

EMCB-ENVIS

on
Environmental Biotechnology

NEWSLETTER



Department of Environmental Science

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Environmental Biotechnology utilizes variety of organisms to improve environmental quality. These improvements include preventing the discharge of pollutants to the environment, cleaning up contaminated environments and generating valuable resources for human society. This is truly unique as a technical discipline.

Environmental biotechnology is historic and eminently modern. Microbiological treatment technologies developed at the beginning of the 20th century, such as activated sludge and anaerobic digestion. At the same time new technologies are constantly introduced to address contemporary problems, such as detoxification of hazardous chemicals, the development of new crop plants and crop protectants which will influence the use of land and our ability to feed a growing population. The replacement of the “dirty” manufacturing process by clear biotechnological strategies can also be regarded as ecofriendly technology.

On the whole, environmental biotechnology means the specific application of biotechnology to the management of environmental problems. It encompasses aspects of natural resources management, the treatment of waste and control of pollution.

Need of this Study:

Man can not be considered in isolation from his environment. Changes of the relationship between man and his physical environment depend to a large degree of changes in the organization and aims of society. If man is to escape from a situation in which much energy and resources are devoted to correcting past mistakes, his aim must be to build a society that is intrinsically compatible with its environment. The need to control pollution and the desirability of conserving the ecology and genetic richness and also the natural beauty of the Earth should be duly emphasized. The Environmental Biotechnology for balanced development of nature.

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Major Areas of Recent Development

In recent years, considerable development in terms of R&D and its application in “Environmental Biotechnology” has been made around the world. The major areas of application are microbial biodegradation of pollutant, development of new biofuel technology, development of appropriate technology for biofertilizer and biopesticides production and its use in the field of agriculture and also horticultures, production of single cell protein etc.

Future Prospect of R& D and application

Enormous attention is currently paid on enhanced activities in terms of R&D and its application in Biotechnology. The study of pollutant degradation and detoxication process in industrial sector in particular is of paramount importance.

NEWS

Environmental Information System (ENVIS) was established in 1984 as a network of Information Centres. ENVIS is a network of information planned by the Ministry of Environment and Forest, Government of India, New Delhi on different subject areas. EMCB-ENVIS on Environmental Biotechnology was established at the Department of Environmental Science, University of Kalyani, Nadia-741235, West Bengal in June 2002. This is the first newsletter of our ENVIS Centre published to highlight the current topics of interest on the concerned subject.

Biotechnology Policy in West Bengal

Since 2002, Department of Science and technology, Department of Commerce and Industries, Govt. of West Bengal are involved in ensuring scientific and technological improvement of West Bengal’s human resources. Their aim at creating a strong infrastructure both for research and commercialization on biotechnology. They intend to launch a major well directed effort for generation of products, process and technologies to enhance the cost effectiveness and productivity of agriculture, modern medicine, pollution control, biodiversity conservation and bioindustrial development.



Inauguration

The centre was formally inaugurated by Prof. Nityananda Saha, Honorable Vice-Chancellor, University of Kalyani, in July 9th, 2002 at the Department of **Environmental Science**, University of Kalyani, Nadia, West Bengal. This function was well attended by eminent personalities of the University.

Current Activities

- ?? Database creation on Environmental Biotechnology on the areas of :
 - ☞ Conventional Waste Water Treatment Strategies Using Biosystem
 - ☞ Biotechnological Methods of Pollution Detection
 - ☞ Biotechnological Methods of Pollution Abatement
 - ☞ Biotechnology and Biodegradation
 - ☞ Biohydrometallurgy and Biomining
 - ☞ Genetically Engineered Microbes in Biotreatment of Wastes and Environmental Safety
 - ☞ Eco-friendly Bio-products for Environmental Health
 - ☞ Environmental Biotechnology in the 21st Century.
- ?? Transfer of database to website for user purpose;
- ?? Collection of new items for publication in newsletter of ENVIS Centre;
- ?? Establishment of linkage between R&D Institutes and user agencies (both national and International)

Future plan

Creation of newsletter in regional language for promotion of knowledge base on the subject concerned.

BIOREMEDIATION IN THE PERSPECTIVE OF ENVIRONMENTAL POLLUTION ABATEMENT

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Environmental pollution abatement by using microbes and higher organisms is now a very widely accepted means, which is often referred to as "Bioremediation" or "Biotreatment". Land and water pollution caused by industrial effluents or air pollution caused by industries, transportation or by anthropogenic activities could be ameliorated in a much better way by biotreatment processes. Stress tolerant microbes or higher organisms either degrade the toxicants or absorb the toxicants and transform them into non-toxic organic forms. Now in most of the polluting industries, there are combined process of chemical and biological treatment facilities. This process is efficient and ecofriendly.

A good number of trials have been made currently in different industries for removal of phenols, cyanide, furfural compounds by using different categories of microbes. Similarly macrophytic plants were capable of treatment of waste water in terms of removal of BOD, COD, nitrate and phosphate. Some *in-vitro* trials have been made for screening of tolerant plant species suitable for field application in constructed wetland. Bioleaching of metals from industrial sludges was also attempted for recovery of precious metals.

Screening of tolerant microbes or higher organisms suitable for different types of bioremediation processes followed by appropriate designing of biotreatment facilities like ETP or BOD plant is a very important aspect of commercial application. In the long run genetic modification of organisms may also be required for more efficient and effective treatment/abatement processes.

Bioremediation is defined as the use of microorganisms or green plants to remove pollutants from the environment or to renders them harmless. Several comprehensive reviews have been written on this subject, summarizing many important aspects of this novel technology (Chaney et al 1997, Cunningham and OW, 1996; Salt et al,1995). The basic idea of use of microorganisms or plants for environmental remediation is very old and can not be traced to any particular source. However, a series of fascinating scientific researches combined with an interdisciplinary research approach have allowed the development of this idea into a promising, cost effective, and environmentally friendly technology. This technology can be applied to both organic and inorganic pollutants, present in solid substrates (e.g soil) liquid substances (e.g water) and the air. On the whole, the broad areas of bioremediation can be discussed (with some experimental data) into the following areas:

Bioextraction / Phytoextraction: The use of pollutant accumulating microbes or plants to remove metals or organics from soil by concentrating them in the harvestable parts.

Biodegradation: The use of plants and associated microorganism to degrade organic pollutants;

Rhizofiltration: The use of plant roots to absorb or adsorb pollutants, mainly metals, from water or aqueous waste of streams;

Phytostabilization: The use of plants to reduce the bioavailability of pollutants in the environment;

Volatilization: The use microbe or plants to volatilize pollutants;

Airsink: The use of plants to remove pollution from air either as a site of particulate filter or as a pollutant gas sink.

Among these phytoextraction of metals, biodegradation of aromatics and other organics is a very common technology often adopted commercially in many countries.

Bioextraction, Phytoextraction, Bioremediation: There are two basic strategies of phytoextraction / bioextraction that are currently being developed: (a)Chelate assisted phytoextraction (i.e induced phytoextraction) and (b)long-term continuous phytoextraction. There are very few reliable reports of natural bioaccumulation of toxic metals like lead, cadmium, arsenic and radionuclides etc. by different plant species. But it was possible to demonstrate that acceleration of accumulation of such metal like,

cadmium, nickel, zinc, copper etc. is seen after addition of EDTA/EGTA or some organics like citrate in the field condition (Blaylock et al 1997). On the contrary there are a couple of plants which are capable of accumulating metals on a long term basis as hyperaccumulation forms, though the ecological role of such metal hyperaccumulation is unclear. However plants must possess an efficient mechanism for the detoxification of the accumulated metal. There are a few mechanisms of metal detoxification by the resistant species, these are chelation, compartmentalization, biotransformation, and cellular repair mechanisms. Chelation of metal ions by specific high affinity ligands reduce the solution concentration of free metal ions. Two major classes of heavy metal chelating peptides are known to exist in plants, metallothioneins and phytochelatins. Metallothioneins are gene encoded low molecular weight cysteine rich polypeptide found in many tolerant plant species (Robinson et al 1993, Salt et al), and phytochelatins are low molecular weight, enzymatically synthesized cysteine rich peptides known to bind cadmium and copper in plants (Rausser; 1990, 1995, Robinsan et al 1993, Steffens, 1990).

In addition, metal may be redistributed and accumulated in various cellular compartments either in bound forms or precipitate as salts. Sometime toxic metals like chromium, selenium and arsenic can be reduced in plants by chemical reduction of the element and / or by its incorporation into organic compounds (Ortiz et al, 1992, 1995). However there are couple of plants which are able to volatilize metals viz selenium, arsenic or even mercuric ions (Zayed and Terry, 1992, 1994).

The use of plants to cleanse water contaminated with organic and inorganic pollutants dates back hundreds of years and has been the basic for the present use of constructed wetlands in treating municipal and industrial waste streams (Hastman, 1975). In addition, the role of rhizospheric microorganisms in detoxification processes can not be ignored (Walton et al 1994).

CASE STUDIES: At present phytoremediation of metals and organic may be approaching commercialization. A good number of field trials has already been made; only the future can tell whether bioremediation will become a widely accepted technology. However it is clear that the utilization of the remarkable potential of green plants to accumulate elements and compounds from the environment and to perform biochemical transformations is becoming a new frontier of plant biology. Some applications of field sample of waste-water treatment by micro-organisms were described in recent years. In tannery industry, wastewater contain very high amount of hexavalent chromium. In recent years, several chromium resistant microorganisms have been isolated from diversified environment. Biosorption and biotransformation of Cr(VI) to nontoxic Cr(III) was reported in several cases (Bhide et al, 1996; Luli et al 1983; Ul-Haq and Shakoon, 1998, Das and Santra, 2001).

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