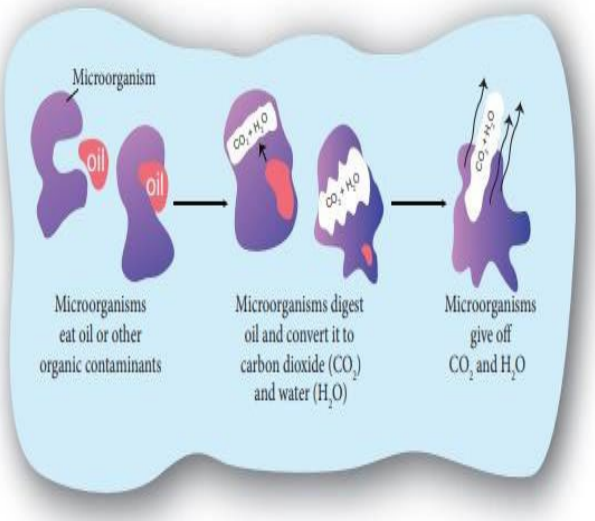
Mustansiriyah University
College of Science
Biology department \ Microbiology

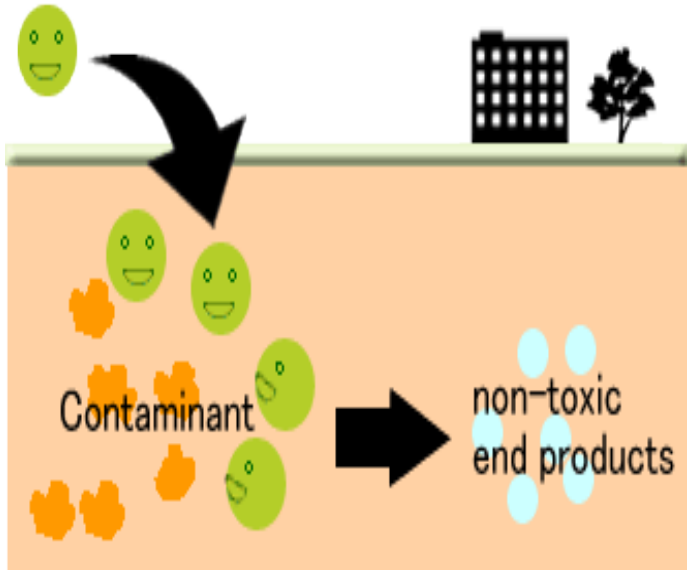
Bioremediation



Lecture Two

By

Dr. Zaid Shaker Naji



Nanoremediation

It's one of the newest and modern technologies which is used to remove the most toxic material that could exist in our environment.

Nano-remediation is one of the nanotechnology applications and this because of their unique properties. Nanomaterials that are used in nano-remediation are considered to be one of the ideal solutions for removing toxic pollutants and this process is called nano-remediation. Nano-remediation has a potential effect on toxic materials. However, with the application of nano-remediation, the risk associated with their use also needs to be focused on, because nanoparticles have also been shown to be toxic to the component of the environment.

The application of nanotechnology for the remediation of contaminants

1) Remediation or handling of the pollutants in groundwater could be achieved via applying nanotechnology, nanomaterials such as zero-valent iron (nZVI), and carbon nanotubes (CNTs) which can be used also in environmental cleanups such as groundwater remediation for drinking and reuse.

2)Titanium dioxide (TiO_2) and zinc oxides (ZnO) are on the list of most popular materials used in various nanotechnology applications because of their semiconducting, photocatalytic, energy converting, and electronic and gas-sensing properties.

Because of these properties, many researchers have focused research on TiO_2 and ZnO nanoparticles and their application as photocatalysts in water treatment.

TiO_2 and ZnO nanoparticles are frequently studied for their ability to remove organic contaminants from various media.

These nanoparticles have the advantages of being readily available, inexpensive, and of low toxicity

3)Among the various nanomaterials, the magnetic nanoparticles (MNPs) have been attracting particular attention because of their convenient magnetic field assisted separation which is a quality step for nano-remediation.

Examples of Nanoparticles and Nanomaterials for Use in Water Remediation

1) Nanocrystalline zeolites used for remediation nitrogen dioxide. Nanocrystalline zeolites are porous nanomaterials with crystal sizes of less than 100 nm that possess unique external and internal surface reactivity

2) Activated carbon fibers (ACFs) used for remediation Benzene.

How the (ACFs) works in bioremediation process? Activated carbon, also called activated charcoal, is a form of carbon commonly used to filter contaminants from water and air, among many other uses. It is processed (activated) to have small, low-volume pores that increase the surface area available for adsorption (**adsorption** is : the process by which a solid holds molecules of a gas or liquid or solute as a thin film and not the same as **absorption** which is the process or action by which one thing absorbs or is absorbed by another.) or chemical reactions.

3)Bimetallic nanoparticles (Pd/Fe nanoparticles) used for remediation chlorinated ethane. Pd is the Palladium, chemical element have the lest dense and the lowest-melting of the platinum.

4) Nanocrystalline TiO2 used for remediation Heavy metal ion.

Since we emphasize one of the most active bioremediation processes nano-remediation, we need to focus on the type of microorganism that has the ability to participate actively in bioremediation and nano-remediation for this reason we need to know an important term which is indigenous bacteria

Indigenous microorganisms are a group of innate microbial consortium that inhabits the soil and the surfaces of all living things inside and outside which have the potentiality in biodegradation, bio-composting, nitrogen fixation, improving soil fertility and as well in the production of plant growth.

Stimulation of indigenous microbial growth:

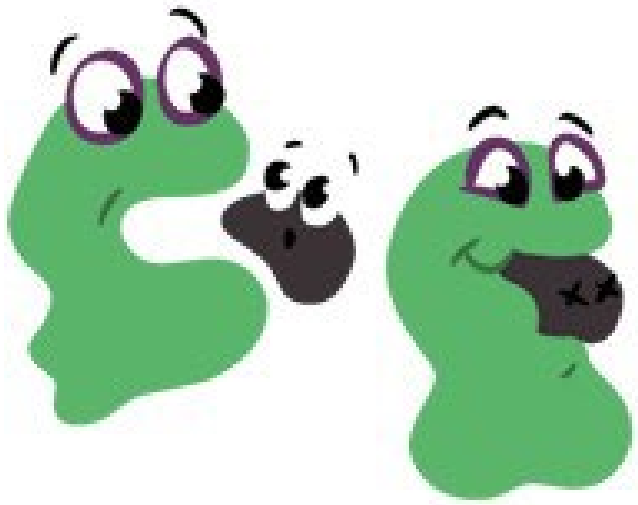
The biodegradation of organic compounds including hydrocarbons is associated with microbial growth and metabolism and therefore any of the factors affecting microbial growth will influence degradation. If the microorganisms cannot use the pollutants as their sole source of energy and carbon skeletons, some other growth substrate will be needed. The microorganisms may also require supplementation with nitrogen and phosphorous as demonstrated in marine situations.

There are some following factors affect the growth of indigenous microorganisms:-

- Presence of other biodegradable organic material.
- Presence of nitrogen and phosphorus containing inorganic
- Non degradable chemical compounds.
- Oxygen levels.
- Temperature, pH , presence of water, soil moisture if the biodegradation process happened in soil.
- Number and type (their ability of degradation) of microorganisms present, and presence of heavy metals or salt.

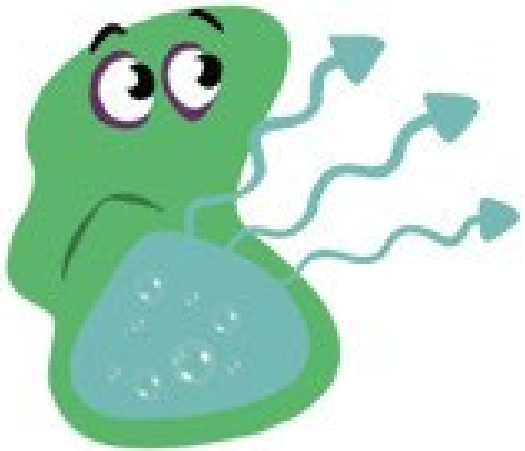
Why Oxygen level is an important factor in biodegradation? The aerobic degradation (depends on oxygen) of hydrocarbons is faster than the anaerobic process, so that a supply of oxygen will be needed to maintain aerobic conditions if rapid degradation is required. A soil with an open structure will encourage oxygen transfer and the water amount inside the soil will have the reverse effect.

Biodegradation process



Friendly bacteria in SpillAway products eat oil and hydrocarbon waste

The microbes digest and metabolise this waste, turning it into water and harmless gases



Finally the microbes release the water and gases back into nature

Does the temperature have an effect on microbial growth during the biodegradation process? Yes, at low temperature the biodegradation will be slow. The addition of nitrogen and phosphate-containing fertilizer greatly increases the degradation of contaminants and hydrocarbons. The pH of the soil will affect both the growth and the solubility of the compound to be degraded.

Is there any link between the concentration of hydrocarbon contaminants and heavy metals levels in the biodegradation area? In some cases, hydrocarbon contamination may also be associated with high levels of heavy metals, which may inhibit microbial growth depending on the concentration and type of metals. The rate of degradation of xenobiotics in soil and water is also dependent on the presence of microorganisms with the enzymatic capability to degrade the polluting molecules.

Bioaugmentation: the inoculation of microorganisms (e.g., bacteria containing the required catabolic genes in their active way) into contaminated soil or sewage water in order to enhance the rate of contaminant degradation, bioaugmentation has a great potential for the bioremediation for contaminated sites with organic compounds.

Bioaugmentation process occurred when a mixed microbial consortia is preferred to be selected due to their wide metabolic networks, through which they can easily digest the complex hydrocarbons in oil contaminated soils.

Moreover, the enrichment of indigenous microorganisms and bioaugmentation with these enriched microorganisms which are well adapted to the contaminated environment has been recommended by various researchers.

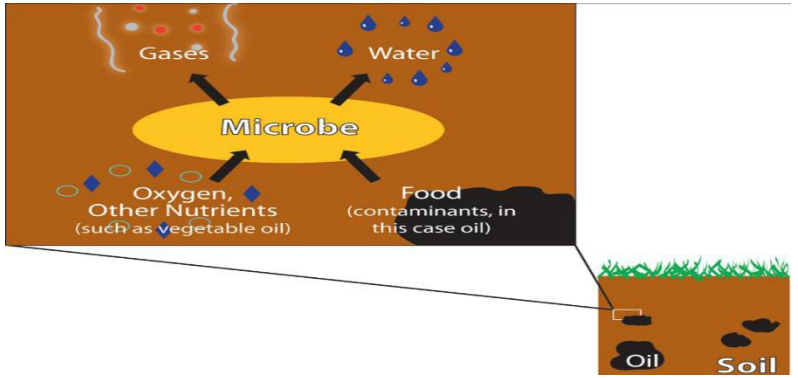
Biostimulation: is the process of adding electron acceptors , electron doners or nutrient to stimulate naturally occurring microbial populations in the contaminated area.

Often oil contaminated soil is found to have a much higher carbon content in comparison to nitrogen (N) and phosphorous (P). An adequate supply of N and P is essential for microbial growth and contaminant degradation.

Moreover, during the course of natural attenuation, nutrient depletion may lead to a reduction in the indigenous microbial population. Thus, biostimulation with nutrients in the form of N and P is often found to induce contaminant degradation by the native microbial population, while the activity of bioaugmented cultures is also enhanced.

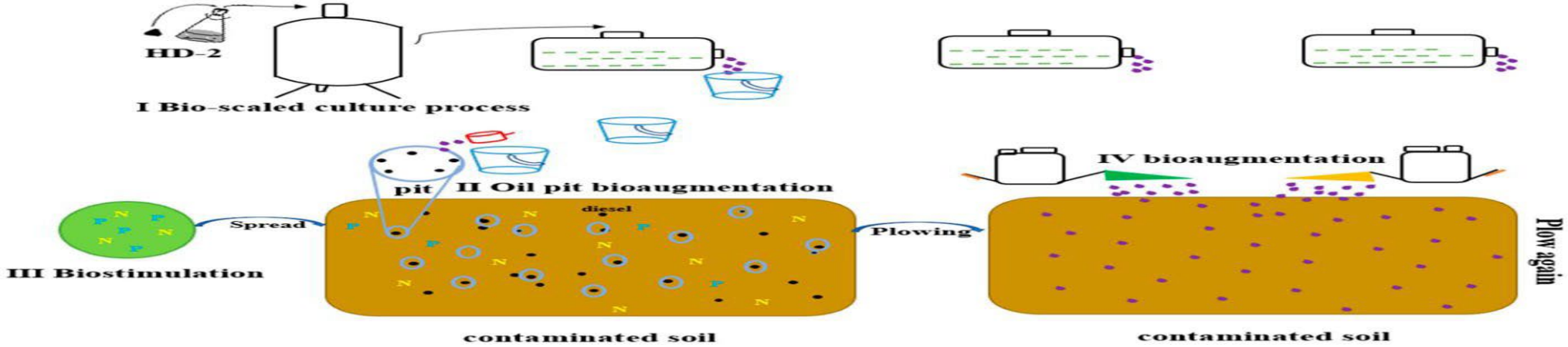
- **What are the Similarities Between Bioaugmentation and Biostimulation?**

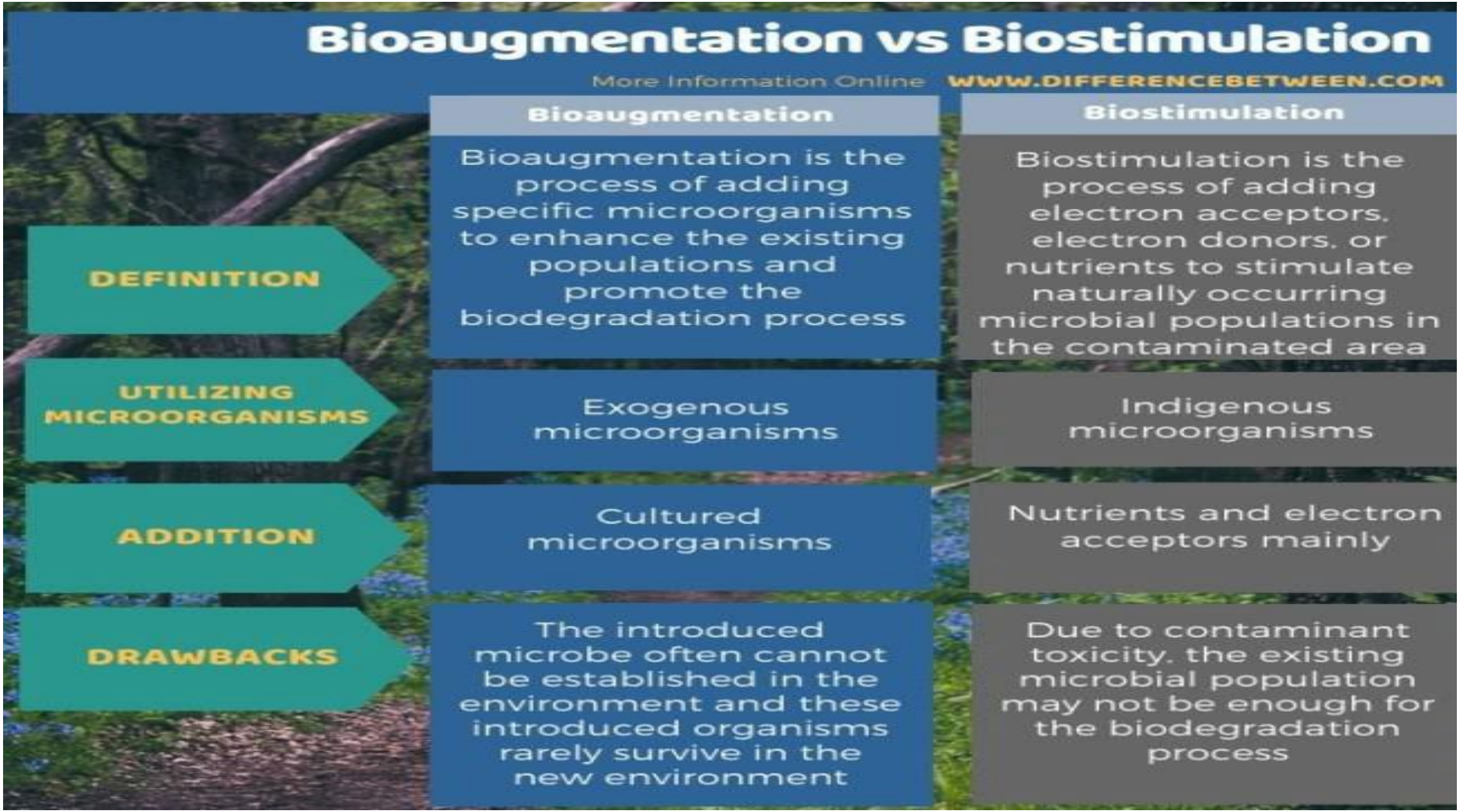
- Bioaugmentation and biostimulation are two sustainable treatment methods to clean polluted areas.
- Biostimulation can be enhanced by bioaugmentation.
- In both processes, microorganisms are utilized.
- Both methods are biological methods.

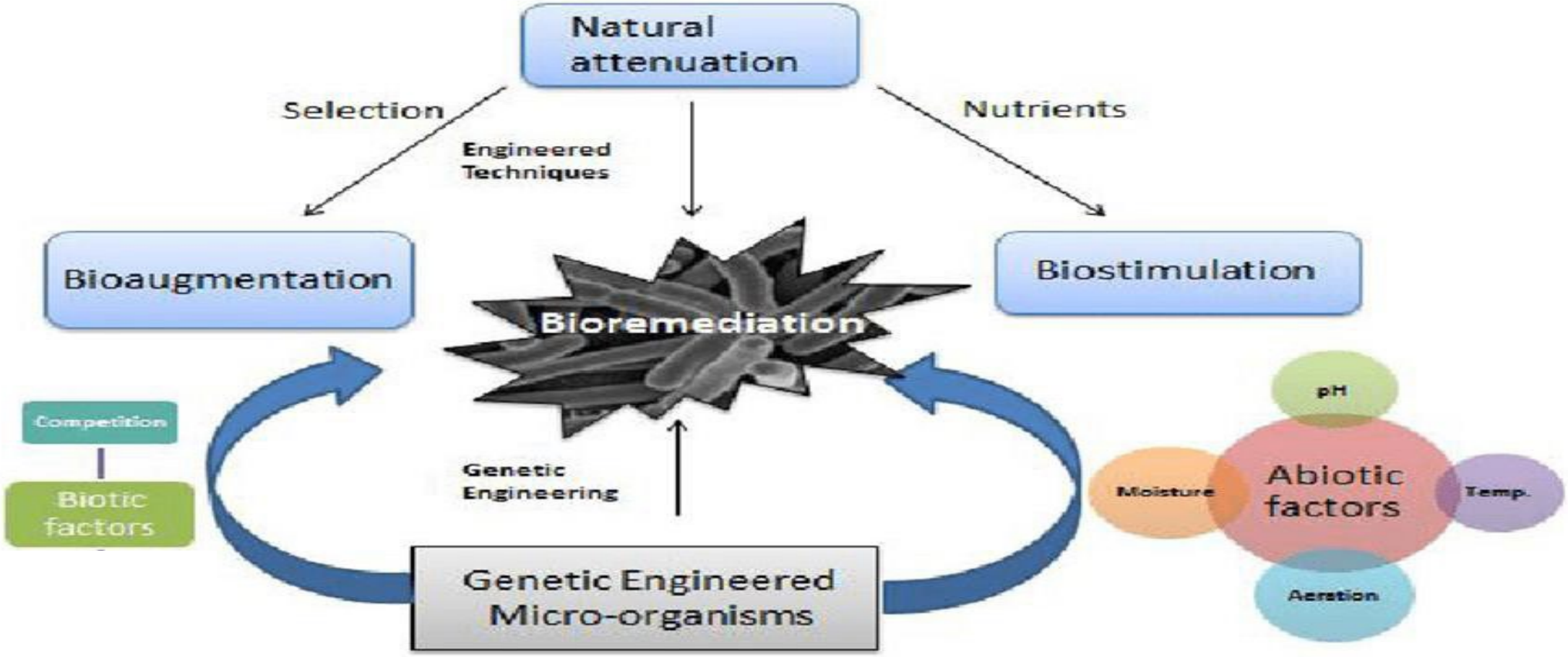


- These methods do not result in toxic byproducts and are not harmful, unlike chemical methods.
- Both methods have received much attention nowadays due to their potential and sustainability.
- They are promising and long-term solutions for the degradation of contaminated soil and water.
- Moreover, they are cost-effective methods, unlike chemical methods.

- **What is the Difference Between Bioaugmentation and Biostimulation?**
- **Bioaugmentation** is the process of adding specific microorganisms to enhance the existing populations and promote biodegradation process while **Biostimulation** is the process of adding electron acceptors, electron donors, or nutrients to stimulate naturally occurring microbial populations in the contaminated area. So, this is the difference between bioaugmentation and biostimulation.
- Moreover, in bioaugmentation, exogenous microorganisms are mainly used, while in biostimulation, indigenous microorganisms are used. Therefore, this is another difference between bioaugmentation and biostimulation




Bioaugmentation vs Biostimulation
More Information Online
WWW.DIFFERENCEBETWEEN.COM
Bioaugmentation
Biostimulation
DEFINITION
Bioaugmentation is the process of adding specific microorganisms to enhance the existing populations and promote the biodegradation process
Biostimulation is the process of adding electron acceptors, electron donors, or nutrients to stimulate naturally occurring microbial populations in the contaminated area
UTILIZING MICROORGANISMS
Exogenous microorganisms
Indigenous microorganisms
ADDITION
Cultured microorganisms
Nutrients and electron acceptors mainly
DRAWBACKS
The introduced microbe often cannot be established in the environment and these introduced organisms rarely survive in the new environment
Due to contaminant toxicity, the existing microbial population may not be enough for the biodegradation process



Biodegradation strategies of crude oil

The Lecture is over

Thank you