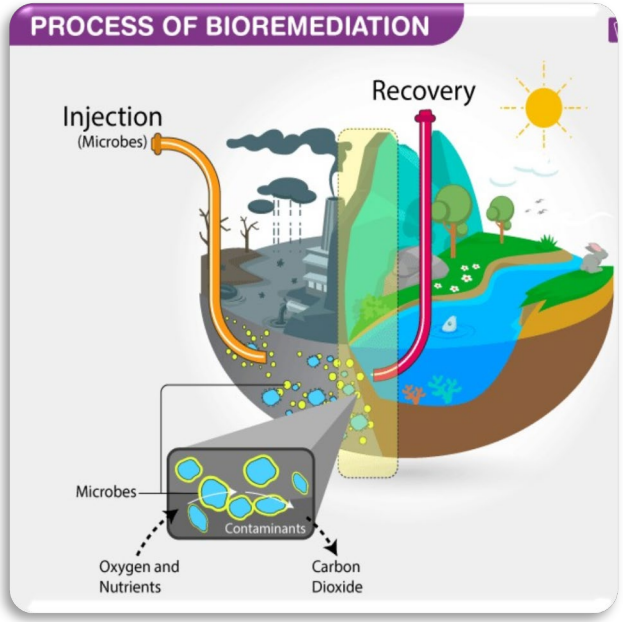
# Mustansiriyah University
# College of Science
# Biology department \ Microbiology

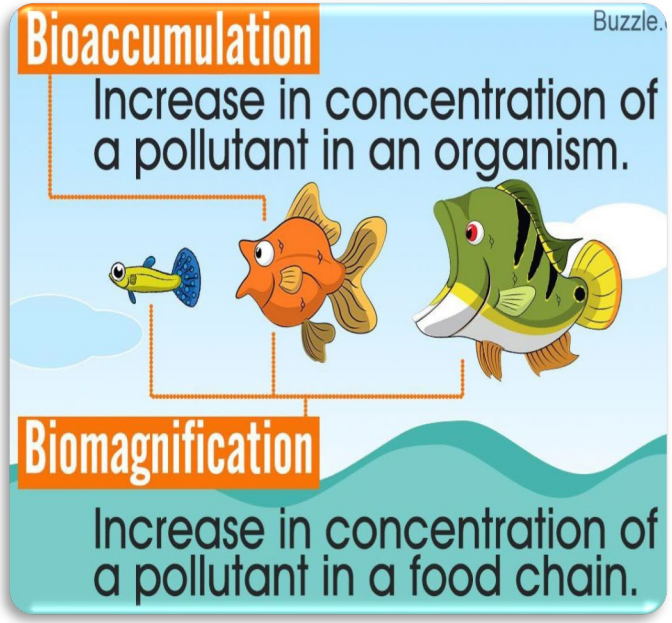
## Bioremediation




## Lecture One

## By

## Dr. Zaid Shaker Naji



**Bioremediation:** the use of either naturally occurring or deliberately introduced microorganisms to consume and break down environmental pollutants, in order to clean a polluted site. The main organisms in bioremediation is bacteria and fungi which have the ability to degrade hydrocarbons such as oil , coal tar, and xenobiotic such as pesticides.

**Xenobiotics:** is a chemical substance found within an organism that is not naturally produced or expected to be present within the organism. It can also cover substances that are present in much higher concentrations than are usual. Natural compounds can also become xenobiotics if they are taken up by another organism, such as the uptake of natural human hormones by fish found downstream of sewage treatment plant outfalls. Xenobiotics may be grouped as carcinogens, drugs, environmental pollutants, food additives, hydrocarbons, and pesticides.

The Bioremediation processes used mixed populations of microorganisms with complex dynamics. This process depends greatly on the pollution quantity and is affected by other factors such as the presence of toxic agents, temperature, presence of nutrient, bioavailability of the compounds, and oxygen limitation. One of the most important pollutants that bioremediation process could control on it is sulfur and nitrous oxide.

**Sulfur dioxide** is a gas composed of one sulfur atom and two oxygen atoms (SO2) in each molecule. The largest source of SO2 in the atmosphere is the burning of fossil fuel that contains sulfur, such as coal or oil, in power station and other industrial facilities. Other sources of SO2 emissions include industrial processes such as extracting metal from ore, natural sources such as volcanoes, and locomotives, ships, and other vehicles and equipment that burn fuel that contains sulfur.


**Nitrous oxide** emissions gets produced by both natural and human sources. Important natural sources include soils under natural vegetation and the oceans. Natural sources create 62% of total emissions. Important human sources come from agriculture, fossil fuel and industrial processes. Human-related sources are responsible for 38% of total emissions.

Legislations now seeks to reduce the levels of sulfur and nitrous oxide emissions from power stations. A Number of approaches have been made to reduce these:

- Burn less Fossil fuel, switch to gas or other energy sources.
- Use into sulfur coal or reduce the sulfur content by a biological process of desulphurization.
- Improve combustion.
- Flue gas desulphurization using an alkali such as limestone.
- The CO2 is known as a greenhouse gas as it traps heat radiated from the Earth, so that an increase in CO2 will cause global warming.

The contamination of soil and water with organic and inorganic pollutants is an increasing concern nowadays and that's why we need to establish new legislation to protect our environment. These pollutants include complex organic compounds, heavy metals, and natural products such as oils which are derived from industrial processing, deliberate release, and accidental release to toxic products.

There are different types of pollutants released into the environment which are considered biodegradable contaminants such as sewage, industrial waste, and agricultural waste. The contaminants can come from industrial effluents, deposition from flue and exhaust gases, old industrial sites and disused mines runoff from waste tips and landfills, excess application of herbicides and pesticides, and accidental spills.

When the air is heavily polluted and these pollutants will deposition later in the soil by the action of rain and this may cause contamination for a wide range of areas but likely the concentration of these contaminants may be very low. Air pollutants deposition from heavy metals contributes to the high proportion of pollutants that are accumulated in the soil. ultimately, all the heavy metals pollutants have their negative effect on microbial organism's activity and this will affect directly soil fertility.

If the pollutants or (heavy metals) are water-soluble they may dissolve in rivers, lakes, or groundwater. This will mean that these compounds will be freely mobile through the soil and might contaminate the water table at the end. The microbial population may have the ability to degrade some pollutants because water-soluble compounds are more accessible. If the pollutants are insoluble (hydrophobic) it will be much more difficult to metabolize them via microorganisms although, some pollutants could be easily dissolved in living organisms and might become part of the food chain for others.

Heavy metals are special case as they cannot be biodegraded easily, but heavy metals could be absorbed by some specialized microorganisms resulting in lowering their concentration in the environment.

Complex organic compounds that are released into the environment are known as xenobiotics for example DDT. **Dichlorodiphenyltrichloroethane (DDT)** is an insecticide used in agriculture. The United States banned the use of DDT in 1972. Some countries outside the United States still use DDT to control of mosquitoes that spread malaria , and the herbicide linden but not to petrochemicals as these are the products of living material laid down millions of years ago and are not considered xenobiotics.

**Q\ Can we classify petrochemical as one of xenobiotics compounds?**

**Mineralization:**

Mineralization in soil science is the decomposition (i.e., oxidation) of the chemical compounds in organic matter, by which the nutrients in those compounds are released in soluble inorganic forms that may be available to plants. **Mineralization** is the opposite of **immobilization.**

Mineralization increases the bioavailability of the nutrients that were in the decomposing organic compounds, most notably, because of their quantities, nitrogen, phosphorus, and sulfur. Whether the decomposition of an organic compound will result in mineralization or immobilization is dependent on its concentration proportionate to that of the carbon in the organic matter. If the concentration of a specific element exceeds the needs of the decomposer for biosynthesis or storage, then it will mineralize.

**Watch this link below: for more information**

https://youtu.be/HshlgDyY0Do

## What are the non-degradable organic compounds?

Recalcitrant compounds are not degraded under any conditions.

**Bioaccumulation:** is the increase in a compound in an organism compared with the level found in the environment.

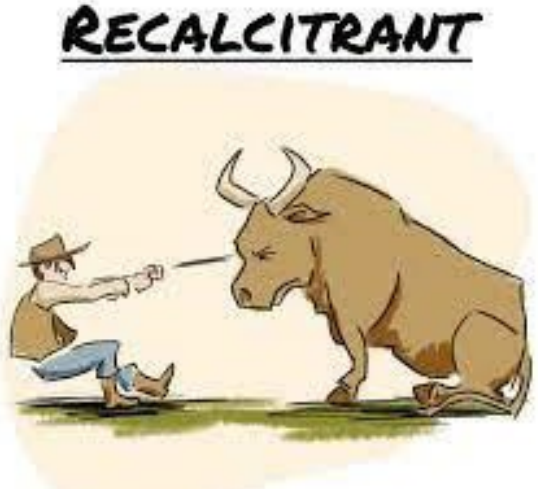
**Biomagnification:** is the increase in a pollutant in tissues of Successive organisms of a food chain.

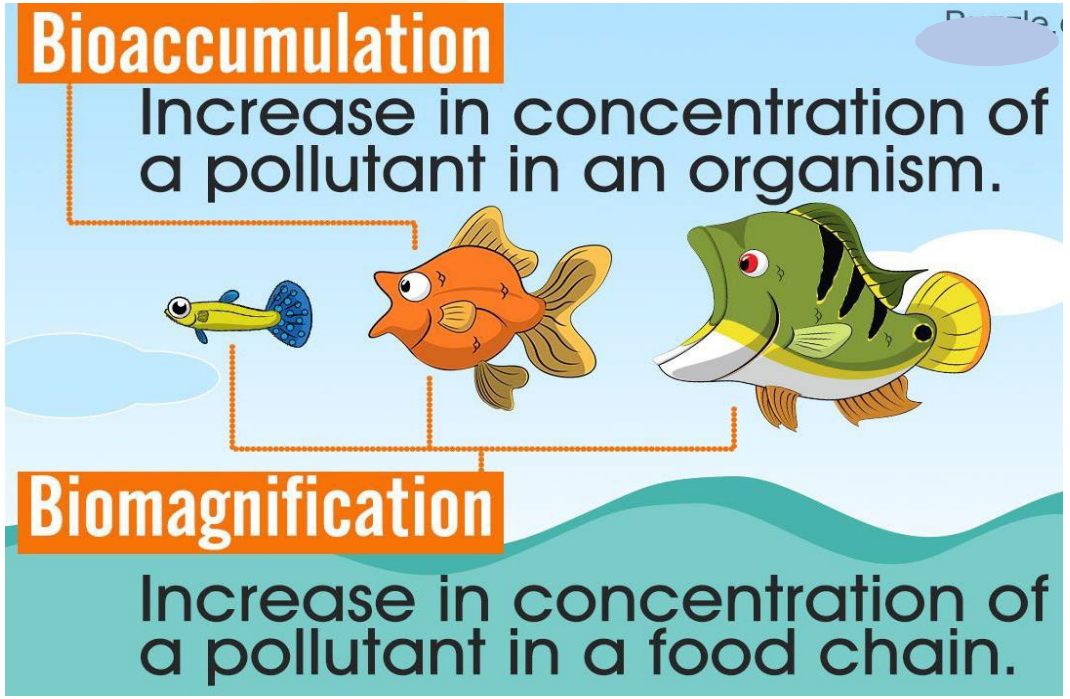
**Examples of bioaccumulation and biomagnification include:**

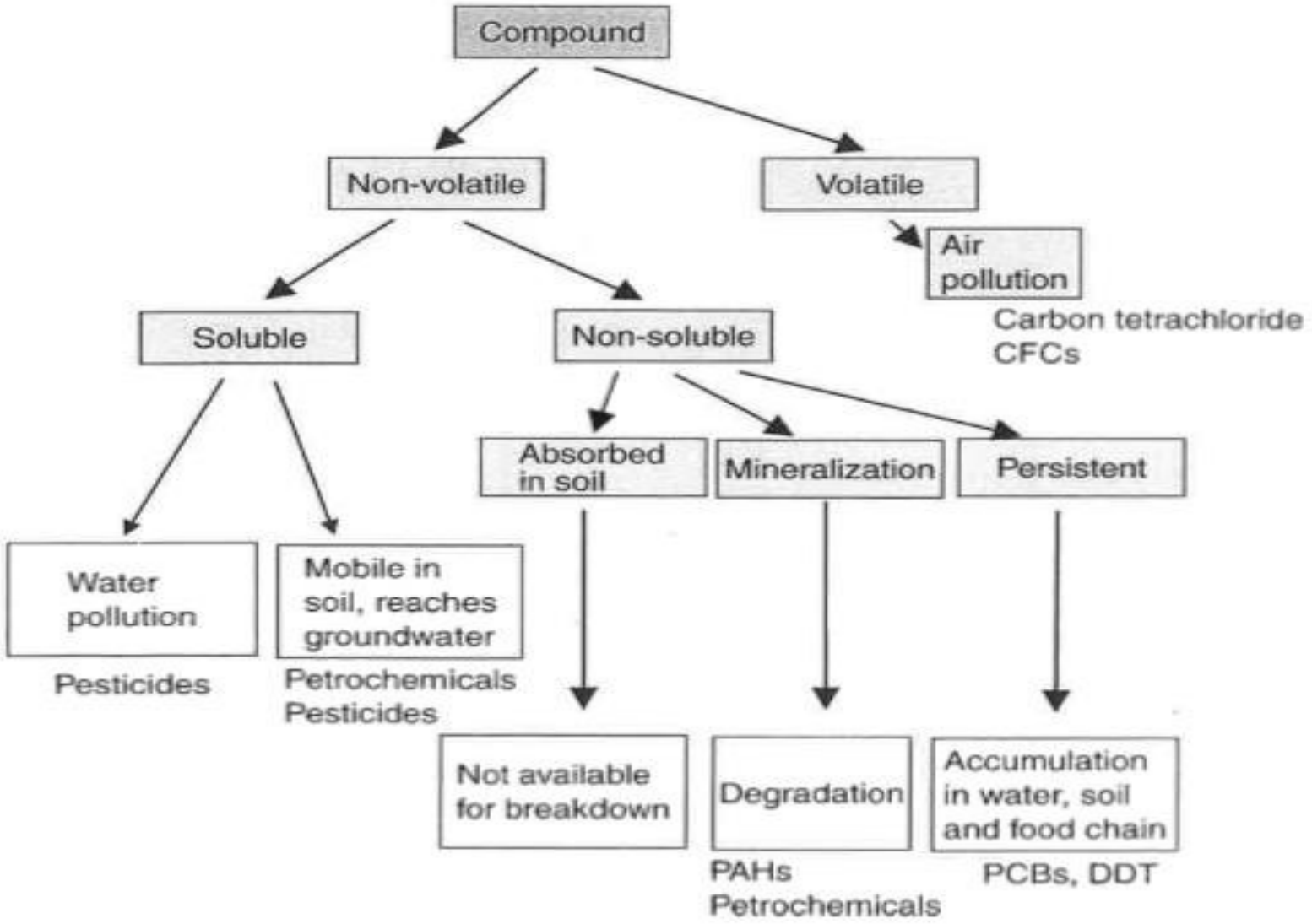
*Car emission chemicals building up in birds and other animals.

*Mercury building up in fish.

*Pesticides building up in small animals.



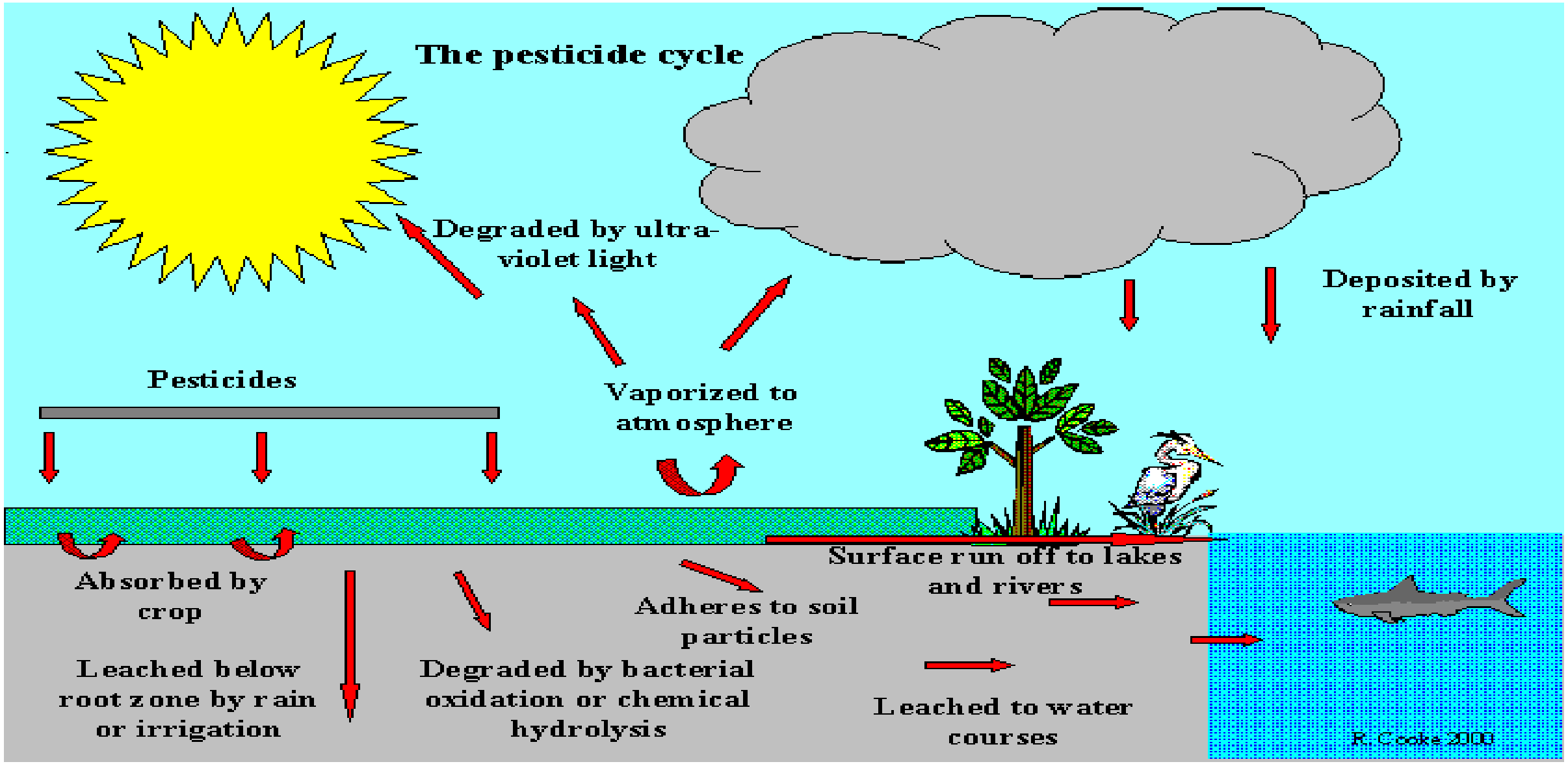






An outline of the fate of a compound released into the environment, which depends on its volatility and solubility. CFC, chlorofluorocarbon; PAH, polyaromatic hydrocarbon; PCB, polychlorinated biphenyl; DDT, 1,1,1-trichloro-2,2-*bis*(4-chlorophenyl)ethane.

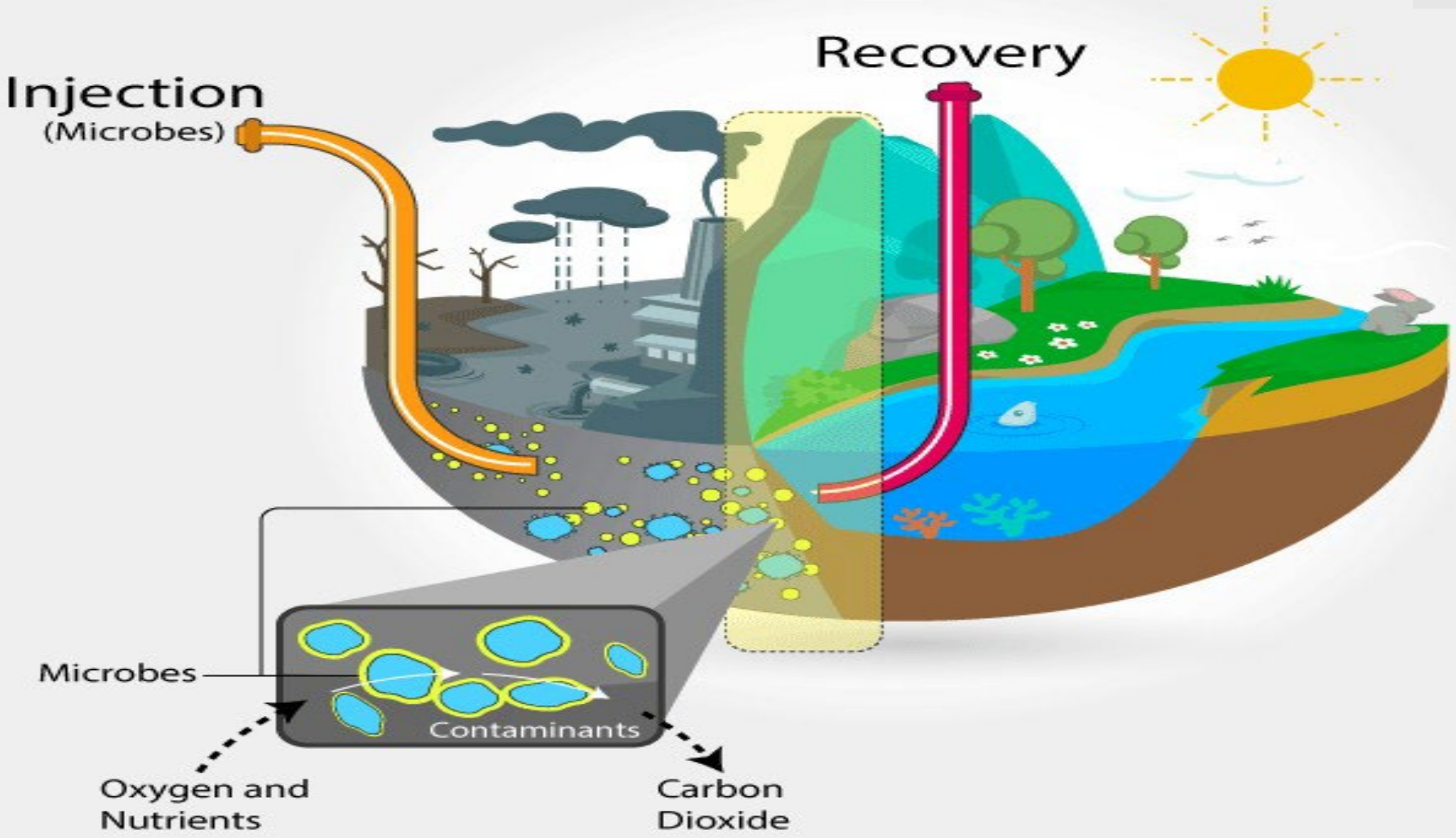
# Table 1: Some of chemicals and metals that can contaminate the environment

| pollutant | Maximum contaminated level (MCL; mg/l) | Health hazard | source |
|---|---|---|---|
| **benzene** | 0.005 | Anaemia, increased risk of cancer | Factories, gas storage and landfill |
| **chlordane** | 0.002 | Liver or nervous problems, increased risk of cancer | Residue from banned termiticide |
| **lindane** | 0.0002 | Kidney and stomach problems | insecticide |
| **Toluene** | 1 | Nervous system, liver, kidney | Petroleum factories |
| **xylenes** | 10 | Damage to nervous system | Petroleum and chemical factories |
| **dioxin** | 0.00000003 | risk of cancer,<br>reproduction problems | Emission from waste incineration and other combustion |
| **chlorine** | 4 | Eye/nose irritation Anaemia, stomach discomfort | Water additive to control microbes |
| **cadmium** | 0.005 | Kidney damage | Corrosion of galvanized pipes, natural deposits |
| **Nitrate and Nitrite** | 10<br>1 | Infant below 6 months old blue baby syndrome | Fertilizer, run-off,<br>Leaching from septic tanks, sewage system, Natural deposits |
| **Selenium** | 0.05 | Hair/fingernail loss, circulatory problems | Petroleum, refineries, mines, Natural deposits |
| **Mercury** | 0.002 | Kidney damage | Natural deposits, refineries, run-off from landfills and crops |




**DDT and pesticide**

# PROCESS OF BIOREMEDIATION



# The Lecture is over

Thank you