**ROLE OF BIOREMEDIATION TO COMBAT POLLUTION HAZARD**

**Reshma Sinha**

**Department of Zoology**

**Sri Guru Gobind Singh College, Patna City**

**Patna, Bihar, India**

**ABSTRACT**

Green technology is the application of the environmental science to conserve the natural environment and resources and to curb the negative impacts of human involvement. It can be applied to either the sub-surface or surface layer depending on its location. There is above ground system that treats the soil outside the affected area. The goals informing development in this rapidly growing field include: sustainability, cradle to cradle design, source reduction, innovation and viability. Bioremediation is a green technology that uses genetically engineered living organisms to return the natural environment altered by contaminants to its original condition. It can be an effective bio-weapon on the pollution front. However, it has relatively less potential to reduce heavy metal contamination.

Keywords: Green technology, Bioremediation, Genetic engineering, Bio-weapon, Pollution

**I. INTRODUCTION**

The term technology refers to the application of knowledge for practical purposes. Green technology is the application of the environmental science to conserve the natural environment and resources and to curb the negative impacts of human involvement. The field of green technology encompasses a continuously evolving group of methods and materials from techniques for generating energy to non-toxic cleaning products. The goals informing development in this rapidly growing field include:

1. ***Sustainability:*** meeting the needs of society without damaging or depleting natural resources.
2. ***Cradle to cradle design:*** ending the cradle to grave cycle of manufactured products by creating products that can be fully reused.
3. ***Source reduction***: Lowering waste and pollution by way of changing patterns of manufacturing and intake.
4. ***Innovation:*** developing alternatives to technologies that have been demonstrated to damage health and the environment.
5. ***Viability:*** creating a centre for ecological pastime around technologies and merchandise that benefit the environment and speeding their implementation.

**II. METHODOLOGY**

Various biological processes can be utilized to minimize contamination. Green technology can be applied to either the sub-surface or surface layer depending on its location. The sub-surface layer can be removed while the surface layer can be treated with contaminated soil that is twelve inches down the ground level. Besides tilling, nutrients and water are also added to the soil in order to improve the bacterial growth rate and initiate the process of biological development. Unlike technologies that are directly used to deal with surface and sub-surface contamination, above ground systems treat the soil outside the affected area. Above ground systems are commonly used for treating contaminated soil. They can be divided into two phases: solid-phase and slurry-phase. The former involves the application of a bio-reactor to decontaminate the soil, while the latter involves the use of water and nutrients combined with the contaminated soil. The outcome of both the treatments is the same.

**III. BASIC CONCEPTS OF GREEN TECHNOLOGY**

1. ***Recycling***
2. ***Water purification***
3. ***Air purification***
4. ***Sewage treatment***
5. ***Environmental remediation***
6. ***Solid waste management***
7. ***Renewable energy***
8. ***eGain forecasting***
9. ***Energy conservation etc.***

**IV. ENVIRONMENNTAL REMEDIATION OR BIOREMEDIATION**

Microbes and microbial processes have served the need of mankind since time immemorial and now occupy an enviable position in the core of the new biotechnology revolution. Out of many branches of this biotechnology revolution, “Bioremediation” is one of the most important area of global concern that has emerged in the last decade.

The term bioremediation can be defined as any process that uses living organisms to return the natural environment altered by contaminants to its original condition. Indeed, bioremediation is not a magic to control pollution, but all the available evidences suggest that it can be an effective additional bio-weapon on the pollution front. Various meetings and workshops of scientists and government representatives from USA, Canada, Japan and West European countries are being sponsored by OECD (Organization for Economic Co-operation and Development) since 1991. All have recognised bioremediation as an effective measure to combat the pollution hazard.

Some examples of bioremediation technology are:

1. ***Bio-venting***: It is the in-situ remediation technology that makes use of microbes to biodegrade organic matters absorbed in soil in the unsaturated zone. It involves the induction of air to provide oxygen to promote biodegradation of the organic matter. It is used in the cleaning of petroleum products- gasoline, jet fuels, kerosene and diesel.
2. ***Land-farming***: It is the process that is performed in the upper soil zone or in bio-treatment cells. Contaminated soils, sediments or sledges are incorporated into the soil surface and periodically turned over to aerate the mixture. It is used in the cleaning of oil sledge, petroleum.
3. ***Bio-reactor:*** It is a tool that supports a biologically active environment meant to grow cells or tissues in the context of cell culture designed to treat sewage and wastewater.
4. ***Composting:*** It involves the aerobic decomposition of organic matters- plant and animal matters. The method requires carbon, oxygen, nitrogen, water which can destroy pathogen or unwanted seeds. Microbial pesticide in compost destroy pathogens.
5. ***Bio-augmentation:*** It involves the addition of matched microbial strains to the medium to enhance the resident microbe population’s ability in order to degrade contaminants.
6. ***Rhizo-filtration:*** It is a technique which employs mycelia to filter toxic waste and micro-organisms from water in soil. The mycelium secrets extracellular enzymes and acids that breakdown lignin and cellulose, the two main building blocks of plant fibre. These are organic compounds composed of long chains of carbon and hydrogen, similar to many organic pollutants.
7. ***Bio-stimulation:*** Fertilizers are added in order to increase the bioavailability within the medium.
8. ***Phyto-remediation:*** In this technology, plants play their role. Natural plants or transgenic plants are capable of bio-accumulating toxins (heavy metals like cadmium, lead, mercury etc.) which are not easily absorbed by organisms. They are then harvested for removal. The heavy metals in the harvested biomass may be incinerated or even recycled for industrial use.

**V. GENETIC ENGINEERING APPROACH**

Using genetic engineering to create organisms specifically designed for bioremediation has great potential. The bacteria involved are gluttonous microbes placed within the contaminated site immediately start breaking down the organic constituents. These break up the carbon chains until the contamination is eliminated. It results in the release of carbon dioxide and water with little fatty acid. pH for bacterial growth is 7. Bacteria requires carbon source (carbon dioxide from air) for growth and nitrogen and phosphorus as energy source to sustain their metabolic process.

In early 1980s, little knowledge was available about how toxic wastes interact with the hydrosphere. But with the changing time the researchers acquired the maximum possible utility of these tiny organisms to degrade a wide range of pollutants. Microbes that can grow under extreme environmental conditions are yet to be discovered.

Researchers have also been using genetic engineering to develop new microbial strains with novel bio-degradable capabilities. Microbes are induced with genes that code for enzymes, that breakdown toxic chemicals. They are prepared to be able to survive and grow in much disturbed and harsh environments. This would greatly extend the range of compounds that might be treated with bioremediation.

Many examples in this concern are available out of which the most striking research work is of Japanese research team. They isolated a species of *Pseudomonas* that could grow in solvent containing more than 50% tolune, a condition that kills most organism through cell lysis.

Similarly, many instances of oil tanker leakages in oceans had caused massive devastation of flora and fauna in the past. No doubt, there were methods to neutralise these oil spills, but the most effective and safe measure is the use of biological treatment. The microbes once sprayed on the oil surface, emulsify it and disperse it throughout the water body so thinly that it no longer remain precarious. Professor Anand Chakraborty, a hydrocarbon biotechnologist, working at the University of Llinois Medical Centre, Chicago, USA has developed very efficient oil-eating bacterium “SUPERBUG” using species of *Pseudomonas* through recombination DNA technology.

With the first emerging trends for bioremediation, it is difficult to cite many examples, but broadly three different foci of research and development for bioremediation research are emerging worldwide and these are:

1. ***European upgrading of traditional waste and water treatment systems:*** Using this technology, European countries particularly Germany, Netherland, Belgium Austria and Italy are producing biogas from solid wastes, removing inorganic compounds of water aerobically to reduce BOD, removing toxic chemicals from industrial wastewater, developing biological gas treatment systems to treat air pollutants, etc.
2. ***American focus on on-site specific clean up:*** In the United States, the Environmental Protection Agency includes more than 1200 locations, where this method of bioremediation is extensively used to combat the menace of pollution. This technology is being used to treat sites contaminated with complex organic pollutants including petroleum products in oil spills and sites contaminated with heavy metals or radio-nuclides.
3. ***Japanese Global Application of bioremediation technology:*** This formula of Japanese bioremediation is also working on replacement of petrochemicals, reducing global warming, biodegradable plastics etc.

From the ongoing account it is clear that bioremediation has promising future. It has great potential to clean-up the polluted environment and treat wastes. It can therefore be used as a “Bio-weapon.”

**VI. REFERENCES**

* Sharma, P. D. 2004. Bioremediation-An emerging biotechnology for environmental clean-up. Environmental Biology and Toxicology. Rastogi publication.16:386-405.
* Norman, J. 2007. Where there’s never an oil shortage” NY Times.
* Diaz, E. 2008. Microbial biodegradation: Genomics and Molecular Biology. Caister Academic Press. ISBN 978-1-904455 17-2
* [http://www.sciencedirect.com/science-ob=articleURL$-Udl=B6V24-4DVBJZS](http://www.sciencedirect.com/science-ob%3DarticleURL%24-Udl%3DB6V24-4DVBJZS)
* <http://www.terranovabiosystems.com/science/remediation-resource.html>

The term technology refers back to the software of expertise for sensible functions. Inexperienced era is the application of the environmental technology to preserve the natural surroundings and resources and to diminish the bad impacts of human involvement. The sphere of inexperienced generation features a constantly evolving institution of techniques and substances from techniques for producing power to non-poisonous cleaning merchandise. The desires that tell development on this hastily developing field consist of:

A. Sustainability: assembly the desires of society without detrimental or depleting natural resources.

B. Cradle to cradle design: finishing the cradle to grave cycle of manufactured merchandise by using growing merchandise that may be fully reused.

C. Source reduction: lowering waste and pollution by way of changing patterns of manufacturing and intake.

D. Innovation: developing alternatives to technologies that have been verified to harm fitness and the surroundings.

E. Viability: developing a centre for ecological pastime around technology and merchandise that benefit the environment and rushing their implementation.

II. Methodology

Infection can be minimised by using numerous organic techniques. Depending upon the vicinity of the contamination, green era can either be applied to the floor and sub-surface or require above floor elimination. Surface and sub-surface era deals with infected soil right down to 12 inches underneath floor level. In this era water and nutrients are added in addition to tilling to the soil, so as to optimise bacterial boom and start the organic system. In oppose to era which might be immediately carried out to floor and sub-floor contamination, above ground technology entails treatment of soils out of the given place. Such remedy used in above floor era, include that of slurry-segment and solid-segment remediation. Slurry-section entails the initial mixture of water with the contaminated soil and later treatment includes the degradation in a bioreactor. Solid-segment remedy achieves the similar intention of the former remedy. Yet in this method the tainted soil is located in a bed and nourished with nutrients, moisture and oxygen in hopes that decomposition will arise.

III. Basic standards OF green generation

A. Recycling

B. Water purification

C. Air purification

D. Sewage remedy

E. Environmental remediation

F. Strong waste control

G. Renewable power

H. EGain forecasting

I. Energy conservation and many others.

IV. ENVIRONMENNTAL REMEDIATION OR BIOREMEDIATION

Microbes and microbial methods have served the need of mankind in view that time immemorial and now occupy an enviable role inside the core of the new biotechnology revolution. Out of many branches of this biotechnology revolution, a totally important vicinity of world problem that has emerged inside the last decade is “bioremediation”.

The time period bioremediation can be defined as any procedure that uses living organisms to return the natural environment altered with the aid of contaminants to its original circumstance. Indeed, bioremediation isn't a magic to govern pollution, however all the available evidences advise that it can be an powerful additional bio-weapon on the pollution the front. The OECD (employer for financial Co-operation and improvement) has been sponsoring conferences and workshops of scientists and government representatives from u.S.A., Canada, Japan and West eu nations seeing that 1991, and recognises bioremediation as an powerful measure to fight the pollutants threat.

A few examples of bioremediation technology are:

A. Bio-venting: it's far the in-situ remediation generation that makes use of microbes to biodegrade natural subjects absorbed in soil inside the unsaturated sector. It entails the induction of air to offer oxygen to promote biodegradation of the organic matter. It's far used inside the cleaning of petroleum products- gas, jet fuels, kerosene and diesel.

B. Land-farming: it is the process that is carried out within the top soil area or in bio-treatment cells. Infected soils, sediments or sledges are integrated into the soil floor and periodically turned over to aerate the mixture. It's miles used within the cleaning of oil sledge, petroleum.

C. Bio-reactor: it is a tool that supports a biologically lively surroundings meant to grow cells or tissues inside the context of cellular subculture designed to treat sewage and wastewater.

D. Composting: It includes the cardio decomposition of natural subjects- plant and animal subjects. The approach calls for carbon, oxygen, nitrogen, water that may ruin pathogen or unwanted seeds. Microbial pesticide in compost spoil pathogens.

E. Bio-augmentation: It involves the breakdown of contaminants thru the addition of matched microbe traces to the medium to enhance the resident microbe population’s capability.

F. Rhizo-filtration: it is a technique using mycelia to clear out toxic waste and micro-organisms from water in soil. The mycelium secrets extracellular enzymes and acids that breakdown lignin and cellulose, the two fundamental constructing blocks of plant fibre. Those are natural compounds composed of long chains of carbon and hydrogen, just like many natural pollutants.

G. Bio-stimulation: It entails the addition of fertilizers to increase the bioavailability within the medium.

H. Phyto-remediation: in this era, flowers play their position. Herbal plants or transgenic flowers are capable of bio-accumulate toxins which are not easily absorbed by means of organisms- heavy metals like cadmium, lead, mercury and many others., in their above ground elements, which might be then harvested for elimination. The heavy metals inside the harvested biomass may be in addition focused by incineration or maybe recycled for business use.

V. GENETIC ENGINEERING approach

Using genetic engineering to create organisms mainly designed for bioremediation has splendid capacity. The bacteria concerned are gluttonous microbes located inside the infected web page right now begin breaking down the organic components. These break up the carbon chains till the contamination is eliminated. It effects in the release of carbon dioxide and water with little fatty acid. PH for bacterial boom is 7. Bacteria requires carbon supply (carbon dioxide from air) for increase and nitrogen and phosphorus as strength source to preserve their metabolic technique.

In early Nineteen Eighties, little expertise turned into available approximately how toxic wastes engage with the hydrosphere. However with the changing time the researchers received the most possible utility of those tiny organisms to degrade a extensive variety of pollution. There's also a search of microbes that would grow underneath excessive environmental situations.

Researchers have additionally been using genetic engineering to expand new microbial traces with novel bio-degradable abilities. Adding genes that code for enzymes, that breakdown poisonous chemical substances, to microbes and are able to continue to exist and grow in lots disturbed and harsh environments would substantially amplify the range of compounds that is probably handled with bioremediation.

Many examples on this subject are to be had out of which the most placing studies work of japanese research crew is the isolation of a species of Pseudomonas that may develop in solvent containing extra than 50% tolune, a situation that kills maximum organism thru disruption of mobile membrane.

In addition, many instances of oil tanker leakages in oceans had brought on massive devastation of flora and fauna in the beyond. No doubt, there were strategies to neutralise these oil spills, but the most effective and safe degree is the usage of biological remedy. Those microbes are sprayed at the surface which blend with the oil, emulsify it and disperse it at some stage in the water body so thinly that it now not continue to be dangerous. Professor Anand Chakraborty, a hydrocarbon biotechnologist, working on the college of Llinois scientific Centre, Chicago, united states of america has advanced very green oil-ingesting bacterium “SUPERBUG” using species of Pseudomonas via recombination DNA generation.

With the primary emerging traits for bioremediation, it's miles tough to quote many examples, but widely three one of a kind foci of studies and development for bioremediation research are emerging global and these are:

A. Ecu upgrading of conventional waste and water treatment systems: the usage of this era, european international locations especially Germany, Netherland, Belgium Austria and Italy are generating biogas from solid wastes, doing away with inorganic compounds of water aerobically to lessen BOD, eliminating toxic chemical compounds from business wastewater, growing biological fuel treatment structures to treat air pollution, and so forth.

B. American awareness on on-website online unique clean up: in the united states of america, the Environmental protection enterprise consists of extra than 1200 places, where this approach of bioremediation is notably used to fight the threat of pollution. This era is being used to deal with sites infected with complicated natural pollution which includes petroleum merchandise in oil spills and sites contaminated with heavy metals or radio-nuclides.

C. Eastern global utility of bioremediation generation: This formula of jap bioremediation is likewise working on substitute of petrochemicals, reducing worldwide warming, biodegradable plastics and so on.

The above account suggests that bioremediation has promising destiny with numerous potential packages to easy-up the polluted surroundings and treat wastes. It can be used as a “Bio-weapon.”

VI. REFERENCES

• Sharma, P. D. 2004. Bioremediation-An rising biotechnology for environmental smooth-up. Environmental Biology and Toxicology. Rastogi publication.16:386-405.

• Norman, J. 2007. Wherein there’s by no means an oil scarcity” big apple instances.

• Diaz, E. 2008. Microbial biodegradation: Genomics and Molecular Biology. Caister instructional Press. ISBN 978-1-904455 17-2

• http://www.Sciencedirect.Com/science-ob=articleURL$-Udl=B6V24-4DVBJZS

• http://www.Terranovabiosystems.Com/science/remediation-useful r

III. BASIC CONCEPTS OF GREEN TECHNOLOGY

1. ***Recycling***
2. ***Water purification***
3. ***Air purification***
4. ***Sewage treatment***
5. ***Environmental remediation***
6. ***Solid waste management***
7. ***Renewable energy***
8. ***eGain forecasting***
9. ***Energy conservation etc.***

IV. ENVIRONMENNTAL REMEDIATION OR BIOREMEDIATION

Microbes and microbial processes have served the need of mankind since time immemorial and now occupy an enviable position in the core of the new biotechnology revolution. Out of many branches of this biotechnology revolution, a very important area of global concern that has emerged in the last decade is “bioremediation”.

The term bioremediation can be defined as any process that uses living organisms to return the natural environment altered by contaminants to its original condition. Indeed, bioremediation is not a magic to control pollution, but all the available evidences suggest that it can be an effective additional bio-weapon on the pollution front. The OECD (Organization for Economic Co-operation and Development) has been sponsoring meetings and workshops of scientists and government representatives from USA, Canada, Japan and West European countries since 1991, and recognises bioremediation as an effective measure to combat the pollution hazard.

Some examples of bioremediation technology are:

1. ***Bio-venting***: It is the in-situ remediation technology that uses microbes to biodegrade organic matters absorbed in soil in the unsaturated zone. It involves the induction of air to provide oxygen to promote biodegradation of the organic matter. It is used in the cleaning of petroleum products- gasoline, jet fuels, kerosene and diesel.
2. ***Land-farming***: It is the process that is performed in the upper soil zone or in bio-treatment cells. Contaminated soils, sediments or sledges are incorporated into the soil surface and periodically turned over to aerate the mixture. It is used in the cleaning of oil sledge, petroleum.
3. ***Bio-reactor:*** It is a device that supports a biologically active environment meant to grow cells or tissues in the context of cell culture designed to treat sewage and wastewater.
4. ***Composting:*** It involves the aerobic decomposition of organic matters- plant and animal matters. The method requires carbon, oxygen, nitrogen, water which can destroy pathogen or unwanted seeds. Microbial pesticide in compost destroy pathogens.
5. ***Bio-augmentation:*** It involves the breakdown of contaminants via the addition of matched microbe strains to the medium to enhance the resident microbe population’s ability.
6. ***Rhizo-filtration:*** It is a process using mycelia to filter toxic waste and micro-organisms from water in soil. The mycelium secrets extracellular enzymes and acids that breakdown lignin and cellulose, the two main building blocks of plant fibre. These are organic compounds composed of long chains of carbon and hydrogen, similar to many organic pollutants.
7. ***Bio-stimulation:*** It involves the addition of fertilizers to increase the bioavailability within the medium.
8. ***Phyto-remediation:*** In this technology, plants play their role. Natural plants or transgenic plants are able to bio-accumulate toxins which are not easily absorbed by organisms- heavy metals like cadmium, lead, mercury etc., in their above ground parts, which are then harvested for removal. The heavy metals in the harvested biomass may be further concentrated by incineration or even recycled for industrial use.

V. GENETIC ENGINEERING APPROACH

The use of genetic engineering to create organisms specifically designed for bioremediation has great potential. The bacteria involved are gluttonous microbes placed within the contaminated site immediately start breaking down the organic constituents. These break up the carbon chains until the contamination is eliminated. It results in the release of carbon dioxide and water with little fatty acid. pH for bacterial growth is 7. Bacteria requires carbon source (carbon dioxide from air) for growth and nitrogen and phosphorus as energy source to sustain their metabolic process.

In early 1980s, little knowledge was available about how toxic wastes interact with the hydrosphere. But with the changing time the researchers acquired the maximum possible utility of these tiny organisms to degrade a wide range of pollutants. There is also a search of microbes that could grow under extreme environmental conditions.

Researchers have also been using genetic engineering to develop new microbial strains with novel bio-degradable capabilities. Adding genes that code for enzymes, that breakdown toxic chemicals, to microbes and are able to survive and grow in much disturbed and harsh environments would greatly extend the range of compounds that might be treated with bioremediation.

Many examples in this concern are available out of which the most striking research work of Japanese research team is the isolation of a species of *Pseudomonas* that can grow in solvent containing more than 50% tolune, a condition that kills most organism through disruption of cell membrane.

Similarly, many instances of oil tanker leakages in oceans had caused massive devastation of flora and fauna in the past. No doubt, there were methods to neutralise these oil spills, but the most effective and safe measure is the use of biological treatment. These microbes are sprayed on the surface which mix with the oil, emulsify it and disperse it throughout the water body so thinly that it no longer remain hazardous. Professor Anand Chakraborty, a hydrocarbon biotechnologist, working at the University of Llinois Medical Centre, Chicago, USA has developed very efficient oil-eating bacterium “SUPERBUG” using species of *Pseudomonas* through recombination DNA technology.

With the first emerging trends for bioremediation, it is difficult to cite many examples, but broadly three different foci of research and development for bioremediation research are emerging worldwide and these are:

1. ***European upgrading of traditional waste and water treatment systems:*** Using this technology, European countries particularly Germany, Netherland, Belgium Austria and Italy are producing biogas from solid wastes, removing inorganic compounds of water aerobically to reduce BOD, removing toxic chemicals from industrial wastewater, developing biological gas treatment systems to treat air pollutants, etc.
2. ***American focus on on-site specific clean up:*** In the United States, the Environmental Protection Agency includes more than 1200 locations, where this method of bioremediation is extensively used to combat the menace of pollution. This technology is being used to treat sites contaminated with complex organic pollutants including petroleum products in oil spills and sites contaminated with heavy metals or radio-nuclides.
3. ***Japanese Global Application of bioremediation technology:*** This formula of Japanese bioremediation is also working on replacement of petrochemicals, reducing global warming, biodegradable plastics etc.

The above account shows that bioremediation has promising future with several potential applications to clean-up the polluted environment and treat wastes. It can be used as a “Bio-weapon.”

VI. REFERENCES

* Sharma, P. D. 2004. Bioremediation-An emerging biotechnology for environmental clean-up. Environmental Biology and Toxicology. Rastogi publication.16:386-405.
* Norman, J. 2007. Where there’s never an oil shortage” NY Times.
* Diaz, E. 2008. Microbial biodegradation: Genomics and Molecular Biology. Caister Academic Press. ISBN 978-1-904455 17-2
* [http://www.sciencedirect.com/science-ob=articleURL$-Udl=B6V24-4DVBJZS](http://www.sciencedirect.com/science-ob%3DarticleURL%24-Udl%3DB6V24-4DVBJZS)
* <http://www.terranovabiosystems.com/science/remediation-resource.html>

III. BASIC CONCEPTS OF GREEN TECHNOLOGY

1. ***Recycling***
2. ***Water purification***
3. ***Air purification***
4. ***Sewage treatment***
5. ***Environmental remediation***
6. ***Solid waste management***
7. ***Renewable energy***
8. ***eGain forecasting***
9. ***Energy conservation etc.***

IV. ENVIRONMENNTAL REMEDIATION OR BIOREMEDIATION

Microbes and microbial processes have served the need of mankind since time immemorial and now occupy an enviable position in the core of the new biotechnology revolution. Out of many branches of this biotechnology revolution, a very important area of global concern that has emerged in the last decade is “bioremediation”.

The term bioremediation can be defined as any process that uses living organisms to return the natural environment altered by contaminants to its original condition. Indeed, bioremediation is not a magic to control pollution, but all the available evidences suggest that it can be an effective additional bio-weapon on the pollution front. The OECD (Organization for Economic Co-operation and Development) has been sponsoring meetings and workshops of scientists and government representatives from USA, Canada, Japan and West European countries since 1991, and recognises bioremediation as an effective measure to combat the pollution hazard.

Some examples of bioremediation technology are:

1. ***Bio-venting***: It is the in-situ remediation technology that uses microbes to biodegrade organic matters absorbed in soil in the unsaturated zone. It involves the induction of air to provide oxygen to promote biodegradation of the organic matter. It is used in the cleaning of petroleum products- gasoline, jet fuels, kerosene and diesel.
2. ***Land-farming***: It is the process that is performed in the upper soil zone or in bio-treatment cells. Contaminated soils, sediments or sledges are incorporated into the soil surface and periodically turned over to aerate the mixture. It is used in the cleaning of oil sledge, petroleum.
3. ***Bio-reactor:*** It is a device that supports a biologically active environment meant to grow cells or tissues in the context of cell culture designed to treat sewage and wastewater.
4. ***Composting:*** It involves the aerobic decomposition of organic matters- plant and animal matters. The method requires carbon, oxygen, nitrogen, water which can destroy pathogen or unwanted seeds. Microbial pesticide in compost destroy pathogens.
5. ***Bio-augmentation:*** It involves the breakdown of contaminants via the addition of matched microbe strains to the medium to enhance the resident microbe population’s ability.
6. ***Rhizo-filtration:*** It is a process using mycelia to filter toxic waste and micro-organisms from water in soil. The mycelium secrets extracellular enzymes and acids that breakdown lignin and cellulose, the two main building blocks of plant fibre. These are organic compounds composed of long chains of carbon and hydrogen, similar to many organic pollutants.
7. ***Bio-stimulation:*** It involves the addition of fertilizers to increase the bioavailability within the medium.
8. ***Phyto-remediation:*** In this technology, plants play their role. Natural plants or transgenic plants are able to bio-accumulate toxins which are not easily absorbed by organisms- heavy metals like cadmium, lead, mercury etc., in their above ground parts, which are then harvested for removal. The heavy metals in the harvested biomass may be further concentrated by incineration or even recycled for industrial use.

V. GENETIC ENGINEERING APPROACH

The use of genetic engineering to create organisms specifically designed for bioremediation has great potential. The bacteria involved are gluttonous microbes placed within the contaminated site immediately start breaking down the organic constituents. These break up the carbon chains until the contamination is eliminated. It results in the release of carbon dioxide and water with little fatty acid. pH for bacterial growth is 7. Bacteria requires carbon source (carbon dioxide from air) for growth and nitrogen and phosphorus as energy source to sustain their metabolic process.

In early 1980s, little knowledge was available about how toxic wastes interact with the hydrosphere. But with the changing time the researchers acquired the maximum possible utility of these tiny organisms to degrade a wide range of pollutants. There is also a search of microbes that could grow under extreme environmental conditions.

Researchers have also been using genetic engineering to develop new microbial strains with novel bio-degradable capabilities. Adding genes that code for enzymes, that breakdown toxic chemicals, to microbes and are able to survive and grow in much disturbed and harsh environments would greatly extend the range of compounds that might be treated with bioremediation.

Many examples in this concern are available out of which the most striking research work of Japanese research team is the isolation of a species of *Pseudomonas* that can grow in solvent containing more than 50% tolune, a condition that kills most organism through disruption of cell membrane.

Similarly, many instances of oil tanker leakages in oceans had caused massive devastation of flora and fauna in the past. No doubt, there were methods to neutralise these oil spills, but the most effective and safe measure is the use of biological treatment. These microbes are sprayed on the surface which mix with the oil, emulsify it and disperse it throughout the water body so thinly that it no longer remain hazardous. Professor Anand Chakraborty, a hydrocarbon biotechnologist, working at the University of Llinois Medical Centre, Chicago, USA has developed very efficient oil-eating bacterium “SUPERBUG” using species of *Pseudomonas* through recombination DNA technology.

With the first emerging trends for bioremediation, it is difficult to cite many examples, but broadly three different foci of research and development for bioremediation research are emerging worldwide and these are:

1. ***European upgrading of traditional waste and water treatment systems:*** Using this technology, European countries particularly Germany, Netherland, Belgium Austria and Italy are producing biogas from solid wastes, removing inorganic compounds of water aerobically to reduce BOD, removing toxic chemicals from industrial wastewater, developing biological gas treatment systems to treat air pollutants, etc.
2. ***American focus on on-site specific clean up:*** In the United States, the Environmental Protection Agency includes more than 1200 locations, where this method of bioremediation is extensively used to combat the menace of pollution. This technology is being used to treat sites contaminated with complex organic pollutants including petroleum products in oil spills and sites contaminated with heavy metals or radio-nuclides.
3. ***Japanese Global Application of bioremediation technology:*** This formula of Japanese bioremediation is also working on replacement of petrochemicals, reducing global warming, biodegradable plastics etc.

The above account shows that bioremediation has promising future with several potential applications to clean-up the polluted environment and treat wastes. It can be used as a “Bio-weapon.”

VI. REFERENCES

* Sharma, P. D. 2004. Bioremediation-An emerging biotechnology for environmental clean-up. Environmental Biology and Toxicology. Rastogi publication.16:386-405.
* Norman, J. 2007. Where there’s never an oil shortage” NY Times.
* Diaz, E. 2008. Microbial biodegradation: Genomics and Molecular Biology. Caister Academic Press. ISBN 978-1-904455 17-2
* [http://www.sciencedirect.com/science-ob=articleURL$-Udl=B6V24-4DVBJZS](http://www.sciencedirect.com/science-ob%3DarticleURL%24-Udl%3DB6V24-4DVBJZS)
* <http://www.terranovabiosystems.com/science/remediation-resource.html>

III. BASIC CONCEPTS OF GREEN TECHNOLOGY

1. ***Recycling***
2. ***Water purification***
3. ***Air purification***
4. ***Sewage treatment***
5. ***Environmental remediation***
6. ***Solid waste management***
7. ***Renewable energy***
8. ***eGain forecasting***
9. ***Energy conservation etc.***

IV. ENVIRONMENNTAL REMEDIATION OR BIOREMEDIATION

Microbes and microbial processes have served the need of mankind since time immemorial and now occupy an enviable position in the core of the new biotechnology revolution. Out of many branches of this biotechnology revolution, a very important area of global concern that has emerged in the last decade is “bioremediation”.

The term bioremediation can be defined as any process that uses living organisms to return the natural environment altered by contaminants to its original condition. Indeed, bioremediation is not a magic to control pollution, but all the available evidences suggest that it can be an effective additional bio-weapon on the pollution front. The OECD (Organization for Economic Co-operation and Development) has been sponsoring meetings and workshops of scientists and government representatives from USA, Canada, Japan and West European countries since 1991, and recognises bioremediation as an effective measure to combat the pollution hazard.

Some examples of bioremediation technology are:

1. ***Bio-venting***: It is the in-situ remediation technology that uses microbes to biodegrade organic matters absorbed in soil in the unsaturated zone. It involves the induction of air to provide oxygen to promote biodegradation of the organic matter. It is used in the cleaning of petroleum products- gasoline, jet fuels, kerosene and diesel.
2. ***Land-farming***: It is the process that is performed in the upper soil zone or in bio-treatment cells. Contaminated soils, sediments or sledges are incorporated into the soil surface and periodically turned over to aerate the mixture. It is used in the cleaning of oil sledge, petroleum.
3. ***Bio-reactor:*** It is a device that supports a biologically active environment meant to grow cells or tissues in the context of cell culture designed to treat sewage and wastewater.
4. ***Composting:*** It involves the aerobic decomposition of organic matters- plant and animal matters. The method requires carbon, oxygen, nitrogen, water which can destroy pathogen or unwanted seeds. Microbial pesticide in compost destroy pathogens.
5. ***Bio-augmentation:*** It involves the breakdown of contaminants via the addition of matched microbe strains to the medium to enhance the resident microbe population’s ability.
6. ***Rhizo-filtration:*** It is a process using mycelia to filter toxic waste and micro-organisms from water in soil. The mycelium secrets extracellular enzymes and acids that breakdown lignin and cellulose, the two main building blocks of plant fibre. These are organic compounds composed of long chains of carbon and hydrogen, similar to many organic pollutants.
7. ***Bio-stimulation:*** It involves the addition of fertilizers to increase the bioavailability within the medium.
8. ***Phyto-remediation:*** In this technology, plants play their role. Natural plants or transgenic plants are able to bio-accumulate toxins which are not easily absorbed by organisms- heavy metals like cadmium, lead, mercury etc., in their above ground parts, which are then harvested for removal. The heavy metals in the harvested biomass may be further concentrated by incineration or even recycled for industrial use.

V. GENETIC ENGINEERING APPROACH

The use of genetic engineering to create organisms specifically designed for bioremediation has great potential. The bacteria involved are gluttonous microbes placed within the contaminated site immediately start breaking down the organic constituents. These break up the carbon chains until the contamination is eliminated. It results in the release of carbon dioxide and water with little fatty acid. pH for bacterial growth is 7. Bacteria requires carbon source (carbon dioxide from air) for growth and nitrogen and phosphorus as energy source to sustain their metabolic process.

In early 1980s, little knowledge was available about how toxic wastes interact with the hydrosphere. But with the changing time the researchers acquired the maximum possible utility of these tiny organisms to degrade a wide range of pollutants. There is also a search of microbes that could grow under extreme environmental conditions.

Researchers have also been using genetic engineering to develop new microbial strains with novel bio-degradable capabilities. Adding genes that code for enzymes, that breakdown toxic chemicals, to microbes and are able to survive and grow in much disturbed and harsh environments would greatly extend the range of compounds that might be treated with bioremediation.

Many examples in this concern are available out of which the most striking research work of Japanese research team is the isolation of a species of *Pseudomonas* that can grow in solvent containing more than 50% tolune, a condition that kills most organism through disruption of cell membrane.

Similarly, many instances of oil tanker leakages in oceans had caused massive devastation of flora and fauna in the past. No doubt, there were methods to neutralise these oil spills, but the most effective and safe measure is the use of biological treatment. These microbes are sprayed on the surface which mix with the oil, emulsify it and disperse it throughout the water body so thinly that it no longer remain hazardous. Professor Anand Chakraborty, a hydrocarbon biotechnologist, working at the University of Llinois Medical Centre, Chicago, USA has developed very efficient oil-eating bacterium “SUPERBUG” using species of *Pseudomonas* through recombination DNA technology.

With the first emerging trends for bioremediation, it is difficult to cite many examples, but broadly three different foci of research and development for bioremediation research are emerging worldwide and these are:

1. ***European upgrading of traditional waste and water treatment systems:*** Using this technology, European countries particularly Germany, Netherland, Belgium Austria and Italy are producing biogas from solid wastes, removing inorganic compounds of water aerobically to reduce BOD, removing toxic chemicals from industrial wastewater, developing biological gas treatment systems to treat air pollutants, etc.
2. ***American focus on on-site specific clean up:*** In the United States, the Environmental Protection Agency includes more than 1200 locations, where this method of bioremediation is extensively used to combat the menace of pollution. This technology is being used to treat sites contaminated with complex organic pollutants including petroleum products in oil spills and sites contaminated with heavy metals or radio-nuclides.
3. ***Japanese Global Application of bioremediation technology:*** This formula of Japanese bioremediation is also working on replacement of petrochemicals, reducing global warming, biodegradable plastics etc.

The above account shows that bioremediation has promising future with several potential applications to clean-up the polluted environment and treat wastes. It can be used as a “Bio-weapon.”

VI. REFERENCES

* Sharma, P. D. 2004. Bioremediation-An emerging biotechnology for environmental clean-up. Environmental Biology and Toxicology. Rastogi publication.16:386-405.
* Norman, J. 2007. Where there’s never an oil shortage” NY Times.
* Diaz, E. 2008. Microbial biodegradation: Genomics and Molecular Biology. Caister Academic Press. ISBN 978-1-904455 17-2
* [http://www.sciencedirect.com/science-ob=articleURL$-Udl=B6V24-4DVBJZS](http://www.sciencedirect.com/science-ob%3DarticleURL%24-Udl%3DB6V24-4DVBJZS)
* <http://www.terranovabiosystems.com/science/remediation-resource.html>