BIOREMEDIATION

biotrickling filter: *a filter over which sewage flows and causes the growth of a layer of microbial slime, called biofilm*
to break down: *to decompose*
customer: *consumer, client*
delivered: *distributed*
device: *tool*
effluents: *emissions*
exploited: *used*
further: *more*
to lead (led-led): *to bring, to drive*
provided: *furnished*
reclamation: *recuperation*
remediation: *elimination*
to result in: *to cause*
to trickle: *to drop*
washed out: *removed (with a liquid)*

Bioremediation is the use of biological systems in the reduction of pollution from air, water and soil. Microorganisms and plants are the biological systems which are generally used. Microorganisms can break down most compounds for their growth and/or energy needs.

Bioremediation is applied to:

- waste water and industrial effluents – microorganisms in sewage treatment plants remove the more common pollutants from waste water before it is discharged into rivers or the sea. New methods include aerobic, anaerobic and physico-chemical processes in fixed-bed filters and in bioreactors. Most anaerobic waste water treatment systems produce useful biogas.
- drinking and processed water – a very important aspect of biotechnology is its potential for the reclamation and purification of waste waters for re-use. In many agricultural regions of the world, animal wastes and excess fertilisers result in high levels of nitrates in drinking water. Biotechnology has provided successful methods by which these compounds can be removed from processed water before it is delivered to customers.
- air and waste gases – biotechnological research has produced methods such as bioscrubbers, in which the pollutants are washed out using a cell suspension, and biotrickling filters, in which the pollutant is degraded by micro-organisms immobilised on an inert matrix and provided with an aqueous nutrient film trickling through the device. The selection of microorganisms that are more efficient at metabolising pollutants has also led to better air and gas purifying biofilters.
- soil and land treatment – both *in situ* and *ex situ* methods are exploited for the clean-up of soil and the associated groundwater. *In situ* treatments may include the introduction into the ground of microorganisms (bioaugmentation), ventilation and/or addition of nutrient solutions (biostimulation). *Ex situ* treatment involves removing the soil and groundwater and treating it above ground. Phytoremediation (bioremediation using plants) is presently already used to remove metals from contaminated soils and groundwater and is being further explored for the remediation of other pollutants. The combined use of plants and bacteria may also be possible.
- solid waste – domestic solid wastes are a major problem in our consumer society. They are made up mostly of readily biodegradable organics. Bio-wastes can be converted to a valuable resource by composting or anaerobic digestion. In particular, anaerobic digestion permits the recovery of substantial amounts of high-value biogas together with a high-quality stable organic residue.

New frontiers in Bioremediation

The principle underlying bioremediation is that microorganisms (mainly bacteria) can be used to destroy hazardous contaminants or transform them into less harmful forms. Today, only a few of the countless microbial processes that could be used in bioremediation are applied in practice. As novel biotransformations become better understood at ecological, biochemical and genetic levels, new strategies will become available for bioremediation. A recent example is microbial dechlorination of polychlorinated biphenyls (PCBs), compounds once thought to be undegradable. Anaerobic microbes in the sediments can transform highly chlorinated PCBs to lightly chlorinated PCBs, which can be degraded completely by aerobic microbes.

Bioremediation after the Exxon Valdez oil spill disaster in 1989

1 Student A: use these prompts to ask questions about the reading passage. Student B: answer the questions. Then give an oral report describing how environmental pollution can be reduced using bioremediation.

1. What / bioremediation / be?
2. What organisms / in bioremediation / be used?
3. What / the function of microorganisms in waste water treatment / be?
4. What / nitrates in water / derive from?
5. What methods / to remove pollutants from air and waste gases / be used?
6. What / the usual *in situ* land treatment techniques / be?
7. What / phytoremediation and what / be / be used for?
8. What methods / to treat bio-wastes / can be used

2 Many words in this Unit are made with the prefix '*bio*', which means *life*. Choose from the following the words which complete the definitions when joined with '*bio*':

augmentation • conversion • film • filter • gas • plastics • reactor • remediation • stimulation • wastes

1. Bio ..... is the use of living things to break down or remove toxins and harmful substances from soil and water.
2. Bio ..... is the addition of selected microorganisms to digest contaminants.
3. Bio ..... is the addition of nutrients to stimulate the growth of microorganisms that favour degradation.
4. Bio ..... is a mixture of carbon dioxide and methane produced by the biological breakdown of organic matter.
5. Bio ....., made from renewable materials, are a 'green' alternative to traditional plastics.
6. Bio..... are the biodegradable parts of municipal, agricultural and industrial wastes.
7. A bio..... is a thin layer of microorganisms that form on and coat various surfaces.
8. A bio ..... is a bed of organic matter that removes air pollutants as waste air passes through.
9. A bio ..... is used for growing microorganisms for the bioconversion of organic waste.
10. Bio ..... is the transformation of organic materials into usable products or energy sources by biological processes or agents.

3 Listen to *Biotechnological agents* and fill in the missing words.

A few (1) ..... have the ability to degrade some of the most (2) ..... chemicals. They are of particular interest in a ggod deal of environmental technologies, such as activated (3) ..... or biofilm in wastewater (4) ..... Biotechnological agents include (5) ..... microorganisms, and (6) ..... microorganisms. Prokaryotes are the most active organisms in the (7) ..... of organic matter and are used in all areas of (8) ..... biotechnology. (9) ..... assimilate organic substances. They are used in solid (10) ..... treatment, especially in soil (11) .....Fungal biomass can also be used as an adsorbent of (12) ..... metals. (13) .....assimilate light energy and are used in environmental biotechnology for the removal of organic matter and (14) ..... from water exposed to light. (15) ..... play an important role in the treatment of hazardous (16) .....solid, liquid and gas wastes by grazing on bacterial cells. Bioremediation using (17) ..... is used to remove metals from contaminated soils and groundwater. Certain plants have also been found to absorb toxic (18) ..... from polluted soils and water.