**Battling Pollution with Microbes**

**Introduction:**

Pollution is a worldwide problem. It can affect any human from any age group or gender. Sensitive populations include children, older adults, people who are exposed to open environments more frequently and patients with low immunity. Pollution is defined as “the introduction of contaminants into the natural environment that causes adverse changes”. Pollution can be of various types depending upon its source of origin. It can be in the form of chemical substances or energy such as noise, heat or light. The components that create pollution are termed as pollutants. They can be either foreign substances/ energies or may originate naturally as a result of certain biological activities. (1)

 Our planet has been constantly facing destruction from human activities going on ever since man has learnt to put on fire. The drastic effects of these activities have endangered life and has created many changes since then. Along with other living organisms, microbial world has also been affected. It has been shown I studies that these microbes are so diverse that they can help human battling the pollution and restoring the world. To understand the concept of microbial use in bio remediation, first we have to take a look at the various forms and sources of pollution and what effects does it has on life. The second part of the chapter includes the microbial role in winding this problem in a nature friendly environment.

**Various Forms of Pollution:**

As per the definition of pollution, anything that disturbs the natural environment is a pollutant. It may have a single source of origin or might be the by-product of a productive activity being carried out on the planet. Major forms of pollution are as follows:

* **Air pollution:** It is the release of chemicals directly in to the atmosphere. Over burning of fuel and gas in industry and motor vehicles are the major contributor to this type of pollution. Common gaseous pollutants include carbon dioxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides. Photochemical ozone and smog are created by nitrogen oxides and hydrocarbons react to sunlight resulting in the depletion of the ozone layer around earth. Fine dust also adds its share to create pollution thus living beings find it hard to breath in oxygen proficiently to carry out certain life activities. The origin of air pollution is both human-made and natural sources. However over the past 50 years the human made pollutants from the combustion of fuel either in the motor vehicles or in the industry, construction, mining, agricultural practices and the warfare have fairly added its part to pollute the atmosphere. Motor vehicles, chemical plants, coal-fired power plants, oil refineries, petrochemical plants, nuclear waste disposal activity, incinerators, large livestock’s farms, PVC factories metal and plastic production units and other heavy industry contribute a major part in making the atmosphere contaminated. (1)
* **Littering:** This is related to throwing of inappropriate man-made objects directly in to the environment. Garbage and sewerage expel is one example in this case.
* **Noise pollution:** This form of pollution includes the noise created by the human activities on the planet. The noise created by the motor vehicles, aircrafts and the industrial noise adds health hazards to the living beings around. High intensity sonars also belong to this class of pollutants.
* **Soil Contamination:** this is the result of direct release of harmful chemicals directly in to the soil. This results in the disturbance of the soil pH and the microbial diversity that is meant to keep the soil fertile and productive. The major soil contaminants are the hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons and municipal landfills.
* **Water pollution:** it is the direct discharge of waste chemicals from the industry in to the local water bodies like canals and rivers. The garbage dropped in to the oceans each year is also a water pollutant and it endangers the marine life. Discharge of untreated domestic sewer, pesticides and herbicides are also adding pollution in to the water making it unsafe for living consumption.
* **Thermal pollution:** it is the temperature change of the environment we are living in. burning of fossil fuel and industrial expel is causing greenhouse effect. This has resulted in the ozone depletion and melting of the polar ice which has raised the water level s globally.
* **Plastic pollution:** It includes the accumulation of the plastic products in the environment that is adversely affecting the wild life, wild life habitat or humans.
* Pollution can also be the result of a natural disaster like floods or hurricanes. These menfistaions induce certain contaminants directly in to the environment. Environmental damage is also related with the costal oil rigs and refineries. Other sources of pollution include the nuclear plants and the oil tankers that may cause a wide scale environmental damage under any unfavorable condition or if mishandled. (1, 3)

**Health Effects of Pollution:**

With respect to human health air pollution along with water pollution are the two classes that impose an immediate and drastic effects on the human health. High level of accumulation of pollutants in the air is harmful. Urban smog, particle pollution and toxic pollutants pose a serious health alarm. People exposed to high concentrations of air pollutants may have Irritation of the eyes, nose and throat, wheezing, coughing, chest congestion and breathing problems. There could be cardiac and respiratory complications like hypertension and asthma in patients. Along with these complications, elevated risk of heart attacks are also reported now. Long term exposure to pollutants can cause cancer. It may also result in the damage to the immune, reproductive system, neurological and respiratory systems creating chronic complications.

The water that is usually available for daily consumption is loaded with high levels of heavy metal load and microbial contamination that are the leading cause of gastrointestinal diseases and heavy metal poisoning and ulcers. Several behavioral and mental problems depression, anxiety and fatigue are some to name upon noise pollution. The rise in temperature and UV light of sun are causing rapid changes in the skin resulting in frequent cases of skin cancer and skin burns. (3)

Atmospheric moisture precipitation containing high amounts of nitric acid and sulfuric acid result in **acid rain.** These acids when fall on earth either in the form of wet precipitation such as smog, snow or fog or in the form of dry precipitation such as gas particles, damage trees and erode the soil by changing its pH. Water bodies are also affected by this acid rain making it unsuitable for the fish and other wild life. Another pollution complication arises when sunlight encounters tiny pollution particles suspended in the air and cause **Haze.** This obscures the clarity of the vision.

**Eutrophication** is another adverse manifestation of accumulation of high concentrations of nutrients such as nitrogen in the water bodies. This stimulates the rapid and high growth of the algae. This bloom of algae in turn kills fish and results in loss of plants and animal diversity. Although eutrophication is a natural phenomenon in the aging of the water bodies like lakes and estuaries but the rate at which a water body eutrophication takes place is greatly influenced by the human activities.

Ozone depletion is another major damage that has been caused by the pollution and is adversely affecting humans by causing skin cancers and other associated problems. (3)

**Battling Pollution with the help of Microbes:**

Bioremediation is “the process of using living organisms (e.g., bacteria) to clean up oil spills or remove other pollutants from soil, water, and waste water.” This process largely rely upon the enzymatic activities of the living organisms, usually the microbes to catalyze the destruction of pollutants or their transformation to less harmful forms. Microbes are extraordinary diverse in their properties. Their environment restoration activity is highly based upon factors like ambient environmental conditions, composition of the microbial community, nature and amount of the pollutant present in that particular area. Other factors include pH., temperature, lack of nutrients and molecular oxygen. (2)

There are three categories of pollutants;

* Organic pollutants: these are naturally occurring in the environment and are catabolized by the micro flora of the region naturally.
* Xenobiotics: these are substances which are entirely foreign to an entire biological system i.e. artificial substances, which did not exist in nature before their synthesis by humans.
* Metals: these are released into the environment from the ore extraction and manufacturing.

Microbes are abundant in nature. They are continuously exposed to more and more obstinate xenobiotic (strange, foreign agent/chemical) compounds into the environment. The index of xenobiotic compounds released in the environment are increasing as the industrialization is gaining strength exponentially. It is very essential to combat this pollution for the substance of better future. Like other living organisms, microbes have a high quality of adaptability. Naturally living in such highly polluted environment these microbes are getting used to these compounds and adapting certain changes within their structure that renders them not only survival in harsh conditions but also they are found to be helpful in bio remediation of certain chemicals. The catalytic prospective of microbes is colossal. This has proved to be advantageous for humans to restore back the environment.

Potential microbes with broad variety of activities from their natural habitat have been screened, characterized, genetically modified. They are then released back to their native habitat to do better. Microbes such as algae, fungi and bacteria play a vital role. Degradation of pesticides by different bacterial population has become the best example for microbial role in bioremediation of xenobiotic compounds. A number of pesticides and insecticides like morpholine, methyl parathion, organophosphorus compounds and benzamidazoles are widely used to get a greater yield of crops. They have considerably contributed to the pollution as most of these components are not biodegradable. (4)

 Microbes mineralize the pollutants either by natural selection or by recombinant DNA technology thus making bioremediation process an extension of their normal metabolism. They are also found to mediate the degradation of harmful chemicals like dyes and plastics. Certain species like *Pseudomonas* has characteristics for complete or partial mineralization of morpholine, methyl parathion and other organophosphorus compounds. It is also used in the oil hydration by means of aromatic and aliphatic hydrocarbon degradation. Other species include *Serratia* sp and *Bacillus* sp. That are known to have ability to degrade benzamidazole compounds and to effectively decolorize the distillery and textile mill effluents respectively. (2)

Advanced knowledge about the microorganisms and ability to genetically manipulate the microorganisms and infuse engineering principles into biology have led to innovative combating environmental problems. By the formulation of strains with broad spectrum of catabolic prospective with heavy metal resistant traits making them perfect for bioremediation of polluted environments in both aquatic and terrestrial ecosystems. The transfer of the genetic traits from one organism to another results in the production of Genetically Engineered Organisms (GEOs). They have the potential to combat pollutants in extreme environments. This has turned out to be a hope for clearing the mess man has made. Certain strains are found to consume some of the harmful pollutants from the environment thus acting as a natural cleaning agent. These include iron oxidizing bacterial species found in soil. In addition to this it has been also observed that some of the microbes produce such enzymes that are responsible for the bioremediation of so many chemicals and other related substances. (4)

**Conclusion:**

Human activities are rapidly destroying the environment that support our life. The man-made products are depleting the ozone. Untreated industrial waste is carelessly emitted in the environment. This is sheer in our interest to take care of our planet. Life is for everyone. Pollution is taking its toll due its horrifying nature on our future. If we do not address this now, future holds a dramatic rise in the survival problems. Natural processes of bioremediation are expected to be safe as they are nature guided. But the mess that man has created has gone far beyond the capacitance of nature to handle alone. With the help of modern technologies we have a fair chance to get hold of the destruction that has been made on earth. Recombinant DNA technology has enabled us to produce such strains of microbes that can digest the heavy metals from the environment and reduce the metal load in a certain vicinity. We must educate others and help ourselves to restore the environment for our future generations.

**References**

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