ENVIS CENTRE ON ENVIRONMENTAL BIOTECHNOLOGY

SUPPORTED BY:

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

GOVERNMENT OF INDIA, NEW DELHI

VOLUME-31 ISSN : 0974 2476 DECEMBER, 2017

BIOTECHNOLOGICAL ASPECTS FOR ENVIRONMENTAL HEALTH CARE

DEPARTMENT OF ENVIRONMENTAL SCIENCE, UNIVERSITY OF KALYANI, NADIA, WEST BENGAL

Email: desku@envis.nic.in, Phone: +91-33-25828750, Ext :272

Fax : +91-33-2582 8282, Website: http://www.deskuenvis.nic.in

INSTRUCTIONS TO CONTRIBUTORS

ENVIS Newsletter on Environmental Biotechnology is a half-yearly publication publishes articles related to the thematic area of the ENVIS Centre. Popular or easily intelligible expositions of new or recent developments are welcome.

Manuscripts should be typewritten (font should be Times New Roman and font size ought to be 12) on one side of the paper in double spacing with maximum of 6-8 typed pages.

Figures and typed table should be in separate pages and provided with title and serial numbers. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

The Coordinator
ENVIS Centre
Department of Environmental Science
University of Kalyani, Kalyani-741235
Nadia, West Bengal
Email: **desku@envis.nic.in**
ddas_kly@rediffmail.com

EDITORIAL

The increasing global population is now a big challenge towards providing food, water, energy, shelter and health services. The modern society people are expects a higher standard of living. These need must be met in a sustainable and environment friendly manner. Biotechnology paves the way to many new opportunities for meeting those challenges. The biotechnology will lead to more accurate methods for prevention and treatment of physiological, environmental health, food, energy and industrial production in more sustainable and eco-friendly ways. Since, rapid industrialization, urbanization and other developments have been resulted to a threatened environment and depleted natural resources, the application of environmental biotechnology protects the environment from the current problematic scenario. Environmental biotechnologies are also used to find new ways to reduce economic and environmental impacts from the overuse of natural resources and protect environmental health.

IN THIS ISSUE:

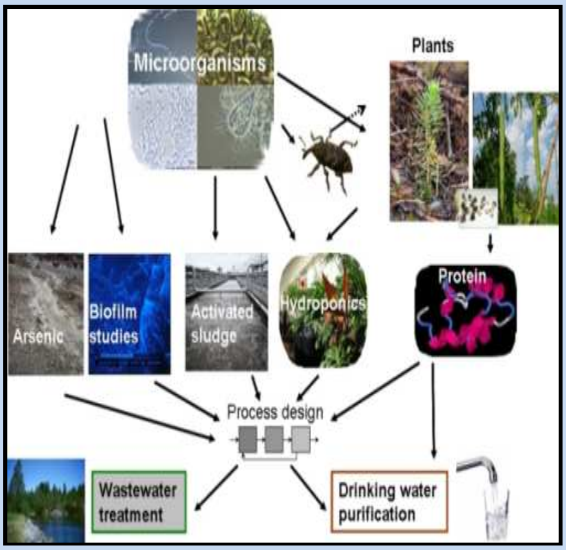
Biotechnological aspects for Environmental Health Care

INTRODUCTION

Biotechnology is an integrated, multi disciplinary field that focuses on the mechanics of life processes and their application. It has been around almost since the first time humans began domesticating plants and animals. Depending on the tools and applications that are developed; it helps to modify the products or processes for a particular use.

Biotechnological processes to protect the environment have been used for almost a century now, even longer than the term 'biotechnology' exists. Environmental Biotechnology, a sub discipline of Biotechnology is the application of biotechnology used to study the natural environment. It is useful in treating waste water and preventing pollution. Environmental pollution is one of the major challenges faced by environmental biotechnologists. It deals with detoxification of waste and industrial effluents, treatment of sewage water, and control of plant diseases and insects through the use of biological agents, such as viruses, bacteria, fungi etc. The increase in population and industrialization, issues associated with agriculture (such as erosion of fertile soils and over usage of chemical pesticides), accidental-intentional release of hydrocarbons in sea and land (oil spills), generation of electronic/electrical waste releasing endocrine disruptors, and uncontrolled use of antibiotics both as medicine and in meat industries are few reasons among others.

People have used yeast, for example, to make unleavened bread, beer and alcohol for centuries. Farmers have been selectively breeding animals and "hybrid" crops for decades, and bacteria have long been used to modify food (e.g., creating cheese and yogurt from milk). Bacteria and other microorganisms have been used for years to "treat" environmental contamination in soil and groundwater, and other microbial processes have been employed in sanitary sewer systems. In short, selective breeding has long been used to enhance the natural characteristics of food, plants and animals (Fig.1).



Source:https://saferenvironment.wordpress.com

Fig: 1 Process of Environmental Biotechnology

What is Environmental Health?

Environmental health is focused on the natural and built environments for the benefit of human health, whereas environmental protection is concerned with protecting the natural environment for the benefit of human health and the ecosystem. Research in the environmental health field tries to limit the harmful exposures through natural things such as soil, water, air food, etc

Environmental health entails grasping the effects of environment and human-made vulnerabilities/ hazards and insulation of human health and environmental systems from these hazards. This involves examining and evaluating the effects of chemicals made by humans to human health or wildlife and how the ecological systems impacts spread of illnesses. It can include everything from managing the use of pesticides to the quality of drywall used in construction.

It is a healthcare area that is gaining increasing attention around the world as there are more studies proving that the impact of environmental health extends beyond the individual and can determine the cost of public health care and the health of the local economy. In short, environmental health is the study of how environmental factors can harm human health and how we can identify and control such effects. Environmental health also address issues related to:

- ✓ Air Pollution
- ✓ Climate Change
- ✓ Exposure to toxic chemicals
- ✓ Solid Waste Management which includes recycling facilities, landfills and composting.
- ✓ Management of medical waste such as mitigation of dangerous materials from finding way to the ecological system.
- ✓ Hazardous Materials Management.

Common applications and processes

The following list shows some of the more common applications

In Aquaculture

Disease outbreaks are a serious constraint to aquaculture development. Fishes in culture are susceptible to a wide range of bacterial, viral, parasitic and fungal infections, and losses through disease. Disease control and health management in aquaculture are different from the terrestrial livestock sector, particularly due to the fluid environment. Disease occurs in all systems, from extensive to intensive, and losses are possible in all types of production systems. There is a need for better management of intensive systems, and biotechnologies are being used for this purpose (Fig.1).

Biotechnology can have a direct positive impact on many of the main elements of fish health management, with knock-on effects on other important issues. Rapid detection and identification of pathogens, for example, is crucial for effective disease management considering the interplaying genetic, nutritional and environmental factors and this, in turn, leads to a reduction in the use of antibiotics and chemicals in the environment; prevention of disease by vaccination significantly reduces antibiotic use .

Source: https://marinebiotechnology.umbc.edu

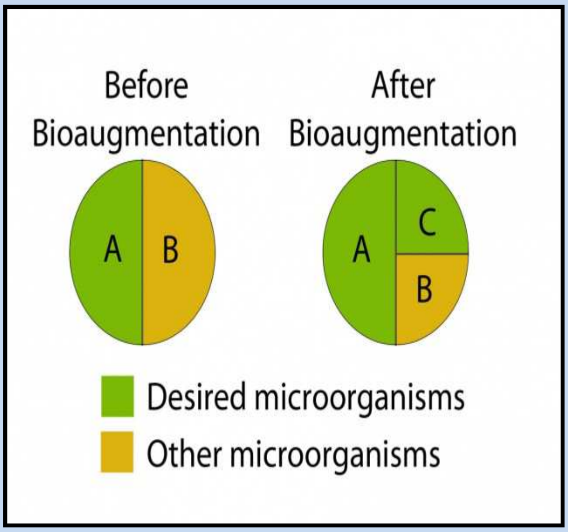
Fig: 2 Aquaculture and Fisheries

Reducing the environmental impacts of aquaculture is a significant task. Aquaculture is often accused of being unsustainable and not environmentally friendly. Reducing the impacts of effluent discharge, improving water quality and responsible use of water are key areas to be considered in aquaculture development. Some biotechnologies are being used to address these areas, including bioremediation for the degradation of hazardous wastes and use of DNA-based methodologies for the early detection of toxin-producing algae.

Some of the approaches suggested include rapid detection and avoidance of the pathogen, biocontrol of the pathogen, immunoprophylaxis through vaccines and immunostimulants and bioremediation of the environment. Biotechnological approaches show promise to improve the health of cultured fish and shellfish and improve aquaculture production, while safeguarding the environment.

Bioaugmentation

Biological augmentation is the addition of archaea or bacterial cultures required to speed up the rate of degradation of a contaminant (Fig.3). Organisms that originate from contaminated areas may already be able to break down waste, but perhaps inefficiently and slowly. Bioaugmentation is a process where selected, standardized bacteria (microbes) are added to an area that has been contaminated with an unwanted substance. These bacteria breakdown the contaminants. It has many applications in all types of biological wastewater treatment systems, including once-through lagoons, activated sludge plants, sequencing batch reactors (SBR's) and rotating biological contactors (RBC's).



Source:http://www.alpha-bioenergy.com/

Fig: 3 Bioaugmentation

Bioaugmentation has been proven successful in cleaning up of sites contaminated with aromatic compounds but still faces many environmental problems. Both abiotic and biotic factors influence the effectiveness of bioaugmentation (Cho et al., 2000; Bento et al., 2005; Wolski et al., 2006). It is commonly used in municipal wastewater treatment to restart activated sludge bioreactors. Most cultures available contain microbial cultures, already containing all necessary microorganisms (*B. licheniformis*, *B. thuringiensis*, *P. polymyxa*, *B. stearothermophilus*, *Penicillium* sp., *Aspergillus* sp., Flavobacterium, Arthrobacter, Pseudomonas, Streptomyces, Saccharomyces, Triphoderma, etc.). Activated sludge systems are generally based on microorganisms like bacteria, protozoa, nematodes, rotifers, and fungi, which are capable of degrading biodegradable organic matter. There are many positive outcomes from the use of bioaugmentation, such as the improvement in efficiency and speed of the process of breaking down substances and the reduction of toxic particles in an area.

Applications

- ✓ Papermill, Gun Powder plant, Cookie factory, Vegetable processing plant, Textile.
- ✓ Food and Beverage- Dairy Products, Wineries, Orange Juice factory,
- ✓ Ornamental Pond for algae control, Nursing home lift stations and kitchen drains
- ✓ Steel Mill, Animal Feed lot, Palm Oil
- ✓ Municipal wastewater treatment plants, Grease, Filaments, Sludge reduction
- ✓ Municipal Lift Stations
- ✓ Barbecue Restaurant,
- ✓ Nitrification recovery
- ✓ Industrial- Food, Paper, Chemical, Refinery, Animal Feed lots, etc.
- ✓ Landfills
- ✓ Agriculture
- ✓ Hospital and Hotel, Marine Environmental
- ✓ Home septic, Salt water Environments
- ✓ Ponds,golf courses and ornamentals
- ✓ Fish and Shrimp Farming

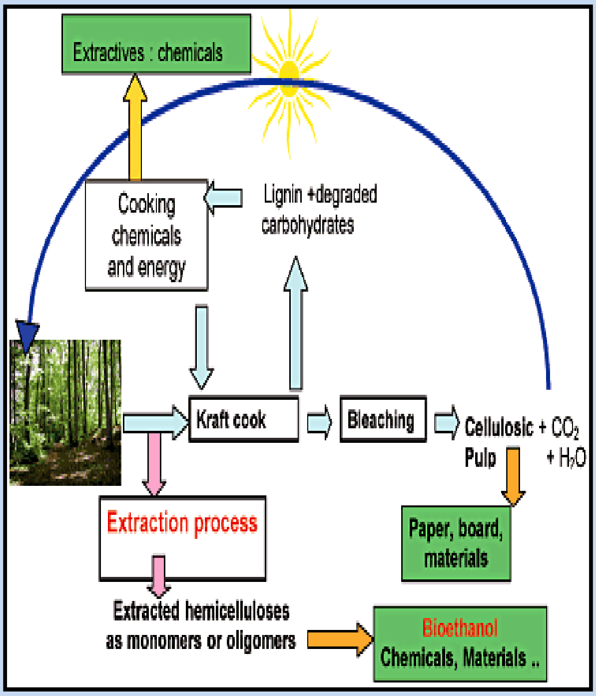
Biobleaching

The worldwide charm of environmental friendliness has resulted in the development of innovative biotechnological processes in various processing industries. Biotechnology seems to be a major player in solving the major problems of pollution created by these industries. A vast pulp and paper industry exists around the world to supply an ever increasing demand of multitude of paper products. Paper manufacturing industries are considered to be the worst offenders as far as deteriorating health of the environment are concerned. Organochlorine compounds, mainly produced by reactions between residual lignin present in pulp and chlorine used for bleaching, have found to be toxic, mutagenic and nondegradable. This causes significant harm to the environments and release of spent liquors in water bodies represents the most important environmental problem posed by the pulp and paper industry.

Biobleaching involves using microorganisms and enzymes for bleaching pulp. It relies on the ability of some microorganisms to depolymerize lignin directly and on the use of microorganisms or enzymes that attack hemicellulose and hence favour subsequent depolymerization. Biobleaching does not result in a high brightness, but reduces the strength, costs and in particular the contaminating effects of the subsequent conventional chemical bleaching.

The application of enzymes has a high potential in the pulp and paper industry to improve the economics of the paper production process and to achieve, at the same time, a reduced environmental burden. Specific enzymes contribute to reduce the amount of chemicals, water and energy in various processes.

At present, enzymes are being considered as only partial replacements for chemicals, but there is hope that as the mechanisms of enzymatic treatment are elucidated, refinements in the process may allow enzyme assisted "Total Chlorine Free" (TCF) bleaching sequences to become an effective and economic method of pulp treatment (Fig.4).



Source: http://cerig.pagora.grenoble-inp.fr

Fig: 4 Kraft biorefinery mil

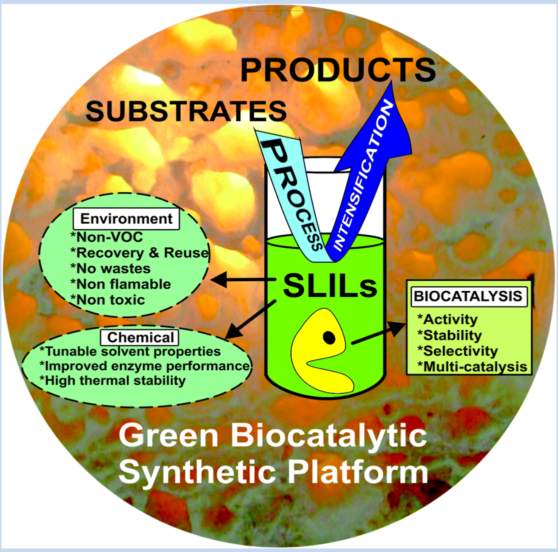
Biocatalysis

Biocatalysis is the application of enzymes and microbes in synthetic chemistry, and uses nature's catalysts for new purposes: applications for which enzymes have not evolved (Buchholz, et al., 2012; Drauz, et al., 2012; Bornscheuer, Kazlauskas, 2006 and Liese, et al., 2006).The field of biocatalysis has reached its present industrially proven level through several waves of technological research and innovations. Biocatalysis has been used widely in the pharmaceutical industry to make small molecule drugs. Biocatalysis, either using whole microorganisms or just enzymes (known as white biotechnology), is implicated in many spheres of human activity in terms of:

- environmentally friendly processes;
- the limited opportunities for the production of renewable and clean energies; and
- remediation of many compounds that are unfriendly or even toxic to the environment by the present ecological standards of our societies.

Modern biocatalysis is developing new and precise tools to improve a wide range of production processes, which reduce energy and raw material consumption and generate less waste and toxic side-products. Biocatalysis is also achieving new advances in environmental fields, from enzymatic bioremediation to the synthesis of renewable and clean energies and biochemical cleaning of 'dirty' fossil fuels.

The pace of application of biotechnology in the chemical industry is increasing, as the scientific and technological progress of the last decade has established biocatalysis as a practical and environmentally friendly complement to classical synthetic chemistry (Bornscheuer, et al., 2012). Todays chemical and pharmaceutical industry considers biocatalysis as a valuable tool: Enzymes are used to carry out chiral resolutions (Simeonov., et al., 2016; Sepelgy., 2016) for the manufacture of chiral alcohols and amines and, where possible, to help circumvent protection and deprotection chemistry, thus shortening process routes and consequently saving costs. The use of cheap raw materials or (agricultural) waste products in enzymatic processes is an additional way of creating value (Fig.5).



Source: http://pubs.rsc.org/en/content/articlehtml/
Fig: 5 Key aspects for the green synthetic platform based on biocatalysis

Biodetergent

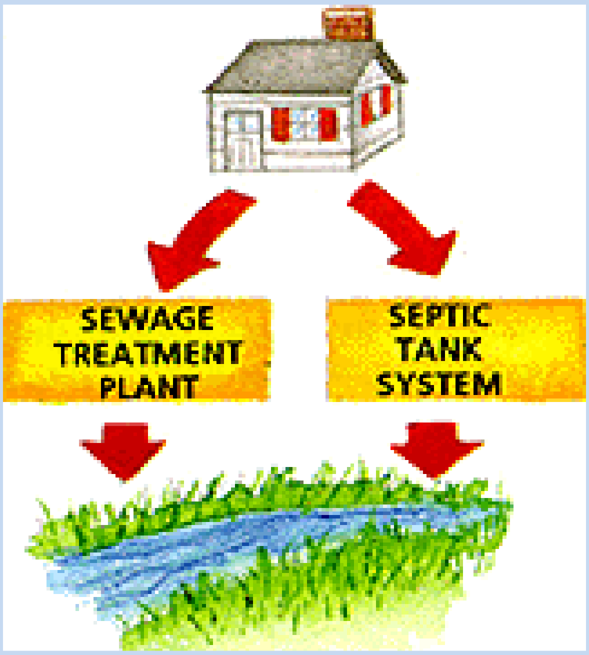
A biological detergent is a laundry detergent that contains enzymes harvested from micro-organisms such as bacteria adapted to live in hot springs. Biological detergents clean in the same way as non-biological ones with additional effects from the enzymes, whose purpose is to break down protein, starches and fat in dirt and stains on clothing to be laundered, for example food stains, sweat and mud.

Most household cleaning products are formulated to be used with water and "go down the drain" into wastewater treatment systems (municipal sewage treatment plants or septic tank systems). To assure that products are safe for the environment, manufacturers evaluate the impacts of product ingredients in wastewater treatment systems, streams, rivers, lakes and estuaries (Fig.6).

Biological detergents contain enzymes that help break down the fatty, greasy, and starchy compounds that are found in some of the most common clothing stains such as pasta sauces, bike oil, and hamburger grease. These enzymes work to lift the stains out of fabrics, making them excellent stain removers and a very welcome addition to laundry detergents, turning stain removal into a quick and easy task.

The soap and detergent manufacturers can contribute to the enhancement of human health and quality of life by adopting responsible formulations and through the production and sale of environment friendly cleaning products & ingredients. Some initiatives, which soap and detergent manufacturers can take for environment / health sustainability are -

- ✓ To only market products, which have proved to be safe for humans and the environment
- ✓ While production, the manufacturers should carefully consider the potential health and environmental effects, exposures and releases, which will be associated with the production, transportation, use and disposal of different cleaning products
- ✓ To encourage and promote transparent communication of safety and handling information
- ✓ To facilitate basic research to resolve uncertainties around human and environmental safety when they arise
- ✓ To follow the spirit and intent of all national laws and regulations

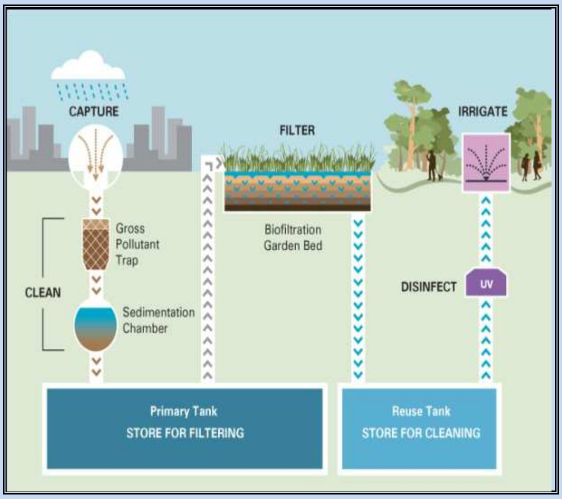


Source: http://www.cleaninginstitute.org/
Fig: 6 Process of biodetergent flow to environment

Biofiltration

Biofiltration is a pollution control technique using a bioreactor containing living material to capture and biologically degrade pollutants. Common uses include processing waste water, capturing harmful chemicals or silt from surface runoff, and microbiotic oxidation of contaminants in air.

Biofilters are an odor treatment technology that utilizes biological processes as the treatment mechanism. Biofiltration utilizes microorganisms in media to oxidize odor and air emission compounds to carbon dioxide, water, biomass, and other benign by-products such as chloride and sulfate. The by-products are emitted in the outlet air, drained from the biofilter, or consumed by the microorganisms. The biological activity in a biofilter is similar to the activities performed by the microorganisms in activated-sludge secondary wastewater treatment processes (Fig.7).



Source:http://urbanwater.melbourne.vic.gov.au

Fig: 7 Biofiltration

Biofiltration is not suitable for highly chlorinated organics, aliphatics, amines, and aromatic compounds. Heavy metals and organic chemicals may kill the microorganisms. Heavy metals and non-biodegradable organics may also concentrate in the sludge. Hydrogen sulfide gas may also be released. It helps in:

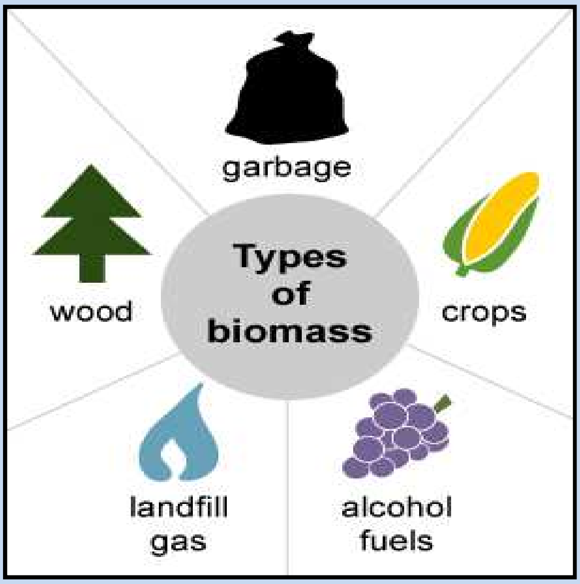
- ✓ Control of air pollution
- ✓ Water treatment
- ✓ Drinking water
- ✓ Wastewater
- ✓ Use in aquaculture

Bioenergy

Bio-Energy is often referred to as alternative energy, green energy, renewable energy, renewable power sources, sustainable energy, etc. It is renewable energy obtained from biological materials derived from biological sources. Bioenergy consists of organic matter derived from plants, crops or from human, animal, municipal and industrial wastes (Meshram and Mohan, 2007). The energy derived from biomass to generate electricity and heat or to produce liquid fuels for transport. Organic material containing bioenergy is known as biomass. It can be used to generate electricity, produce heat, and also for the production of Bio-fuels. Energy is released by either direct burning or by creating a liquid-based fuel for transportation, such as ethanol and biodiesel.

Energy has been the major aspects in the evolution of civilization, and the fossil fuels are the main component of industrial revolution. So, the need for renewable alternative source of energy generation is need of the day. In recent, bioenergy provides about 14% of global primary energy, although the share in some developing countries can be as high as 90%. Energy, especially from fossil fuels, is a key ingredient for all sectors of a modern economy and plays a fundamental role in improving the quality of life in less developed economies. Among various options available for bioenergy, biodiesel, bioethanol and biomass gasification are three major options, which have huge potential to develop as energy sources.

Human can use this biomass in many different ways, through something as simple as burning wood for heat, or as complex as genetically modifying bacteria to create cellulosic ethanol. Since almost all bioenergy can be traced back to energy from sunlight, bioenergy has the major advantage of being a renewable energy source. Traditionally mainly woody biomass has been used for bioenergy, however more recent technologies have expanded the potential resources to those such as agricultural residues, oilseeds and algae. These advanced bioenergy technologies allow for the sustainable development of the bioenergy industry, without competing with the traditional agricultural industry for land and resources (Fig.8).



Source: Adapted from The National Energy Education Project (public domain)

Fig: 8 Types of biomass

Bioenergy production and use have both positive and negative environmental and socio-economic consequences. Bioenergy refers to products of biomass that have been converted into liquid, solid or gas form, depending on the raw material base and the technology employed, for energy generation.

Table. Comparison of some sources of biodiesel

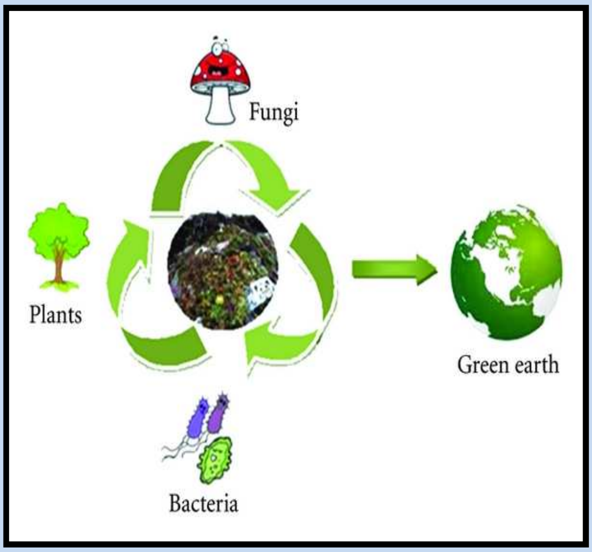
Crop	Oil yield (L/acre)
Corn	68.13
Soybean	181.68
Sunflower	386.07
Rapeseed	480.69
Canola	495.83
Jatropha	788.33
Oil palm	2403.47
Microalgae	19000-57000

Source: Bajhaiya, et. al., 2010

Bioremediation

Bioremediation involves the use of naturally existing microorganisms to speed up the breaking down of biological substances and degradation of various materials. It deals with the problems related to the environment. The application of biotechnology helps in the environmental management of such hazardous contaminants by bioremediation. This process is also referred to as bio-restoration or bio-treatment.

It is a clean-up technology that uses naturally occurring microorganisms and plants to degrade hazardous substances into less toxic or nontoxic compounds. The microorganisms may ingest and degrade organic substances as their food and energy source and degrade organic substances that are hazardous to living organisms and natural environment (Fig.9).



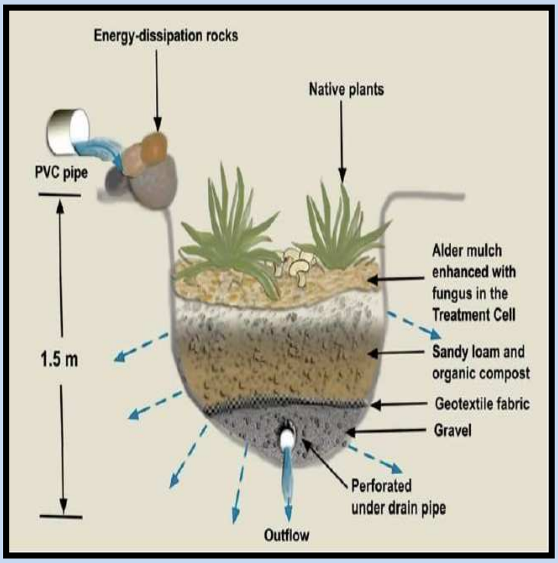
Source: https://www.hindawi.com

Fig: 9 The process of waste bioremediation.

Types of Bioremediation

a) Mycoremediation:

This is a type of Bioremediation; fungi are used for the process of decontamination. The use of fungal mycelia in bioremediation is called Mycoremediation. The role of the fungus in the ecosystem is to perform the work of braking down the organic substances into much smaller and simpler materials. The mycelium helps in braking down the substances and they secrete extracellur enzymes and acids that brakes lignin and cellulose; these are building blocks of plant fiber. The key function of Mycoremediation is to target the right fungal species for a specific pollutant (Fig.10).

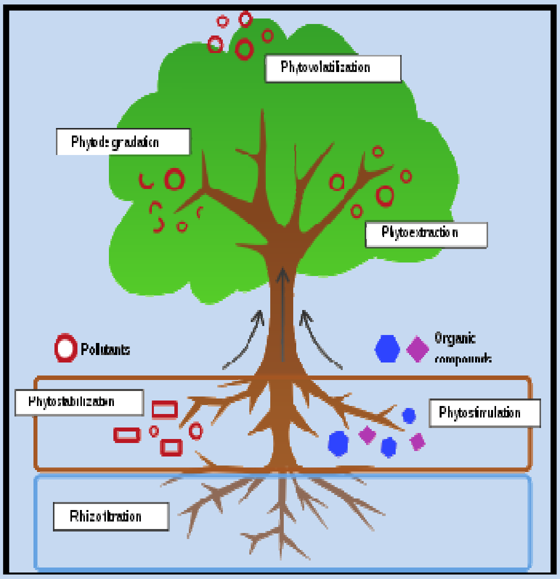


Source: http://plangreen.net

Fig: 10 Cleaning Soils and Water

b) Phytoremediation:

The direct use of the green plants and their microorganisms used to balance or decrease the contaminated soils, sludges, sediments, surface water or ground water is called Phytoremediation. This type of bioremediation explains a way of treating the environmental problems with the help of plants (Fig.11).



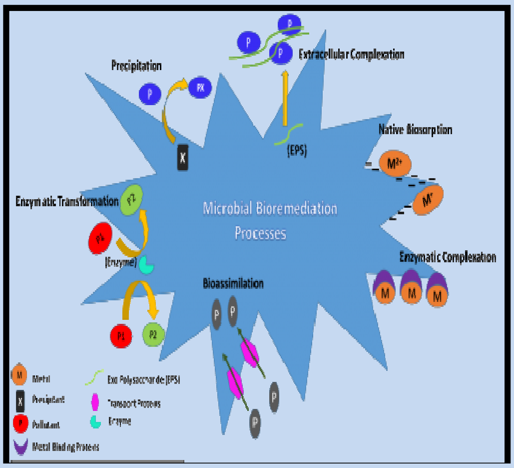
Source: https://en.wikipedia.org

Fig: 11 Phytoremediation

C) Microbial Remediation

The use of microorganisms to degrade organic contaminants and to bind the use of metals in less bioavaliable form is called Microbial Remediation. When the microbes need oxygen to perform its process is in the case of aerobic condition.

In case of anaerobic conditions the microbes perform their work without the presence of oxygen the chemical compounds present in the soil helps the anaerobic to perform its duties efficiently (Fig.12).



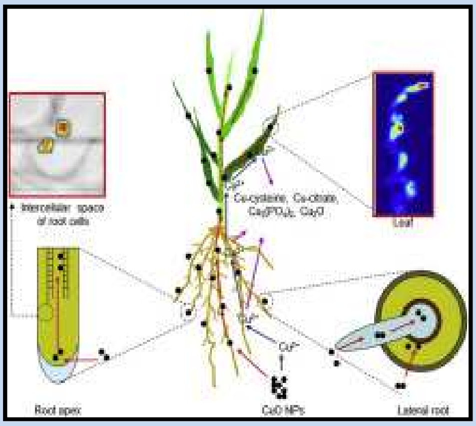
Source:https://www.projectguru.in

Fig: 12 Different metabolism pathways in microbial remediation

Biotransformation

This is a process of Biological changes of complex compound to simpler toxic to non-toxic or vice-versa. Several microorganisms are capable of transforming a variety of compound found in nature but generally with respect to synthetic compound they are unable to show any appropriate action (Fig.13).

- ✓ It is used in the Manufacturing sector where toxic substances are converted to Bi-products.
- ✓ The conversion of molecules from one form to another within an organism.
- ✓ in pharmacologic activity refers especially to drugs and other xenobiotics.



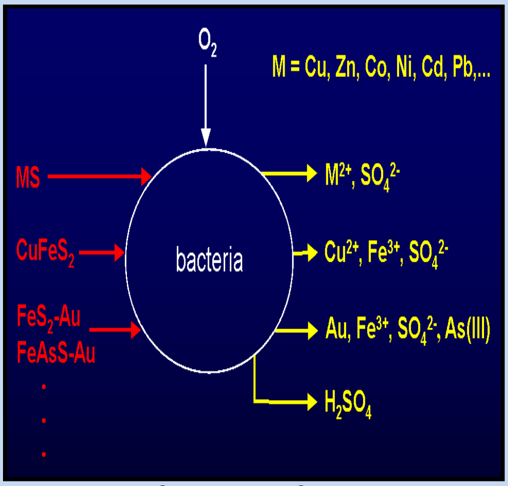
Source: http://www.sciencedirect.com

Fig: 13 Biotransformation

Biomining

Biomining is a method of extracting minerals and metals from their parent ores using naturally occurring biological processes. The practice requires none of the environmentally damaging processes found in conventional refinement methods and instead relies entirely on the natural interaction of biological organisms (Fig.14).

Traditional mining is an especially toxic process involving the use of chemicals like cyanide. Although the process of biomining does not yet completely eliminate the use of harmful chemicals, it allows for a lessened use, resulting in lower production costs of cleaning up the mining processes. Microorganisms are used to leach out the minerals, rather than the traditional methods of extreme heat or toxic chemicals, which have a deleterious effect on the environment. This technology is also environmentally friendly as it generates minimal amount of pollutants. It is a very low capital, low operational cost, and a low energy input process. It has the added benefit of mining low grade ore and/or mine tailings. It is used to recover the various types of minerals from ore using microorganism. Biomining method is cheap, reliable and efficient method of mineral recovery. Using biotechnology efficiency of biomining can be increased by using genetically modified microorganisms. Biomining is done in two steps known as **bioleaching** and **biooxidation**.



Source: http://orion.chemi.muni.cz

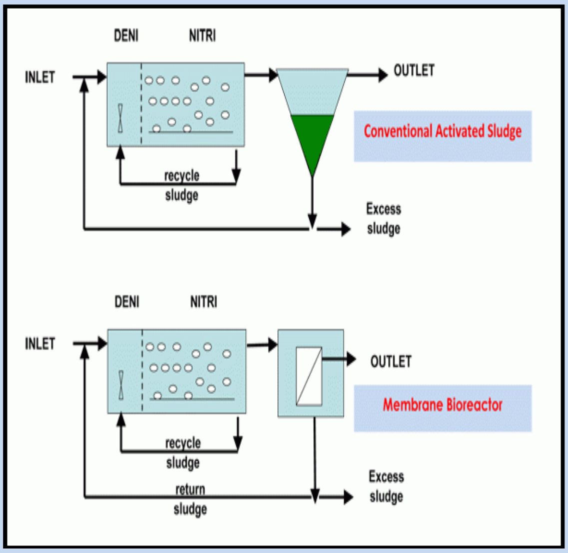
Fig: 14 Biomining

Environmental toxicity amelioration

❖ Waste water by Activated sludge process

The quality of our water resources is deteriorating day by day due to the continuous addition of undesirable chemicals in them (Lvovich, 1979). The main sources of water contamination are industrialization, civilization, agricultural activities and other environmental and global changes. Few hundred organic pollutants have been found contaminating water resources. The contamination due to organic pollutants is very dangerous due to their various side effects and carcinogenic nature (Yang, 2011).

The activated sludge process was discovered in 1913 for treatment of domestic wastewaters. The activated sludge process uses a mass of microorganisms (usually bacteria) to aerobically treat wastewater. Organic contaminants in the wastewater provide the carbon and energy required to encourage microbial growth and reproduction; nitrogen and phosphorus are sometimes added to promote this growth. The organic matter is converted into microbial cell tissue and carbon dioxide by thoroughly mixing the wastewater with air in an aeration tank. Several Countries are willing to use activated sludge process for the treatment of both municipal and industrial wastewaters (Fig.15).



Source: http://www.tristarwater.com.au

Fig: 15 Waste water by Activated sludge process

❖ Bioremediation of contaminated soil

Bioremediation is the a biological degrading processes for the treatment of contaminated soils, groundwater and/or sediments, relying on microorganisms including bacteria and/or fungi to use the contaminant(s) as a food source with resulting degradation of the contaminant.

Contaminated soils may be bioremediated by in-situ techniques, landfarming, composting or in slurry bioreactors. Anaerobic biodegradation may offer an effective alternative to aerobic in-situ bioremediation for some compounds. Chlorinated aliphatic and hetercyclics have been degraded anaerobically. Peholeum hydrocarbons are the most easily bioremediated compounds. White rot fungus Phanerochaete chrysosporium will degrade many PAH compounds found in cresote. Bioremediation is also being used to remediate soils contaminated with explosives.

❖ Cleaning of air

Air is polluted by a variety of volatile organic compounds created by a range of industrial processes. While chemical scrubbing has been used to clean gases emitted from chimneys, the newer technique of 'biofiltration' is helping to clean industrial gases. This method involves passing polluted air over a replaceable culture medium containing micro-organisms that degrade contaminates into products such as carbon dioxide, water or salts. Biofiltration is the only biological technique currently available to remediate airborne pollutants.

Treating Industrial Wastes:

✓ Wastes from the Pulp Industry:

Wastes from the paper and pulp industries contain high levels of cellulose and lignocellulose, which pose massive treatment problems. Cellulose is extremely resistant to enzyme breakdown, and becomes resistant to both chemical and enzymatic attack when bound to lignin. Since lignin's and carbohydrates are interlinked in wood, it becomes difficult to delignify the pulp.

The enzymatic pulp bleaching, which prevents bleach waste formation by eliminating or reducing chlorine consumption. It also reduces the water in pulping and bleaching. This process involves the use of a xylanase producing organism *Bacillus stearthermophilus*, which is isolated from soil.

Another waste from wood pulping process is sulphite waste liquor, which contains ligno-sulphate (60%), sugar (36%) and a mixture of other organic compounds. This can be treated with yeast (*Candida albicans*), which ferments the sugar, producing nearly one ton of yeast for every two tons of sugar in the liquor.

✓ Wastes from Dairy industry:

The whey fluid is a substantial by-product in the manufacturing of cheese. Whey is left after the curd has been separated, and for every one kg of cheese produced, as much as nine litres of this fluid (whey) is generated.

Though the whey contains potentially valuable nutrients, its use is limited to animal feed and some processed food like ice cream. With the world whey output approaching five million tons per annum, enormous waste disposal problems are beginning to haunt the dairy industry.

Whey disposal is now being handled by various biotechnological approaches. These include:

1. Treating whey with proper strains of microbes and nutrients,
2. Direct fermentation of lactose to ethanol,
3. Using yeast like '*Kluyvewmyces fraglis*' and '*Candida intermedi*',
4. Hydrolysis of lactose to glucose and galactose. (Fermentation results in sweet syrup, which is used in the food industry).

✓ **Wastes from Dye Industry:**

The textile and dyestuff industries produce a number of dyes and pigments, which are released into the environment in effluent streams. Though most of the dyes are not toxic or carcinogenic to fish or mammals, some of them pose serious hazards.

Chemical methods for treatment of coloured effluents have proved successful, while the microbial removal of dyes and pigments is still very limited. Microorganisms have been found to degrade dyes only after adaptation to concentrations much higher than normally found in different streams.

Biodegradation of Xenobiotic Compounds:

Xenobiotics are man-made compounds of recent origin. These include dyestuffs, solvents, nitrotoluenes, benzopyrene, polystyrene, explosive oils, pesticides and surfactants. As these are unnatural substances, the microbes present in the environment do not have a specific mechanism for their degradation.

Biotechnological tools can be used to understand their molecular properties, and help design suitable mechanisms to attack these compounds.

Oil Eating Bugs:

Accidental oil spills pose a great threat to ocean environments. Such spills have a direct impact on marine organisms. To counter this problem, scientists have now developed living organisms to clean up the oil spills. The most common oil-eating microorganisms are bacteria and fungi.

Once the oil has been completely removed from the surface, these engineered oil-eating bugs eventually die, as they can no longer support their growth. Penicillium species has also been found to possess oil degrading features, but its effect needs much more time than the genetically engineered bacterium. Many other microorganisms like the Alcanivorax bacteria are also capable of degrading petroleum products.

Landfill Technologies:

Solid wastes account for an increasing proportion of the waste generated by urban societies. While a part of this volume consists of glass, plastics, and other non-biodegradable material, a considerable proportion of this is made of decomposable solid organic material, like food wastes from large poultry and pig farms.

The waste deposit is compressed and covered by a layer of soil every day. These landfill areas house a wide variety of bacteria, some of which are capable of degrading different types of wastes. The only shortcoming in this process is that these bacteria take a considerably long time to degrade the waste.

However, modern biotechnology has enabled scientists to study the available bacteria, which are involved in the degradation of the waste – including hazardous substances. The most efficient strains of these bacteria can be cloned and reproduced in large quantities, and eventually applied to the specific sites. This ensures rapid degradation of the waste material.

Bio-composting

Composting is the process of converting all biodegradable wastes into organic manure. It is the natural process of microbial and biological decomposition and recycling of organic material into a humus rich substance. Vermicompost is a composting technology that convert all biodegradable waste into nutrient rich organic manure with the help of composting earthworm

These have also been used to reduce the cost of fertiliser applications and to reduce the environmental hazards caused by chemical fertilisers. Recently marine plants (seaweeds) have been used as bio fertilisers. They have proved to be very encouraging and thus reducing the burden of using chemical fertilizers (Fig.16).

Source: https://www.livestrong.com
Fig: 16 Biocompost

Bio-pesticide

Bacterial pesticides are now being synthesised by transferring bacterial gene (*Bacillus thrungiensis*) Bt into plants. This gene encodes a protein, which when ingested by feeding insects, results in the solubilisation of the insect's digestive tract (mid gut) and releases protoxins. This leads to disturbances in the equilibrium and ultimately kills the insect.

These 'biological pesticides' are being developed to target insect pests (ball worm and bud worm) by transferring the Bt gene into a soil bacterium (Pesudomonas species). Several American companies are involved in the development and marketing of biological pesticides and have come up with genetically engineered live bacteria for coating seeds before planting. Mycogen kills recombinant bacteria and applies them to the leaves of crop plants. Both these approaches protect the toxin from degradation by microorganisms and ultra violet light when applied to the crop plants (Fig.17).

Weed Control

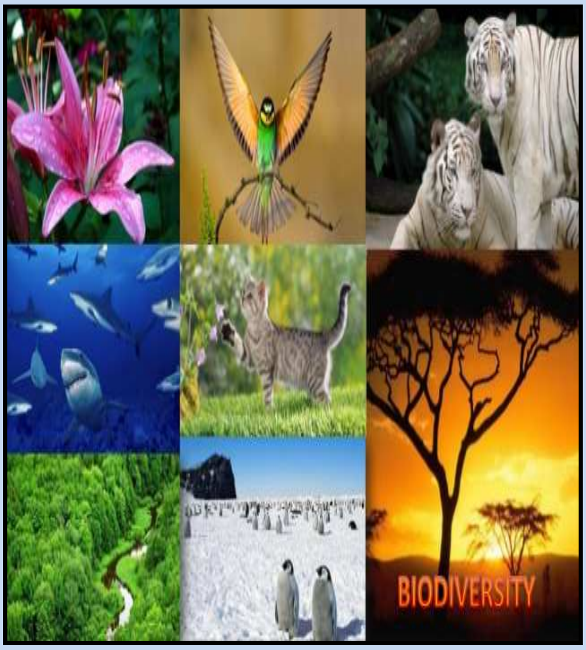
New herbicides have been developed, which will be selective to the target and harmless for the non-target organisms. Genetically engineered herbicide resistant plants have also been developed in a number of crops, which would help in the use of environment friendly herbicides. Genetically engineered insect resistant plants have also been successfully developed in certain crop species, thus suggesting the restricted use of pesticides in future.

Source: http://neem.world/neem-as-biopesticides/
Fig: 17 biopesticides have on the environment

Biodiversity and Conservation

Human activity has also proved devastating for the diversity of species, and the human induced extinction of species has been increasing at exponential rates. The need for expanding population with an unequal distribution of wealth has invariably resulted in unsustainable and exploitative use of existing resources. One of the major concerns today is the preservation of our existing flora and fauna (plants, animals and microbes).

Biotechnological applications have opened up new and improved methods of preserving plant and animal genetic resources, and have accelerated the evaluation of germ plasm collection for specific traits. Maintenance of a wide genetic base, which is an important element of biodiversity, is essential to the future of biotechnology and the sustainable use of biological resources. Plant tissue culture has been regarded as a key technology for increasing the production capability of many plants of selected varieties, so as to improve and increase their production and to prevent them from extinction.



Source:https://www.slideshare.net/
Fig: 18 Biodiversity of flora and funna

Another successful method of conserving biodiversity is the conservation of germ plasm by cryopreservation (freezing the tissue in liquid nitrogen at -196° C). The basic principle here is to bring the metabolic activity to a complete halt while keeping the tissue live (in a passive form).
Biotechnological tools have thus paved a way for restoring and preserving our biodiversity in multidimensional ways. These tools will definitely be the ultimate answer to the growing challenge of a depleting environment (Fig.18).

Conclusion

The major benefits of environmental biotechnology are it helps to keep our environment safe and clean for the use of the future generations. It helps the organisms and the engineers to find useful ways of getting adapted to the changes in the environment and keep the environment clean and green. The benefit of environmental biotechnology helps us to avoid the use of hazardous pollutants and wastes that affect the natural resources and the environment. The development of the society should be done in such a way that it helps to protect our environment and also helps us to development it. Environmental biotechnologies are used to find new ways to reduce economic and also protect the environmental health.

References:

Bento, F.M., Camargo, F.A.O., Okeke, B.C., and Frankenberger. W.T., 2005, Bioresour Technol, 96 pp. 1049-1055.

Buchholz, K., Kasche, V., and Bornscheuer, U. T., 2012. Biocatalysts and Enzyme Technology 2nd edn (Wiley-VCH)

Bornscheuer, U. T. and Kazlauskas, R. J., 2006. Hydrolases in Organic Synthesis - Regio- and Stereoselective Biotransformations 2nd edn (Wiley-VCH).

Bornscheuer, U. T. Huisman, G. W. Kazlauskas, Lutz, R. J. Moore S. J. C. and Robins, K. Nature, 2012, 485, 185

Cho, Y.G. Rhee, S.K. and Lee, S.-T., 2000, Biotechnol Lett, 22, pp. 915-919

Drauz, K., Gröger, H., and May, O. (eds) 2012. Enzyme Catalysis in Organic Synthesis Vols 1–3, 3rd edn (Wiley-VCH)

Liese, A., Seelbach, K., and Wandrey, C. (eds) 2006. Industrial Biotransformations 2nd edn (Wiley-VCH).

Lvovich, M.I., 1979. Water Resources and Their Future. Litho Crafters Inc., Michigan

Ma, S. K. Gruber, Davis, J. C. Newman, Gray, Wang, L. D. Grate, A. J. Huisman G. W. and Sheldon, R. A. 2010, Green Chem., 12, 81.

Meshram, J.R., Mohan, S., 2007. Ministry of New and Renewable Energy, New Delhi, Government of India, p. 109–34.

Simeonov, S. P. Nunes, J. P. M. Guerra, K. Kurteva V. B., and Afonso, C. A. M. 2016. Chem. Rev., 116, 5744.

Wolski, E.A., Murialdo, S.E., and Gonzales, J.F. 2006. Water SA 32:1–5.

Yang, M., 2011. A current global view of environmental and occupational cancers. J. Environ. Sci. Health Part. C 29, 223e249.

FORTHCOMING EVENTS		
Events	**Date**	**Place & Correspondence**
International Conference on Renewable Energy, Green technology & Environmental Science (ICREGTES)	3rd Feb, 2018	GOA,India http://www.asar.org.in/Conference2018/2/Goa/ICREGTES/
National Conference on Advances in Science, Agriculture, Environmental & Biotechnology (NCASAEB)	4th Feb, 2018	Chandigarh, PUNJAB, India http://nationalconferences.org/Conference2018/2/Chandigarh/NCASAEB/
4th International Conference on Geographical Information Systems Theory, Applications and Management	17 – 19th March 2018	Funchal, Madeira, Portugal http://www.eurogeography.eu/conference-2018/
'Sixth International Conference on Remote Sensing and Geoinformation of Environment'	26-29 March, 2018	Aliathon Holiday Village in Paphos, Cyprus. http://www.cyprusremotesensing.com/rscy2018/Workshop

QUERY AND FEEDBACK FORM

Name:

Designation:

Email:

Area of specialization:

Views on our Newsletter:

Suggestion for Improvement:

I would like to collect information on Environmental Biotechnology on the following:

Subject: **Key words:**

BOOK POST

TO

____

____

____

FROM:
ENVIS CENTRE
DEPARTMENT OF ENVIRONMENTAL SCIENCE, UNIVERSITY OF KALYANI
KALYANI-741235, NADIA
WEST BENGAL