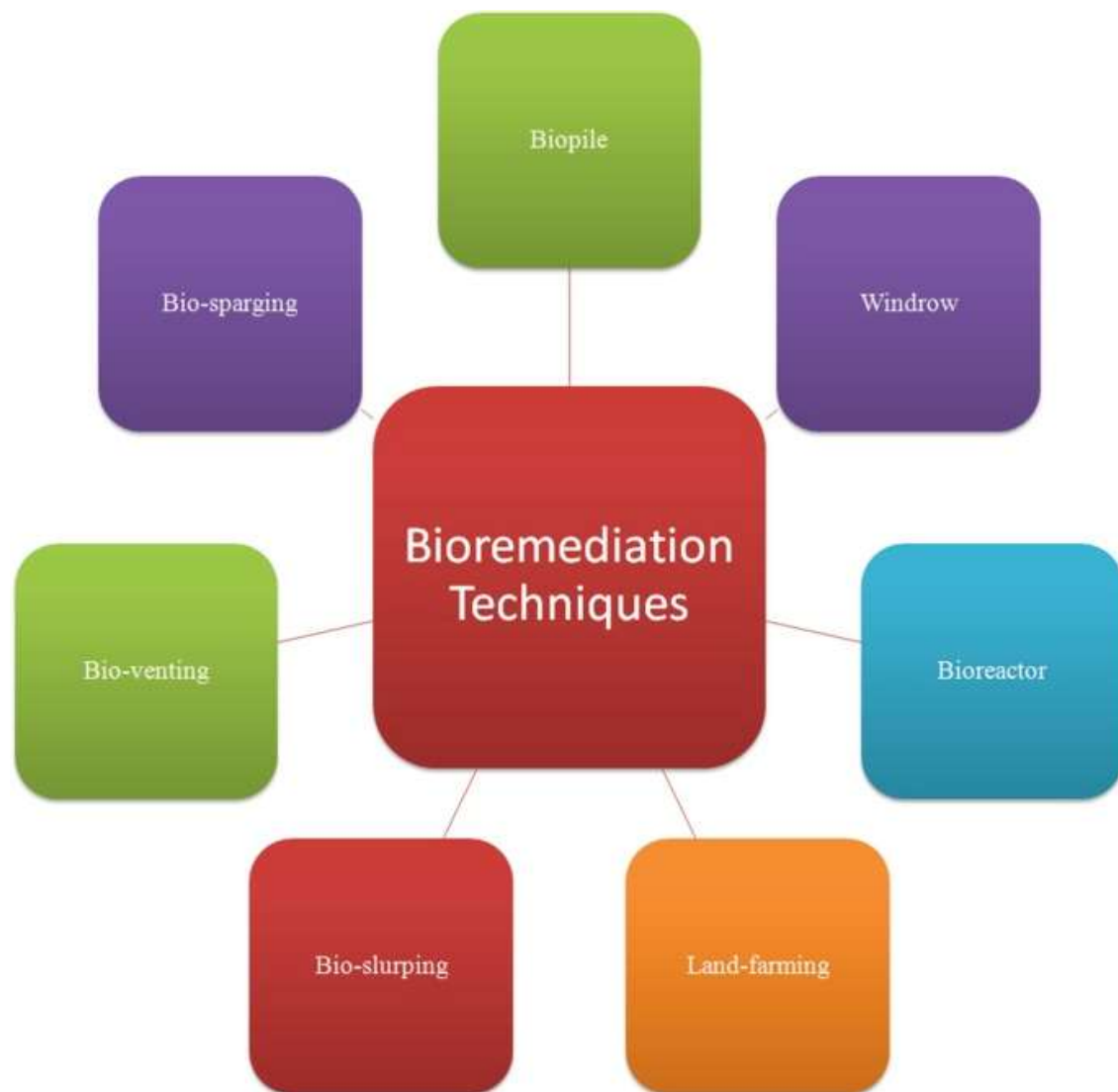
- Bioremediation is a natural process and is therefore perceived by the public as an acceptable waste treatment process for contaminated material such as soil. Microbes able to degrade the contaminant increase in numbers when the contaminant is present, when the contaminant is degraded, the biodegradative population declines. The residues for the treatment are usually harmless products and include carbon dioxide, water, and cell biomass.
- Theoretically, bioremediation is useful for the complete destruction of a wide variety of contaminants. Many compounds that are legally considered to be hazardous can be transformed to harmless products. This eliminates the chance of future liability associated with treatment and disposal of contaminated material.
- Instead of transferring contaminants from one environmental medium to another, for example, from land to water or air, the complete destruction of target pollutants is possible.
- Bioremediation can often be carried out on site, often without causing a major disruption of normal activities. This also eliminates the need to transport quantities of waste off site and the potential threats to human health and the environment that can arise during transportation.
- Bioremediation can prove less expensive than other technologies that are used for clean-up of hazardous waste

## **Disadvantages of bioremediation**

- Bioremediation is limited to those compounds that are biodegradable. Not all compounds are susceptible to rapid and complete degradation.
- There are some concerns that the products of biodegradation may be more persistent or toxic than the parent compound.
- Biological processes are often highly specific. Important site factors required for success include the presence of metabolically capable microbial populations, suitable environmental growth conditions, and appropriate levels of nutrients and contaminants.
- It is difficult to extrapolate from bench and pilot-scale studies to full-scale field operations.
- Research is needed to develop and engineer bioremediation technologies that are appropriate for sites with complex mixtures of contaminants that are not evenly dispersed in the environment. Contaminants may be present as solids, liquids, and gases.
- Regulatory uncertainty remains regarding acceptable performance criteria for bioremediation. There is no accepted definition of “clean”, evaluating performance of bioremediation is difficult, and there are no acceptable endpoints for bioremediation treatments.

# BIOREMEDIATION





## Conclusion

Bioremediation provides a technique for cleaning up pollution by enhancing the natural biodegradation processes. So, by developing an understanding of microbial communities and their response to the natural environment and pollutants, expanding the knowledge of the genetics of the microbes to increase capabilities to degrade pollutants, conducting field trials of new bioremediation techniques which are cost effective, and dedicating sites which are set aside for long term research purpose, these opportunities offer potential for significant advances. There is no doubt that bioremediation is in the process of paving a way to greener pastures. Regardless of which aspect of bioremediation that is used, this technology offers an efficient and cost-effective way to treat contaminated ground water and soil. Its advantages generally outweigh the disadvantages, which is evident by the number of sites that choose to use this technology and its increasing popularity. Once again thanks to the bioremediation technology to clean up the polluted environment and therefore may be used as management tool.

## References

- <https://en.wikipedia.org/wiki/Bioremediation>
- <https://www.aftermath.com/content/types-of-bioremediation>
- <https://www.sciencedirect.com/topics/immunology-and-microbiology/bioremediation>
- <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.dreamstime.com%2Fillustration%2Fbioremediation.html&psig=AOvVaw2C0Ph5BHgKGdD7OrxHqkCQ&ust=1681886821171000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCODMpebqsv4CFQAAAAAdAAAAABAE>
- [https://www.google.com/url?sa=i&url=https%3A%2F%2Flink.springer.com%2Fchapter%2F10.1007%2F978-981-15-7455-9\\_1&psig=AOvVaw2C0Ph5BHgKGdD7OrxHqkCQ&ust=1681886821171000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCODMpebqsv4CFQAAAAAdAAAAABAJ](https://www.google.com/url?sa=i&url=https%3A%2F%2Flink.springer.com%2Fchapter%2F10.1007%2F978-981-15-7455-9_1&psig=AOvVaw2C0Ph5BHgKGdD7OrxHqkCQ&ust=1681886821171000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCODMpebqsv4CFQAAAAAdAAAAABAJ)