Cleaning up environmental pollution

In many countries, urbanization, agriculture, manufacturing, military activity and mining have led to environmental pollution.

Types of Pollutants

Some pollutants, such as pesticides or fertilizers, are used to benefit agriculture and enter the environment intentionally. Others, such as solvents, are toxic by-products of industrial processes that yield medicines or other products for which there is consumer demand. Some pollutants can be a problem if they are present in high concentrations (e.g. after a factory discharge or accidental industrial spillage), while other (e.g. dioxin) are dangerous even at very low concentrations in the environment.

Waste disposal or bioremediation?

Until recently, disposal of waste in the environment, rather than trying to treat it or recover it, was the common answer to the by-products of consumer activity. Newer, environmentally friendly, waste-minimization, remediation (clean-up) and restoration strategies can be based on physical, chemical or biological approaches. Biological remediation (bioremediation) makes use of the living processes of microorganisms or plants. Such systems can be used to clean up ground water, contaminated soils, sludge and industrial waste streams. A very large-scale application of bioremediation was the 70-mile shoreline clean-up after the oil spill in Prince William Sound in Alaska in 1989.

The above Fig1: Recently planted 'phytoremediation' beds to clean up airport runoff, Stockton, UK. Rainwater running off airport runways will be contaminated with a wide variety of toxic organic chemicals from aircraft fuel, and lubricants. The microorganisms that live in the 'rhizosphere' ,around the roots of plants, in phytoremediation beds have a sometimes surprising ability to grow on and convert such chemicals into harmless, or less harmful substances

Helpful microorganisms

Microorganisms can be used for microbial bioremediation. Nutrients can be added to the contaminated soil or water to encourage the growth of microorganisms that are already present. Alternatively, microorganisms that are known to be able to degrade the pollutant can be added to the contaminated soil or water, or the contaminant can be flushed out of the soil into large tanks, where it can be treated with added

microorganisms.

These techniques are used in most sewage plants for treating wastewater to remove nitrogen waste (from sewage and nitrogenous fertilizers). Contaminated water and soil are also treated to remove industrial organic compounds (e.g. solvents, oil). Microorganisms have also been used to remove or immobilize toxic industrial by-products such as heavy metals or radionuclides

Phytoremediation and the rhizosphere microorganisms

Plants can also help to clean up the environment: this is known as phytoremediation. The roots of some plants have the capacity to take up vast amounts of heavy metals. This ability can be used to decontaminate soil, at the same time as 'mining' it for such metals (the metals can be recovered in concentrated form from the plant roots). Some plants have extensive 'communities' ofmicroorganisms that live close to the roots (rhizosphere) and live on nutrients that are released by the roots. These rhizosphere microorganisms can be used to remediate toxic waste organic compounds and metals; wetlands and reed-beds have been planted to clean up wastewater and sewage. Biotechnology is also being used to enhance the ability of these rhizosphere bacteria to provide nutrients, and natural fertilizer by nitrogen fixation, to plants. This will further reduce the need for synthetic fertilizer application

The above Fig Agricultural effluent is often particularly high in nitrogenous wastes from animal manure nitrate fertilizer in water runoff from fields. High levels of such wastes can cause serious pollution of drinking water and upsetting the ecological balance of rivers and lakes. Reed beds can reduce the levels of nitrogenous wastes, and clean the water before it enter waterways.

Designer microorganisms for new pollutants

Changes in industrial practice mean that more chemicals that are not readily broken down by microorganisms are being produced and released into the environment. These chemicals are often man-made (Synthetic). Biotechnology can help deal with these potential pollutants. Techniques can be used to select for natural mutations in the genes of microorganisms that allow them to grow on such 'recalcitrant' chemicals. Genetic engineering techniques can also be used to design microorganisms that have new abilities to break down (metabolize) these

compounds.

(Courtesty: article published in http://www.jic.bbsrc.ac.uk/exhibitions/bio-future/cleaner.htm)