

BIOREMEDIATION IN THE MARINE ENVIRONMENT

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Contents

1. Introduction
 2. Types of Pollutants in the Marine Environment
 - 2.1. Petroleum Hydrocarbons
 - 2.2. Xenobiotics
 - 2.3. Heavy Metals
 3. Pathways for Bioremediation
 - 3.1. Biodegradation of Petroleum Hydrocarbons
 - 3.2. Biodegradation of Xenobiotics
 - 3.3. Bioremediation of Heavy Metal Pollutants
 4. Genetic Engineering and Bioremediation
- Glossary
Bibliography
Biographical Sketch

Summary

The marine environment is subject to pollution by various chemicals, such as petroleum hydrocarbons, xenobiotics and heavy metals. Bioremediation is a process with which to clean up contaminated sites using biological systems. Microorganisms capable of degrading most of the constituents of crude oil, xenobiotics are present in the marine organism. Generally consortia of microorganisms are necessary to bring about the degradation of complex molecules present in the pollutants. Most bioremediation technologies involve naturally occurring microorganisms and improvement of nutrient conditions and environmental factors for the process of biodegradation. In the case of heavy metals, the process might involve the removal of the pollutant by adsorption, precipitation or transformation. Bioremediation is a new technology that has a lot of potential in decontaminating the marine environment

1. Introduction

One of the major consequences of industrialization has been the pollution of coastal environments. Until recently, the marine environment was regarded as a convenient site for the dumping of waste, under the belief that an unlimited possibility of dilution exists. Waste disposal, rather than waste treatment, was the policy. However, the negative impact of this course of action has now been realized. At the same time, the consumer demand for goods has been increasing many fold, and this is the driving force for the industry. Though industry does not deliberately produce products that are toxic

or hazardous, pollutants are either by-products or residues that result from industries designed to satisfy the public demand for improvements in the standard of living.

Bioremediation is the use of biological treatment systems to completely degrade or reduce the concentration of hazardous pollutants in the environment. Bioremediation technologies are predominantly directed towards the cleanup of sites that have been subjected to pollution. The process generally makes use of naturally occurring microorganisms to metabolize the toxic waste products. This concept of detoxification and mineralization of the pollutants to biomass, CO₂ and H₂O, make it environmentally sound, attractive and potentially a cost effective alternative to the conventional treatments, which rely on incineration, volatilization or immobilization of the pollutant.

2. Types of Pollutants in the Marine Environment

2.1. Petroleum Hydrocarbons

It has been estimated that, annually, six million tons of petroleum reach the sea. The sources of contamination are run-off from the land, off-shore oil drilling, ballast water discharged from tankers, and tanker accidents such as the Exxon Valdez spill that occurred in Prince William Sound, Alaska in 1989. Bulk storage tanks have a layer of water beneath the petroleum, due to accumulation of moisture. When this water is discharged, it will carry petroleum hydrocarbons with it. Gasoline storage tanks could be an important source of pollution, because gasoline has additional chemicals that are added to aid combustion and inhibit engine corrosion. Such chemicals are toxic to microorganisms and are a source of pollution.

2.2. Xenobiotics

Some of the most common xenobiotics are pesticides. Over 1 000 such compounds, such as herbicides, insecticides and fungicides are marketed to control pests. These reach the sea through agricultural or river run-off. A wide variety of chemical types exist among pesticides, such as chlorophenoxyalkyl carboxylic acids, substituted ureas, nitrophenols, triazines, phenylcarbamates, organochlorines and organophosphates. The polychlorinated biphenyls (PCBs) are a major class of organochlorine pollutants, used primarily in industrial dielectric, heat transfer and lubricating fluids. Cyanides and nitriles are another important group of toxic wastes. Cyanide is produced in large quantities for use in metal, particularly, gold extraction, electroplating, polymer, steel and other related industries. Nitriles such as acetonitrile, methacrylonitrile, acrylonitriles are used to synthesize complex organic chemicals, or as monomers in polymer production.

2.3. Heavy Metals

It has been estimated that the mining of mercury ores and the burning of fossil fuels release about 40 000 tons of mercury into the environment every year. Mercury is a widely-used industrial product and is an active component of many pesticides. Other sources of mercury include the electronic industry, particularly battery and wiring production, the chemical industry and the burning of municipal wastes. Apart from

mercury, a number of toxic metals are present in wastes generated by the power generation industry, the combustion of fossil fuels, the metal industry and also in agricultural run-off and sewage.

3. Pathways for Bioremediation

Bioremediation essentially involves the utilization of the metabolic versatility of microorganisms to degrade toxic substances. For example, small-scale oil pollution of the aquatic environment from natural activities has been happening and therefore, it is to be expected that a diverse microbial community capable of degrading hydrocarbons exist in nature. Though xenobiotics are not naturally occurring, halogenated compounds occur in the marine environment, therefore microorganisms capable of degrading xenobiotics are also found in nature. However, at the site of contamination, such microorganisms may not be present in sufficient numbers, or the environmental conditions such as oxygen, nutrient availability etc., may not be at levels, optimal for the biodegradation activity of the microorganisms. The technology of bioremediation involves creating conditions favorable for the degradation of the contaminants by naturally occurring organisms, or introducing microorganisms suitable for the purpose.

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Biographical Sketch

Dr. Iddya Karunasagar took his Masters and Ph.D. degrees in Microbiology from the University of

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