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Overview of Bioremediation Process

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Description

Rising human activity on energy reserves, dangerous farming methods, and rapid industrialization have all contributed to increased environmental contamination in recent decades. Heavy metals, nuclear wastes, pesticides, greenhouse gases, and hydrocarbons are among the contaminants that cause environmental and public health concerns due to their toxicity. Because of its environmentally benign characteristics, bioremediation of polluted places has proven to be effective and trustworthy. Bioremediation can be done *ex situ* or *in situ*, depending on a variety of criteria such as cost, site conditions, and the kind and quantity of pollutants. *Ex situ* procedures appear to be more expensive than *in situ* techniques in general, owing to the higher costs associated with excavation. However, when doing *in situ* bioremediation, the cost of on-site equipment installation and the difficulty to adequately visualize and manage the subsurface of polluted sites are key challenges. As a result, selecting the right bioremediation technique to efficiently reduce pollutant concentrations to safe levels is critical to a successful bioremediation project. Furthermore, bio stimulation and bioaugmentation are two primary techniques of enhancing bioremediation, provided that environmental parameters that impact bioremediation performance are maintained at optimal levels.

Recent breakthroughs in bioremediation techniques have been made in the last two decades, with the ultimate goal of effectively restoring damaged areas in an environmentally benign and cost-effective manner. Researchers have created and modelled various bioremediation approaches; however, no one bioremediation technique acts as a "silver bullet" for restoring damaged habitats due to the nature and/or kind of contaminant. Most of the issues related with biodegradation and bioremediation of polluting compounds can be solved by autochthonous (indigenous) microorganisms found in polluted areas, provided the environmental circumstances are adequate for their growth and metabolism. Bioremediation has a number of advantages over chemical and physical remediation approaches, including environmental friendliness and economic savings. Because of human activities such as urbanization, technological innovation, dangerous farming methods, and rapid industrialization, pollution of the environment continues to rise at an alarming rate. Because of their toxicity, heavy metals introduced into the environment persist, posing a serious threat to species exposed to high amounts of such pollutants. Metals are necessary for plant and animal biological activities, but at high quantities, they disrupt metabolic reactions in organisms' systems. Toxic heavy metals that are not useful to plants, such as Lead (Pb), Cadmium (Cd), Mercury (Hg), Chromium (Cr), Zinc (Zn), Uranium (Ur), Selenium (Se), Silver (Ag), Gold (Au), Nickel (Ni), and Arsenic (As), can reduce plant growth by reducing photosynthetic activities, plant mineral nutrition, and essential enzyme activity [1-3].

At low doses, heavy metals are cytotoxic and can cause cancer in humans. These harmful metals could build up in the body after being absorbed in contaminated food and pose a health danger to living creatures. This results in oxidative stress, which is an imbalance between the creation of free radicals and the ability of cells to eliminate or repair the damage. Base damage occurs as a result of the creation of Reactive Oxygen Species (ROS), which include oxygen radicals (superoxide and hydroxyl) and non-radical derivatives of molecular oxygen (O_2), such as hydrogen peroxide (H_2O_2). The DNA molecule is also broken. Heavy metal toxicity increases the generation of Reactive Oxygen Species (ROS), which reduces the antioxidant mechanisms that protect cells (glutathione, superoxide dismutase, etc.). If this condition persists, the organism's regular functioning will be harmed, which will very certainly result in cell death.

Bioremediation is gradually becoming the standard practice for restoring heavy-metal-contaminated soils because it is more environmentally friendly and cost effective than traditional chemical and physical methods, which are often very expensive and ineffective when metal concentrations are low, as well as producing significant amounts of toxic sludge. Bioremediation is a process for removing pollutants from the environment's ecosystem. It makes use of the biological mechanisms found in bacteria and plants to eliminate harmful contaminants and return the ecosystem to its natural state. The basic principles of bioremediation include modifying pH, redox processes, and adsorption of pollutants from a polluted environment to reduce the solubility of these environmental toxins. The efficiency of bioremediation is determined by a number of factors, including the type of organisms used, the prevailing environmental parameters at the contaminated site, and the level of contaminants present. Microbial bioremediation relies on the metabolic potential of microorganisms to breakdown environmental contaminants and transform them to harmless forms through redox reactions. Plants that bind, remove, and remediate contaminants from the environment can also perform this function (phytoremediation). The amount of contaminated soil, the metal contaminant's bioavailability, and the plant's ability to accumulate metals as biomass are all important factors in the efficacy of phytoremediation as a method of removing heavy metals from polluted soil [4,5].

Conflict of interest

None

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